IODP Expedition 395: Reykjanes Mantle Convection and Climate

Week 6 Report (16–22 July 2023)

Operations

Week 6 of IODP Expedition 395 began while coring at Hole U1602E (61°11.7150′N, 38°10.7961′W; 2709.2 m water depth). Cores U1602E-41R to 88R were recovered from 907.8 to 1365.2 meters below seafloor (mbsf). Due to expedition time constraints, coring at Hole U1602E was terminated following the recovery of Core 88R and the rig floor began to prepare for downhole wireline logging operations.

In total, 87 cores were collected using the rotary core barrel (RCB) from Hole U1602E over an 835.9 m interval with 54% core recovery (450.39 m of sediment). The final depth of Hole U1602E is 1365.2 m, to our knowledge making it the 12th deepest hole drilled by the *JOIDES Resolution*, and the second deepest hole drilled with a single bit.

After releasing the RCB bit at the bottom of the hole, the drill pipe was pulled up to 77.8 mbsf. The triple combo logging tool string was made up. The triple combo measures porosity, natural gamma radiation (NGR), magnetic susceptibility (MS), density, and resistivity. The tools were run to a maximum depth of 1270 mbsf, at which point the tool string was unable to descend farther into the hole. The calipers were opened for the first pass up the hole and the tool string immediately became stuck. The calipers were closed but the tool remained trapped in the hole. After attempting to free the tool for over an hour, the wireline cable was cut at the surface and connected to the core winch line to pull on the line with more force. The tool string was briefly freed and ascended 160 m before becoming stuck again. The decision was made to run the drill pipe back down the hole and to move the drill pipe over and around the stuck tool string. The week ended with the end of the pipe at 334.3 mbsf.

Science Results

Sedimentology

Cores U1602E-37R to U1602E-88R (868.90–1357.99 mbsf) were described. The sediments in these cores have various colors grading within each section and there is no predominant color. Lithologies include silty claystone, sandstone, siltstone, and mudstone. Nannofossil preservation is good in silty claystone and sandstone deposits, while nannofossils are mostly absent in the mudstone intervals. The sediment lithology changes to chalk and silt with nannofossils from Core 52R (1014.20 mbsf) to Core 69R (1184.58 mbsf). A wide variety of sedimentary structures are observed, including laminations, soft sediment deformation, rip-up clasts, mud drapes, cross-bedding, and graded beds. These features are particularly common in Cores 37R, 43R, 45R–47R, 56R, 58R, 61R–63R, 69R, and 72R. Herringbone cross-bedding is present in intervals in Cores

55R–59R. Fractures with slickensides and calcite precipitation on their slip surfaces are present beginning in Core 48R and continuing to the bottom of the hole. Quartz, feldspar, glass, glauconite, pyrite, and opaque grains are commonly observed lithic grains. Bioturbation ranges from absent to abundant and burrows are filled with sand, glauconite, and pyrite. Coring disturbance ranges from absent to severely fragmented.

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 90 samples spanning ~450 m of Oligocene to Miocene age sediment recovered from Hole U1602E. Samples from the working half-core sections were selected to further refine calcareous nannofossil biohorizons, or when core catcher samples had very few nannofossils. Calcareous nannofossils were recovered in moderate abundance and demonstrated moderate to poor preservation; however, nannofossil samples with low abundance and good preservation are recovered from unlaminated, greenish, silty fine sand lithologies. The sediment and rocks are very difficult to prepare for planktonic foraminifer analysis; therefore, most of the core catcher samples were placed in the freeze dryer and will be processed in the following days. Several late Miocene to early Oligocene marker species were identified from the calcareous nannofossils and foraminifers, providing relatively good biostratigraphic control and evidence for a significant reduction in the sedimentation rates in the lower part of the hole (below ~1000 mbsf). These biohorizons will be further refined during the next week, when more planktonic foraminifer data become available.

Physical Properties

Whole-round, half-round, and discrete physical properties measurements were conducted for all cores in Hole U1602E. Core recovery throughout Hole U1602E is variable, but the cores for which recovery is high show cyclical variability of physical properties such as NGR and MS. In Hole U1602E, MS values become considerably higher downhole, with values routinely higher than 2000 IU below 1050 mbsf. Between 1220 and 1300 mbsf, the minimum values of MS tend to be higher than in the rest of the hole. The NGR mean value decreases from ~30 counts/s above 1050 mbsf to ~20 counts/s below this depth. There is also a shift to a slightly higher gamma ray attenuation (GRA) density below 1050 mbsf.

Paleomagnetism

We measured the natural remanent magnetization (NRM) of archive half-core sections from Cores U1602E-31R to 88R. An alternating field (AF) demagnetization was performed at 10, 15,

20, and 25 mT, with measurement of the remaining NRM being taken after each step. From Section 52R-4A downhole, we used an additional step at 30 mT. From Core 74R to the base of the hole, a step at 5 mT was added and the 25 mT step was removed. Overall, >250 m of core was measured on the superconducting rock magnetometer (SRM) this week.

