IODP Expedition 401: Mediterranean–Atlantic Gateway Exchange

Week 2 Report (17–23 December 2023)

During Week 2, we arrived at Site U1609 (proposed Site ALM-03B), the first site of the expedition, and completed coring and logging operations in Hole U1609A. Several individuals tested positive for COVID-19. Following a five-day quarantine, they were able to continue work. There are currently no cases of COVID-19 on the ship.

Operations

At 1655 h on 17 December 2023, the ship completed the final 204 nmi of the 1202 nmi voyage to Site U1609 (proposed Site ALM-03B). The total transit, including pilotage in Amsterdam, covered 1220 nmi in 106.9 h, for an average speed of 11.4 kt. The seafloor was found at 1651.5 meters below sea level (mbsl), based on precision depth recorder (PDR) readings. This was deeper than the expected depth of 1627 mbsl. Operations started on the rig floor with assembly of the bottom-hole assembly (BHA). For Site U1609A we used a polycrystalline diamond compact (PDC) drill bit, and for the extended core barrel (XCB) cores we used a PDC cutting shoe. This combination had been found on recent IODP expeditions, including during Expedition 397 in the same area, to yield very good recovery of XCB cores. At 2130 h, the BHA was complete and we started adding drill pipe to lower the bit down through the water column. When the bit reached 1642.4 mbsl, the top drive was picked up and a “pig” was pumped down the drill pipe to clean out any debris from the inside. The first attempt to start the hole, from 1647.4 mbsl, resulted in an empty advanced piston corer (APC) core barrel, so we lowered the bit by 5 m.

At 0430 h on 18 December, we were successful in starting Hole U1609A (37°22.6259′N, 9°35.9120′W), with the seafloor calculated at 1659.5 mbsl based on the core recovery and mudline depth in Core U1609A-1H. We continued APC coring and Cores U1609A-1H to 25H penetrated from the seafloor to 224.7 meters below seafloor (mbsf) and recovered 224.7 m (85%). The advanced piston corer temperature (APCT-3) tool temperature measurements were made during Cores 4H, 7H, 10H, and 13H, all with valid results. Over Cores 23H to 25H, the clay-rich sediment became too hard for the full-length APC, so at 0300 h on 19 December we switched to the half-length APC (HLAPC). Cores U1609A-26F to 37F penetrated from 224.7 to 269.7 mbsf and recovered 45 m (102%). During piston coring it was noted the formation appeared to be stiff in sections, with only partial strokes. The formation was also “sticky,” with the driller having to pull almost the entire length of the core barrel free after firing.

At 1430 h, at 269.7 mbsf, we changed to XCB coring. Cores U1609A-38X to 73X penetrated from 269.7 to 610.0 mbsf and recovered 340.3 m (99%). Over the course of the hole, the driller pumped 30 bbl sepiolite mud sweeps at 274.7, 329.0, 386.9, 426.0, 445.0, 493.0, 532.0, and 571.0 mbsf.

The operational objective for Site U1609 was to recover Messinian and late Tortonian stratigraphy down to 8 Ma and to run a suite of downhole logging tools to cover any coring gaps. Preliminary biostratigraphic results indicated that we had reached the early part of the Tortonian in Core U1609A-68X. We took five more cores to ensure the age target was met and to deepen the hole so that all the downhole logging tools in the ~33 m long tool strings could log the entire target interval. The last core, Core 73X, reached 610.0 mbsf and came on deck at 2015 h on 22 December. We prepared the hole for downhole logging by sweeping it with 30 bbl of sepiolite mud to flush out any loose sediment and then displacing it with 230 bbl of barite-weighted mud to stabilize the borehole walls. The end of the pipe was set at 56.4 mbsf for logging. The triple combo downhole logging tool string was assembled by 0130 h on 23 December, but before it could be run down the pipe, the wireline heave compensator (WHC) control computer was found to be unresponsive. After troubleshooting diagnosed a probable hard drive failure, we decided to log without heave compensation. Ship heave was around 2.5 m throughout the day—higher than desirable but not atypical for logging from the ship. The triple combo logged borehole physical property data down to within 5 m of the bottom of the hole and was back on deck by 0900 h. The second tool string, the Versatile Seismic Imager (VSI), was assembled. A minor delay involved identifying and attaching the go-devil onto the VSI string. (This go-devil is used to open the lockable float valve [LFV] when exiting the pipe and to close it again on the way back up.) Concurrently, we slow-started the air guns and observed for protected marine species, ready for the check shot survey. The VSI tool string was lowered into the hole. Only four of the 13 check shot stations gave reliable first-arrival times, but fortunately those four stations were in the lower part of the hole where the data are most useful for tying borehole depth to the seismic profiles. The borehole width exceeded 15 inch at the other stations, so good coupling of the tool’s geophone to the borehole wall was very difficult. Because of the wide borehole and the lack of heave compensation, we decided not to run the Formation MicroScanner (FMS) tool and to run instead with a sonic velocity and natural gamma radiation (NGR) tool string as the third and final logging run. This tool string ran to near the base of the hole. The logging equipment was rigged down by 2230 h on 23 December. We raised the pipe and the bit cleared the seafloor at 2235 h, ending Hole U1609A. At the end of the week, the drill crew began a routine cut and slip of the drilling line in preparation for Hole U1609B.

