

IODP Expedition 399: Building Blocks of Life, Atlantis Massif

Week 7 report (28 May–4 June 2023)

Operations

Hole U1601C

The week began while logging in Hole U1601C. At 0045 h on 28 May, rigging down the fourth logging tool string with the Formation MicroScanner (FMS) and Dipole Shear Sonic Imager (DSI) tool was complete. We still had the Versatile Seismic Imager tool (VSI) to run as the postponed fifth and final logging tool string. However, this required daylight, so we proceeded with borehole water sampling objectives instead. The plan was to deploy both Kuster Flow Through Samplers (FTS) in series, with the Elevated Temperature Borehole Sensor (ETBS) at the bottom, using the coring line. We planned to do this three times, for a total of 6 sampling stations down the borehole. The first run started at 0205 h and ended at 0340 h. After laying out the tools, removing the water samples, and resetting the tools, the second deployment started at 0515 h and ended at 0725 h. The third deployment started at 0830 h and ended at 1225 h.

The prior issues with the VSI had been resolved and the rig was again readied for wireline logging. The protected species watch began at 1430 h and the fifth logging tool string in Hole U1601C was deployed at 1435 h. An issue with the telemetry head required retrieval of the VSI string at 1515 h and replacement of the telemetry head. The air guns were prepared and at 1640 h the tool string was redeployed to 1069 meters below seafloor (mbsf). Given the remaining daylight hours, the measurement stations on the log up were set at 100 m intervals. The run was completed at 2105 h.

We decided to conduct a fourth water sampling run because one of the samplers on a previous run only recovered ~5% of the chamber volume, and because the results from the other water samples were encouraging. The dual Kuster FTS and ETBS configuration was deployed once more at 2215 h and was back on deck at 0055 h on 29 May. We retrieved the drill string equipped with a logging bit, which cleared the rig floor at 0335 h. This ended the wireline logging and water sampling bit run 6. The borehole water sampling effort in Hole U1601C yielded a total of 8 samples at 6 targeted depths intervals (mbsf): 146, 368, 465, 675 (sampled twice with ~5% and 100% recovery, respectively), 970, and 1074–1065 mbsf (repeated at 1065 mbsf to avoid mud sampled at 1074 mbsf).

Before the next attempt to deepen Hole U1601C, we needed to clear the hole of metal debris left behind by previous coring runs, particularly the last one leaving behind a cone bearing. A bottom-hole assembly (BHA) was assembled with two junk baskets and a 9⁵/₈ inch junk mill. The drill string was lowered to the seafloor at 0430 h, filling the pipe every 15 stands from the rig. The subsea camera was launched at 0527 h and Hole U1601C was reentered for the sixth time at

0704 h on 29 May. The bit was lowered further in the hole and a hard tag was encountered at 1074 mbsf. While washing down to bottom at 1182.2 mbsf, hard spots were encountered at 1084, 1094, 1123 and 1145 mbsf. Milling, which included slowing circulation and rotating and lifting the pipe twice per hour, was carried out from 1430 h to 1945 h. The hole cleaning action ended with pumping a 30 bbl mud sweep with 2× the hole volume of seawater. At 1945 h we began retrieving the drill string, with the mill back on the rig floor at 0050 h on 30 May. The junk baskets contained several metal pieces among the rock cuttings, some clearly being parts of the lost cone bearing.

A BHA with a new C7 coring bit was assembled. At 0330 h, after rig maintenance, the drill string was deployed to the seafloor and Hole U1601C was reentered for the seventh time at 0554 h on 30 May. The drill string was lowered in the hole and encountered a bridge at 1053.6 mbsf. After washing down to bottom at 1182.2 mbsf, including a 30 bbl mud sweep, the wash core barrel was retrieved (“Ghost Core” U1601C-241G), and a new barrel was dropped. At 1445 h coring in Hole U1601C resumed with Core U1601C-242R. Coring continued until the bit had accumulated 43.8 h on bottom and we decided to end coring with Core 259R at 1267.8 mbsf on 2 June. Cores U1601C-242R through 259R recovered 53.9 m of the 85.6 m cored, with core recoveries ranging from 31% to 97% (average recovery 63%). Mud sweeps of 20 bbl were pumped every ~10 m, with a final 30 bbl mud sweep followed by pumping 7× the hole volume of seawater. The last core barrel was retrieved at 1230 h and the pipe was retrieved with the bit clearing the rig floor at 1800 h. This concluded operations in Hole U1601C.