The NRM intensity measured on the archive half sections from Hole U1602E 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 inclinations from the NRM remaining at 20, 25, or 30 mT demagnetization were used to identify magnetic reversals. At Hole U1602E we can match the observed reversals with the geomagnetic polarity timescale (GPTS) until the C5n.1n event around 11 Ma.

Numerous discrete oriented samples from Hole U1602E were collected. For each sample we measured the anisotropy of magnetic susceptibility (AMS) using the MFK2 KappaBridge unit. After AMS measurements, all samples were measured for NRM 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 suggested by the SRM inclination values.

Geochemistry

Geochemical analyses continued with Cores U1602E-40R to 88R. Sampling was completed for headspace gas and sediment chemistry on cores that had a recovered length >0.55 m. Interstitial water (IW) sampling was completed at a resolution of one sample per 10 m from whole-round core samples from Cores 40R, 47R, and 48R, although the amount of water collected did not allow for a complete set of analyses. An IW sample was collected from Core 50R, but no water could be extracted. 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 $CaCO_3$. Discrete samples for bulk elemental and mineralogical composition were also selected from the IW squeeze cakes for X-ray diffraction (XRD) analyses. Microbiology samples were subsampled from the IW samples from Cores 40R, 47R, and 48R, and from discrete whole-round samples from Cores 41R–46R and 49R–88R. These samples were processed shipboard for postexpedition analyses.

Downhole Logging

Downhole logging operations started on 22 July, with the use of the triple combo logging tool string. This tool string includes sensors to collect the natural (spectral) gamma radiation of the formation, electrical resistivity, and MS, as well as density and porosity, which are only collected during the uplog of the tool string. Unfortunately, the data collection needed to be terminated

~100 m above the bottom of the hole. The data collected above this interval showed cyclic patterns in the MS and NGR, which potentially mirror the physical properties data collected for the cores on the track systems. The data have been sent onshore to the Lamont-Doherty Earth Observatory Borehole Group for initial processing and quality control and will be available to the downhole logging team at the beginning of the next week.

Outreach

This week the Outreach Officer (OO) continued to create social media posts and blogs. In addition to coordinating a live televised interview with the Expedition Project Manager (EPM), time was spent scheduling and executing both test Zoom meetings and ship-to-shore events. The OO worked with the captain to create a blog on the dynamic positioning (DP) system and continues to work with the IODP staff and Siem Offshore crew to create interesting and educational content for both the blog and social media accounts.

Social Media

- Twitter: There were 43 posts with 104,000 impressions and 88 new followers.
- Facebook: There were 15 posts and two stories with 13,388 impressions and seven new followers.
- Instagram: There were 10 reels and three stories with 3,250 impressions and 13 new followers.
- YouTube: The latest video posting has 800 new views.

Ship-to-Shore Broadcasts

Three ship-to-shore events took place:

- Introduction to School of Rock.
- UK-IODP Conference: An after-lunch session at the conference that included a tour of the ship and a Q&A with all of the UK scientists.
- Hastings Museum (Nebraska, USA).

One live interview is posted online.

One open house had people from more than seven countries.

Expedition Log (blog posts)

One post about the *JOIDES Resolution*'s DP System.

Feedback

From the open house: “Thank you. Uplifting and inspiring.”

From the Hastings Museum: “Thank you!!! Last night was fantastic! I thought it went really well and the quality was comparable to other videos chats we have done, which is amazing considering where you are.”

Technical Support and Health, Safety, and Environment Activities

Laboratory Activities

- The IODP staff received and processed cores and samples from Hole U1602E.
- Special Task Multisensor Logger (STMSL): The offsets of the MS and GRA density were swapped. This is the second time this issue has appeared. The problem was fixed by closing and restarting IMS. Attempts at troubleshooting have not reproduced the error.
- The SEM was adjusted for better focus.
- The SRM degausser continued to degauss after the user aborted the run. This caused the degausser to heat up and trigger the alarm. We are continuing to monitor the SRM.
- Several platinum crucibles (for bead making) were found in poor condition. We inventoried nine usable crucibles and rebuffed 10 crucibles. The five crucibles that are in the worst shape will be sent to shore to be recast.
- The spare Cahn balance was found to be out of calibration and will be sent to shore for repair. A functioning spare balance will be sent to the ship. We will keep the internal serial cable of the shipboard spare balance for use with the new balance.
- Two titanium IW squeezers were found with misaligned base plate nipples and holes. We requested assistance from ship mechanics, and they were able to finely polish the plates and adjusted the alignment. We will test the seal at the upcoming site.
- Reviewing an acidification method for XRD samples requested by scientists.

Developer Activities

- We deployed Cahn and Coulometer application updates from the test server to testing environments.
- NGR logger and X-Ray Linescan Logger (XSCAN): We added process monitoring to examine reports where memory leaks are causing applications to crash under full-time usage.
- LIVE: We enabled XSCAN sample information (sample type and name) and data (e.g., display flag) to be placed on panels in LIVE.
- iRIS: We are assisting the developers on shore with programming, building, deploying, and committing the new rig instrumentation software.

- Small modifications were made in the LIMS database to either remove test data or tests entered in error.

HSE Activities

- Emergency shower and eye wash stations were tested.
- A lifeboat drill was held on 16 July.