COVID-19

At the start of the week, nine shipboard personnel were in quarantine cabins. Three *JOIDES Resolution* Science Operator (JRSO) staff and three crewmembers who had previously tested positive for COVID-19 on or before the first full day aboard (12 December) were released from their quarantine cabins at 0600 h on 17 December. Three additional crewmembers remained in quarantine.

- On 17 December, four days from leaving port, all shipboard personnel were tested as part of the COVID Mitigation Protocols Established for Safe JR Operations (COPE) protocol. Testing took place at 0600 h and 1200 h to cover all work shifts. Nine individuals tested positive, and they all subsequently quarantined in cabins for five days with either one or two persons per cabin. Based on the 17 December testing results, the Expedition Project Manager (EPM) and Laboratory Officers strongly recommended that all scientists and JRSO staff wear masks in indoor public areas of the ship and to minimize time in the mess hall to minimize further exposure to, and transmission of, the COVID-19 virus. Scientists and staff observed the mask recommendation.
- On 18 December, one staff member tested positive. This was the last case that we know of.
- On 23 December, five days after the last positive test, the mask recommendation was lifted, apart from for those who had previously tested positive who had to continue wearing masks for a further five days after testing negative, per the COPE policy.

There was a total of 19 positive cases. None developed serious illness requiring a stay in the ship's hospital. Only one person was still in quarantine at the end of the week. It is fortunate that there were sufficient backup personnel with the relevant expertise to cover the work of those who were quarantined.

Science Results

Lithostratigraphy

Cores U1609A-1H to 65X (0–522.7 mbsf) were described and the following two lithological units were tentatively defined:

Unit 1 extends from 0 to 350 mbsf (Cores U1609A-1H to 47X). XCB coring was used from Core U1609A-38X (269.7 mbsf), resulting in extensive biscuiting of the core. This unit is composed of calcareous mud and calcareous silty mud, with dominant sediment colors of grayish olive (10Y 5/2) and grayish green (5GY 5/2). Contacts between

lithologies are gradational and are marked by subtle color changes. Calcareous nannofossils are abundant and there are occasional shell fragments and pyrite nodules. There is one horizon of greenish silty sand to very fine-grained sand that is rich in glauconite (dark greenish gray; GLEY 4/1), inferred to be a fine grained turbidite. Subtle and patchy color mottling is present throughout. Bioturbation is sparse to moderate, occasionally abundant, and trace fossils include *Chondrites*, *Planolites*, *Thalassinoides,* and *Zoophycos*. Sometimes burrows are filled with silt and very fine sand.

Unit 2 extends from 350 to 522 mbsf (Core U1609A-47X to 65X). It is composed of calcareous muds (olive gray, 5Y 5/2; and grayish green, GLEY1 5/2) and calcareous ooze (greenish gray, GLEY1 6/1). Unit 2 is similar to Unit 1, except for the occurrence of the olive gray muds and because it includes >20 horizons of silty sand (mostly dark greenish gray, GLEY1 4/1) that interrupt deposition of the calcareous muds and oozes. These are inferred to be fine-grained turbidites, and have varying proportions of quartz, feldspar, glauconite, and calcareous and siliceous biogenic particles. Bioturbation is sparse to moderate, occasionally abundant, and trace fossils are similar to those in Unit 2.

Biostratigraphy

Micropaleontologists sampled, processed, and observed 73 core catcher and 16 section half samples from Hole U1609A. This allowed the development of a robust biostratigraphic framework with 22 calcareous nannofossil and 15 planktonic foraminifer biohorizons determined for the hole, establishing the age of the sediments to be Tortonian to late Pleistocene.