Hole U1309D

The last operation of Expedition 399 was to take more borehole fluid samples from Hole U1309D using the Kuster FTS and then flush the hole rigorously. The ship had already moved over to Hole U1309D in dynamic positioning (DP) mode by 1612 h on 2 June, while the drill string was being retrieved from Hole U1601C. A BHA was assembled with a clean-out bit, no float valve, and an oversized landing ring (logging configuration). At 1915 h the drill string was lowered to the seafloor, the subsea camera was deployed at 2130 h, and Hole U1309D was reentered for the second time on Expedition 399 at 2317 h. At 0045 h on 3 June, the drill string was positioned at 32 mbsf. Two Kuster FTS were assembled with the ETBS and the Conductivity-Temperature-Depth (CTD) tool. The first run on the coring line was deployed at 0100 h and was back on the rig floor at 0315 h. The borehole water samples were taken at 200 mbsf and 400 mbsf. The tool string was retrieved and disassembled, the water samples and data were retrieved, and the tools were reassembled for the second run. The CTD was not included on subsequent runs because its temperature rating would have been exceeded at the deeper sampling stations. The second sampling run from 0400 h to 0645 h triggered the Kuster FTS at 550 mbsf and 736 mbsf. Ample time was available to redress the tools and conduct a third run from 0736 h to 1100 h. During this final run, the tools were not able to pass an obstruction at 1024 mbsf and the samples were taken at 923 mbsf and 1110 mbsf instead of a deeper planned station. After conclusion of the sampling runs, the drill string was tripped to

1421 mbsf and washed down to the bottom of the hole at 1498 mbsf. Next, the hole was flushed with seawater 7× the borehole volume to leave behind as clean as possible a hole for potential future water sampling and temperature measurement operations. Final retrieval of the drill string from Hole U1309D began at 1945 h on 3 June and was completed with the bit clearing the rig floor at 0324 h on 4 June. The rig was secured for transit and the vessel was underway at 0430 h, ending operations at Site U1309. By midnight on 4 June, we had completed 199 nmi of the total distance of 738 nmi to Ponta Delgada, Azores, Portugal.

On 29 May, per instruction from shore, all core splitting and sampling had to stop. Starting with Core U1601C-242R, sections cut and sampled for microbiology were capped, measured with the Whole-Round Multisensor Logger (WRMSL) and Natural Gamma Radiation Logger (NGRL), described through the core liners, and then boxed.

Scientific Results

Igneous Petrology

The Igneous Petrology team described Cores U1601C-235R to 259R, the last interval cored in Hole U1601C. The descriptions were done through plastic core liners on whole-round sections as a result of the splitting and sampling embargo, and thus should be treated as lithologic approximations. Most of these cores were gabbros, and they were entirely beneath Core 245R. The recovered gabbroic rock types were relatively homogeneous compared to shallower levels in Hole U1601C, and they were most commonly granular and medium grained. Troctolitic and other olivine-bearing gabbros continued to be rare in these cores, and gabbronorite intervals appeared to become more common. The first drafts of the Site U1601 report and the final version of the methods section for igneous petrology were completed.

Alteration Petrology

The team performed macroscopic descriptions of Cores U1601C-235R through 259R, based on observations in whole-round sections inside plastic liners. Descriptions of whole-round sections were done by taking the magnetic susceptibility (MS) and density measurements produced by the Petrophysics team into account. The dominant lithologies are slightly to moderately altered gabbro, in addition to minor oxide gabbro, and subordinate amounts of serpentized (pyroxene-bearing) peridotite. The team also examined thin sections of gabbroic rocks from Cores U1601C-211R through 258R. Petrographic observations indicate that hydrothermal alteration of primary minerals is localized. Pyroxene is altered to brown and green amphibole during high-temperature alteration, and then partially altered to chlorite or clay minerals at low-temperature conditions. Plagioclase is relatively fresh but locally replaced by secondary plagioclase, prehnite, and zeolite at low-temperature conditions. Time was spent writing site reports.

Structural Geology

Core U1601C-235R through Section 259R-3 (1153–1264 mbsf), described through the core liners, recovered thin intervals of serpentized peridotite (<5.5 m thick), cut by progressively thicker gabbroic bodies up to 70 m thick at the bottom of the hole. The deepest zone of significant mylonitic deformation (and steeply dipping foliation) was recovered in Section 234R-3 (1151 mbsf). Below this depth, thin intervals (<1.5 m) of moderately dipping (<55°) protomylonite and rare mylonite were recovered. Vein intensity through the described interval decreased with depth to the bottom of the hole barring magmatic veins with dips from 25°–75°. Thin sections were also described with focus on microstructures. Drafts and revision of site reports and methods sections for structural geology were completed. Report writing provided a few team building opportunities including witnessing both sunrise and sunset over the Atlantic at Atlantis Massif, something previously not accomplished.

