IODP Expedition 385: Guaymas Basin Tectonics and Biosphere

Week 5 Report (13–19 October 2019)

The fifth week of International Ocean Discovery Program (IODP) Expedition 385, Guaymas Basin Tectonics and Biosphere, comprised (1) RCB coring from 474 to 540 m below seafloor (mbsf) in Hole U1546C, (2) wireline logging in Hole U1546C, (3) APC/HLAPC/XCB coring to 141 mbsf in Hole U1547A, (4) APC/HLAPC/XCB coring to 210 mbsf in Hole U1547B, and (5) wireline logging in Hole U1547B. All times in this report are in ship local time (UTC – 7 h).

Operations

The week began with rotary core barrel (RCB) coring in Hole U1546C. Cores U1546C-29R to 42R penetrated from 473.6 to 540.2 mbsf. Coring was terminated for safety reasons at a final depth of 540.2 mbsf at 1530 h on 13 October 2019 when safety monitoring for hydrocarbon gases obtained an anomalously low C_1/C_2 value from Core 42R. In total, Cores 2R to 42R penetrated from 308.2 to 540.2 mbsf and recovered 139.8 m (60%) in Hole U1546C. After circulating 50 barrels of high-viscosity mud for hole cleaning twice, we prepared to release the RCB bit in preparation for wireline logging. At 1830 h, we deployed the rotary shifting tool (RST) to trigger the mechanical bit release (MBR). Upon dropping the bit at the bottom of the hole, we deployed the reverse RST to shift the MBR sleeve back into the circulation position. We then raised the end of the drill string to a logging depth of 80.9 mbsf. Upon making up the triple combination logging tool string (triple combo: natural gamma ray, porosity, and density sondes) on the rig floor, we lowered the tool string to the bottom of the hole (540.2 mbsf) at 0100 h on 14 October. After a short calibration pass, we implemented a full logging pass up to the seafloor at 0320 h. The triple combo tool string returned to the rig floor at 0600 h. We then rigged up the Formation MicroScanner (FMS)-sonic (resistivity imaging) logging tool string. The FMS-sonic tool string was deployed in the hole until we reached fill 15 m above the bottom of the hole. After a single upward pass to the seafloor, the tool string returned to the rig floor at 1140 h and was disassembled by 1230 h. Next, we deployed the subsea camera to the seafloor to survey Hole U1546C, and we did not observe any gas release. The subsea camera system was recovered and secured by 1445 h. We then pulled the drill string out of the hole. The drill string cleared the seafloor at 1500 h on 14 October, ending Hole U1546C, and reached the rig floor at 1800 h.

We secured the vessel for transit and started the 13 nmi sea passage to Site U1547 (proposed Site GUAYM-12A) at 1822 h on 14 October. After a 2 h transit, we arrived at the site coordinates, lowered the thrusters, and switched to dynamic positioning mode at 2047 h. We then made up the advanced piston corer (APC) bottom-hole assembly and lowered the drill string to the seafloor. After the drill string had reached a water depth of 1700.9 mbsl at 0300 h on 15 October, we deployed the subsea camera to conduct a survey of the seafloor at this site, which is a

hydrothermally active area about 30 km northwest of the northern axial graben of Guaymas Basin. The seafloor survey did not find any vent communities. At 0530 h, we picked up the top drive and positioned the drill string above the seafloor to start APC coring. We spudded Hole U1547A at 0835 h on 15 October. Mudline Core U1547A-1H recovered 5.4 m. This established a seafloor depth of 1733.7 mbsl. Cores 1H to 19F penetrated from the seafloor to 108.1 mbsf by the end of 15 October. The half-length APC (HLAPC) coring tool was deployed after encountering a partial stroke on Core 11H. Deeper in the hole, we deployed the extended core barrel (XCB) coring system to break through hard carbonate layers. This took place on Cores 12X, 14X, 16X, and 18X. We made formation temperature measurements with the advanced piston corer temperature tool (APCT-3) on Cores 4H, 6H, 8H, and 10H, and the Sediment Temperature 2 Tool (SET2) following Core 16X. On 16 October, we continued HLAPC/XCB coring in Hole U1547A, deploying the XCB coring system whenever we had to core through hard layers. This took place on Core 20X and continuously from Core 25X onward. Cores 20X to 27X penetrated from 108.1 to 141.3 mbsf. We made a formation temperature measurement with the SET2 tool following Core 23F. While coring and recovering Core 27X, hole conditions deteriorated and continued to worsen below 136.3 mbsf; as a result, we decided to terminate coring at a final depth of 141.3 mbsf. Cores 1H to 27X penetrated from the seafloor to 141.3 mbsf and recovered 145.3 m (103%). We then raised the drill string ~10 m and deployed the Kuster Flow Through Sampler (FTS) tool to recover borehole fluid from 131.3 mbsf. We retrieved the tool at 1330 h and sampled 600 mL of fluid. We then started pulling the drill string out of the hole, and the bit cleared the seafloor at 1425 h on 16 October, ending Hole U1547A.