There is a hiatus covering approximately the last 1 Ma in Core U1609A-1H. This hiatus was expected at the site location based on truncated reflectors in the seismic profile, and it was part of the strategy to recover the target Late Miocene sedimentary succession at relatively shallow coring depths. Microfossils are typically abundant, with preservation consistently very good. The base of the recovered section, at 610 mbsf, is estimated to be older than 11.19 Ma.

Five to ten specimens of epibenthic foraminifera, *Planulina wuellerstorfi* and/or *Cibicidoides pachyderma,* were picked from a total of 37 samples for oxygen isotope analysis immediately following the expedition.

Paleomagnetism

The paleomagnetists measured the natural remanent magnetization (NRM) of archive half-core sections from Hole U1609A. An alternating field (AF) demagnetization was performed at 5, 10, 15, and 20 mT, with measurement of the remaining NRM being

taken after each step at 5 cm spacing. The NRM intensity in Hole U1609A is very weak, ranging from about 1.4×10^{-5} to 4.0×10^{-1} A/m, with an average of 2.5×10^{-3} A/m.

Inclination values from the NRM remaining after 20 mT demagnetization were used to tentatively identify magnetic reversals. In Hole U1609A, NRM remaining below 10 mT is likely related to overprint caused by core drilling. Inclination values after 20 mT AF demagnetization roughly show polarity reversals, but with a lot of scatter between expected normal and reverse values, which may be due to dissolution of the most of the original magnetic minerals and precipitation of authigenic iron sulfides. To suppress the influence of these scattered data points, we ran a smoothing window of 1 m for the inclination values. Based on the smoothed inclinations, normal and reversed polarity intervals can be tentatively recognized, and partly based on the bistratigraphic framework, they were correlated to the geomagnetic polarity timescale (GPTS) from about 1.2 to 8.7 Ma.

In Hole U1609A, discrete oriented samples were collected and measured. For each core, three to seven discrete samples were taken. We measured the anisotropy of magnetic susceptibility (AMS) and bulk magnetic susceptibility using the MFK2 KappaBridge unit. After the AMS measurements, one to four samples from each core were subjected to AF demagnetization up to 30 mT and then measured using the JR-6A spinner magnetometer. The NRM of the samples is very weak, even down to 10×10^{-5} A/m, which is close to the background noise of JR-6A (2×10^{-5} A/m). The other two to three discrete samples will be thermally demagnetized up to 600°C, if there is enough time during the expedition.

Geochemistry

The inorganic geochemistry team measured salinity, pH, alkalinity, and concentrations of major anions and cations, ammonium and phosphate, and trace elements for 66 interstitial water (IW) samples and a mudline (bottom water) sample from Hole U1609A. IW was extracted by squeezing a 5–7 cm whole-round sample, and the squeeze cake residues were then sampled for sedimentary geochemistry. One IW sample was collected in every APC and XCB core (Cores 1H to 25H, and Cores 38X to 73X) and one every other HLAPC core (Cores 28F to 36F). Alkalinity increased from 2.4 mM at the mudline to >15 mM between 44.8–256.1 mbsf, driven primarily by sulfate reduction, and pH varied between 7.4 and 7.8. Major ion concentrations, nutrient concentrations, and alkalinity reflect a variety of subsurface diagenetic processes including sulfate reduction, carbonate mineral precipitation and dissolution, organic matter remineralization, and water uptake into clay minerals. The sulfate–methane transition zone occurs around Core U1609A-6H at a depth of ~45 mbsf.

The organic geochemistry team measured weight percent (wt%) total inorganic carbon (TIC), sedimentary carbon (TC), and total nitrogen (TN) on the squeeze cake residues from the IW sampling at Hole U1609A. Headspace gas was also measured from a discrete sample taken at the top of the core section below each of the 66 IW samples. Methane and ethane were commonly detected, while ethene and propane were detected in trace amounts in <10 samples. Methane concentrations ranged from 0–42,000 ppmv, and ethane concentrations ranged from 0–3.3 ppmv, with highest abundances between 100–300 mbsf. Calcium carbonate content ($CaCO_3$ wt%) was calculated from the TIC content assuming that all inorganic carbon is present as calcium carbonate. Total organic carbon (TOC) was determined as the difference between TC and TIC. Calcium carbonate varied between 20–75 wt%, increasing toward the bottom of Hole U1609A, while TOC and TN remained low (<1% and <0.08%, respectively) throughout.