Geochemistry

The processing of the 213 samples collected at Hole U1601C for shipboard geochemistry analyses was finalized. The 191 serpentized peridotite, gabbroic rock, and diabase samples selected for microbiology studies and the 22 gabbro samples selected for geochemistry were analyzed for total carbon and water content and for inorganic carbon (IC) (coulometry). Except for 50 samples, all Site U1601 samples were analyzed by inductively coupled plasma–atomic emission spectroscopy (ICP-AES) for major and minor elements. Preliminary results indicate that, in contrast to Hole U1309D, most samples, including gabbros, contain carbonate. The results are now being assessed. Samples from the Kuster FTS water sampling runs in Hole U1309D were analyzed shipboard for pH, alkalinity, salinity, ion chromatography, and volatile concentrations, and preserved for shore-based geochemistry.

Microbiology

Microbiology samples were collected from 10 of Cores U1601C-242R through 259R. Potentially contaminated exteriors of microbiology rock samples were chiseled away in a fume hood with a KOACH air purifier and an air ionizer for static dust removal. Interior zones of the samples were crushed to millimeter-scale, and the exteriors were returned to the core. The crushed interior core material was subsampled for future microbiological analyses including DNA sequencing, enumeration of microbial cells, microscope imaging, metabolic activity assays, enrichment culturing, and organic geochemistry.

Also at Hole U1601C, microbiological analyses, including enumeration of microbial cells, single-cell activity assays, and filtering for DNA sequencing were conducted again with bottom water sampled with Niskin bottles during recovery of the drill bit and after reentry of the hole. In addition, microbiological subsamples for enumeration of microbial cells and single-cell activity assays were collected from small volumes of water collected from core liners.

At Hole U1309D, samples of borehole water collected with the Kuster FTS were subsampled for microbiological analyses, including DNA sequencing, cell counts, microscope imaging, metabolic activity assays, enrichment culturing, and organic geochemistry.

The Microbiology team has been collecting and curating all records and documentation of microbiology samples, including all photographs, handwritten notes describing samples, and logs of which microbiological analyses were conducted on which samples. In addition, results from the >500 perfluorocarbon tracer (PFT) assays were organized and prepared for reporting. Initial results show that PFT was absent in nearly all interior samples of the microbiology whole-round samples, indicating that the procedure of chiseling away whole-round exteriors was largely successful in eliminating surface contamination as measured by PFT.

Petrophysics

The Physical Properties team measured the remaining whole-round sections of Cores U1601C-241R through 259R for bulk density, MS, and natural gamma radiation (NGR). Whole-round sections were not split, so no discrete samples were measured. Bulk density increases with depth in gabbro from $\sim 2.7 \text{ g/cm}^3$ at $\sim 1183 \text{ mbsf}$ to 2.9 g/cm^3 at $\sim 1266 \text{ mbsf}$. MS in gabbro is higher in the upper interval ($\sim 1180\text{--}1200 \text{ mbsf}$) indicative of Fe-Ti oxide gabbro. This is a continuation of higher proportions of Fe-Ti oxide gabbro above this interval. Below $\sim 1200 \text{ mbsf}$ the proportion of Fe-Ti oxide gabbro is very low. There is one interval of serpentinized peridotite in Core U1601C-244R ($\sim 1191 \text{ mbsf}$) that has a bulk density of $\sim 2.4 \text{ g/cm}^3$. MS of the serpentinized peridotite is higher compared to the background level of gabbro with values of $\sim 8000 \text{ IU}$. All rock types have low values of NGR ($< 2 \text{ counts/s}$). One Section, U1601C-256R-1 ($\sim 1249 \text{ mbsf}$) has elevated values ($\sim 3.5 \text{ counts/s}$).

Paleomagnetism

Measurements of natural remanent magnetization (NRM) and remanences following stepwise alternating field (AF) demagnetization were completed for archive halves of Sections U1601C-202R-2 through 234R-3 using the superconducting rock magnetometer (SRM). Initial magnetizations were progressively demagnetized up to 50 mT. For the unsplit whole-round Sections 235R-1 through 259-2R, low field demagnetizations were approved. So far half of these sections were measured using AF demagnetization from 0 to 16 mT in 2 mT steps.

AF demagnetizations of the ultramafic samples have been completed using both the SRM and an external AF demagnetizer. The final thermal demagnetization experiment of gabbroic samples was completed. For highly altered samples, it was observed that repeated measurements of the same samples yielded very different results. A case study of the thermoviscous properties was performed. It was observed that within a minute, exposing the sample to the ambient field increased the sample's intensity of remanence by an order of magnitude.

Outreach

This week, the shipboard Outreach Officer team posted on [Instagram](#), [Facebook](#), and [Twitter](#), provided ship-to-shore broadcasts, edited videos, organized video interviews, hosted interviews and tours with media outlets, and wrote posts for the expedition log.

Social Media

- The shipboard Outreach Officer team posted to Twitter with 31,276 impressions (–32%) and 4.4% engagements (–0.7%), with 96 profile visits (+2.1%).
- Facebook received 5 new photo posts and reached 261,900 accounts (+61%), engaged 122,000 (+39%) accounts and has 12,000 followers.
- Instagram received 4 new photo posts, 4 new stories, and 2 new reels, reached 3,450 accounts (–32.8%), engaged 343 accounts (–10%) and has 4,000 (+0.5%) followers. Total number of views for Instagram in week 7: 6,400.

Ship-to-Shore Broadcasts

This week we led 8 ship-to-shore broadcasts for +3 million people in 2 states (US), South Africa, China, India, and Australia.

- SEALS, University Wollongong, Australia
- IODP China, Shanghai, China
- Central University of Punjab, Punjab, India
- Nipmuc Environmental Science, Mendon, MA, USA
- Washington Post
- National Geographic

Expedition Log (blog posts)

Expedition 399 Log has 1 new blog post:

- Preparing for Departure (3 June 2023): <https://joidesresolution.org/39792-2/>

Feedback from Community

“Your Monday 9–10 show was fabulous and Sarah is very skilled at explaining what they are doing and expanding on the many implications of their research on various other scientific endeavors.” – Listener Review from 97.3 WVLKAM Radio Interview

“Though the topic discussed was something I didn’t know anything about, Sarah kept it interesting!” – Listener Review from 97.3 WVLKAM Radio Interview

“The IODP 399 voyage ‘Ship Shore Connection’ science popularization activity received a total of 3.064 million live viewers online on the Xinhua website client, with a total of 2245 offline

participants from Shanghai Pudong New Area Private Zhengda Foreign Language School, Tongji Primary School in Foshan City, Guangdong Province, and Chenzhuang Town Middle School in Fan County, Henan Province.” – IODP China

Technical Support and Health, Safety, and Environment (HSE) Activities

The technical staff is conducting end-of-expedition activities, including the preparation of samples and other outgoing shipments. We are in contact with Metizoft, which will perform the laboratory cleaning when we arrive in port.

Core Description and Imaging

- Ceased core splitting on 30 May. Cores U1601C-235R through 259R were described through the liners.
- Images of microbiology samples taken in the splitting room and later on the catwalk (shake out pictures) were processed and uploaded to Data1.

Magnetics and Physical Properties

- After core splitting ceased, ~70 whole-round sections were successfully measured on the SRM with up to 16 mT demagnetization.
- We are testing the new Aluminum inserts for the new Kimble vials to fit in the pycnometer cells. After some adjustments they worked fine. The LORE Report (LIMS) will need an extra column reporting the vial type.
- Non-usable TCON (thermal conductivity) pucks and half-pucks were tested again to verify whether the loss of communication/connection was due to the probe itself or the cable or another reason. Two probes initially discarded passed the self-test and gave good results on the MACOR standards—they can be used again but further testing is recommended.

Developer and Application Support

- Provided the Laboratory Officer with web APIs for the iRIS project.
- ImageGrabber was unable to download images. We debugged and modified the code.

iRIS

- Completed the first test run with the drill crew using the new iRIS Driller’s Worksheet program to calculate hole offsets and Kelly down values.
- Resolved several issues, including entering core records from iRIS into LIMS, and rate of penetration (ROP) and active bit depth calculations.
- The OPS user interface (UI) was completed and tested.

- Not yet completed are the auxiliary keyboard interface for the Driller's UI, iRIS general UI distribution to PCs, and Driller's Worksheet documentation and instructions.

Safety

- Held the weekly fire boat drill.
- Tested the eye wash and safety showers.