Physical Properties and Downhole Measurements

In Hole U1609A, there are three large-scale/long-term units characterized by physical properties datasets collected on whole-round and split core track measurements as well as the color: 0–460, 460–550, and 550–610 mbsf. Small-scale/short-term cyclic variation, with a frequency of about 1–3 m per cycle, is also clearly seen throughout these properties in each unit.

The upper unit (0–460 mbsf) shows overall moderate amplitude variations of gamma ray attenuation (GRA) density, magnetic susceptibility (MS), and NGR. A notable increase of porosity and decrease of *P*-wave velocity is seen at about 270 mbsf, but this is the depth of the transition from HLAPC to XCB cores so these features may be an artifact of the coring process. According to the shipboard initial age model, the upper unit reaches the late Tortonian at about 7.6 Ma. The middle unit (460–550 mbsf) is characterized by high amplitude of GRA density, MS, and NGR. The lower unit (550–610 mbsf) exhibits low amplitude of GRA density, MS, and NGR.

Outreach

Ship-to-Shore Links

It was the expedition's first full week of ship-to-shore video connections. We did ten in total this week, including an Instagram Live with a women in science, technology, engineering, and mathematics (STEM) magazine, a recording with a children's book podcast, and a feature on The Weather Channel.

The ship-to-shore outreach events were given in four languages (Japanese, French, Spanish, and English) and reached around the world, with scientists leading the tours in languages other than English. Scientists also helped with the question-and-answer sessions at the end of the events.

One nice piece of feedback we received from an event with 112 middle school students in the United States said, “Thank you so much! That was so fun and they have not stopped talking about how much fun they had.”

Social Media

- Our top post of the week on Facebook was the pictures posted to recognize our arrival at our first site. Our top posts of the week on X, Threads, and Instagram were of the video of the first core on deck. These are both big milestones so this isn’t surprising, but a good reminder that sharing timely updates on the expedition is one of the things people are most interested in.
- The first two illustrations (pastel drawings of scientists and ship activities) by one of the Outreach Officers went up on the social media channels this week, with a new video format planned to share the next one.
- Other highlights:
    - Kellan turned her salt giant blog post into an infographic for Instagram.
    - Erin made a video about playing (virtual) pinball at sea to hopefully get some of her pinball community over to the *JOIDES Resolution* accounts.

Technical Support and HSE Activities

Laboratory Activities

- Staff processed cores from Hole U1609A.
- Core line depth was not displayed on the Drill Floor TV channel. This problem was solved by resetting Exbob.
- The X-Ray Linescan Logger (XSCAN) had communication errors and a “lifetime exceeded” error, resulting in the instrument being out of service for about 24 h. The programmer bypassed the lifetime error, and we are currently waiting for the vendor to clarify these issues. Communication errors were cleared after physically reconnecting all cables and rebooting the system and computer. The XSCAN is currently operational and scientists are scanning all archive half cores on it.
- LIVE and GEODESC temporarily went down because of a corrupted connection to the server. The programmer solved the issue by rebooting one of the servers.

- The Upper ’Tween Deck stores door Kaba combo lock failed; its keys were not responding. We disabled the lock and instead used a small cable and padlock in its place.
- We deployed the two G-gun air gun arrays for the downhole logging check shot survey and we conducted protected species observation (PSO) from 0900–1600 h on 23 December.
- Staff decorated for Christmas and prepared for the Christmas show.

IT Support Activities

- Marine Computer Specialists (MCS) assisted electronics technicians with troubleshooting and correcting problems with the core line/subsea camera/Schlumberger winch data to RigWatch/IRIS/Stream overlay displays.
- Finished applying updates to Windows and Linux servers and workstations.
- The Rig Instrumentation Laptop had a bad hard drive. Working on a replacement hard drive to swap in.
- Assisting Schlumberger with rescue and recovery for the SLB compensator control PC. Working on repairing and reconfiguring the PC.
- Fixed an issue with the Fo’c’s’le Deck hall copier always attempting to print from Tray 1.

Developer Activities

- Assisted developer onshore in troubleshooting the IRIS Report in the Rig Instrumentation System installation issue.
- Temporarily fixed XSCAN “lifetime exceeded” issue and worked with shore to arrange a long-term solution.
- Continued work on the hyperspectral image core scanning project.

HSE Activities

- Emergency shower and eye wash stations were tested.
- The last COVID quarantined personnel was released on 24 December (see above for details of the COVID outbreak).