After offsetting the vessel 100 m to the southwest, we positioned the bit at a water depth of 1728.9 mbsl and spudded Hole U1547B at 1545 h. Mudline Core U1547B-1H recovered 6.3 m. This determined a seafloor depth of 1732.2 mbsl. Cores 1H to 7H penetrated from the seafloor to 65.6 m. We deployed the APCT-3 tool to make formation temperature measurements on Cores 4H and 6H. On 17 October, we continued coring with the APC/HLAPC/XCB coring systems. Cores 8H to 32F penetrated from 63.2 to 158.8 mbsf. Upon refusal of the APC coring tool, we switched to the HLAPC tool after Core 10H at 90.5 mbsf. While coring with the HLAPC tool, we had to deploy the XCB tool to penetrate hard layers at several depths (Cores 11X, 13X, 15X, 17X, 20X, 23X, 30X, and 31X). We permanently switched to XCB coring after Core 32F indicated refusal at a depth of 158.8 mbsf. We made formation temperature measurements with the APCT-3 tool on Cores 8H, 10H, and 12F, and with the SET2 tool following Cores 20X and 26F. We pumped perfluorocarbon tracers (PFTs) downhole on Cores 1H to 32F to monitor drilling fluid (seawater) contamination. On Cores 1H to 7H, the pacing of coring was adjusted to accommodate the complex microbiology and biogeochemistry sampling on the core receiving platform. On 18 October, coring proceeded with the XCB coring system. Cores 33X to 44X penetrated from 158.8 to 205.2 mbsf. We pumped 20 barrels of high-viscosity mud after every core for hole cleaning. A request for extending the total depth of Hole U1547B from 200 to 240 mbsf was approved by the IODP Environmental Protection and Safety Panel (EPSP). On 19 October, XCB Cores 45X to 50X penetrated from 205.2 to 209.8 mbsf. We circulated 20 barrels

of high-viscosity mud after every core for hole cleaning. At 1200 h on 19 October, we terminated coring at a final depth of 209.8 mbsf due to the slow advancement and hole stability issues encountered at the bottom of the hole. In total, Cores 1H to 50X penetrated from the seafloor to 209.8 mbsf and recovered 161.3 m (77%). We picked up the top drive and raised the drill string to 103.7 mbsf. We then deployed the Kuster FTS tool to successfully recover two borehole fluid samples from 109.7 and 135.7 mbsf, respectively. In preparation for wireline logging, we raised the end of the drill string to 69.7 mbsf, and the rig floor prepared for deploying the triple combo logging tool string. At 1800 h, we lowered the tool string into the hole until we encountered a ledge at 168.7 mbsf. After a short calibration pass, we implemented a full logging pass up to the seafloor that ended at 1945 h. The triple combo returned to the rig floor at 2045 h. The intended deployment of the FMS-sonic tool string was canceled due to deteriorating hole conditions. We pulled the drill string out of the hole and the bit cleared the seafloor at 2205 h, ending Hole U1547B and Site U1547. We then deployed the subsea camera to observe the seafloor while moving ~500 m southwest to the coordinates of Site U1548 (proposed Site GUAYM-03B). The vessel was positioned over the location of Hole U1548A at 2359 h on 19 October.

Science Results

Scientists described and analyzed cores recovered from Holes U1546C, U1547A, and U1547B. The laboratory groups presented their Site U1546 results at two science summary meetings on October 15 and 17, respectively, and submitted their Site U1546 reports.

Core Description

During the past week, the core description team finalized the Site U1545 report and worked on X-ray diffraction analyses, smear slides, and thin section descriptions of Site U1546. We also started to describe and analyze cores recovered from Holes U1547A and U1547B. The sediments recovered at Site U1547 are mostly biogenic (mainly diatom ooze) and subordinate siliciclastic. The recovered sequence shows changes related to the diatom/clay ratio, the presence of authigenic carbonate, and to a lesser extent silica diagenesis. The siliciclastic contribution is much more important than at Sites U1545 and U1546. Below the diatom clay of Subunit IA, silt occurs as a trace component in diatom ooze or constitutes discrete beds in Subunit IB. Sand is more abundant in the lower part of the recovered sequence (Subunit IC). Sand can be found in dark gray layers or at the bottom of the silty beds. The presence of coarse-grained siliciclastics (including pebble-sized siliciclastic grains) suggests deposition by gravity flows. Hole U1547A reached a total depth of 137 mbsf. Igneous rock was encountered at the bottom, in Cores 26X and 27X, starting at ~133 mbsf. These cores contain moderately altered, highly vesicular, aphanitic basalt that has a top chilled margin with volcanic glass. Vesicles are filled with calcite and pyrite, reaching up to 15 mm in size. The microcrystalline groundmass is aphyric. Hole U1547B was drilled to a total depth of 210 mbsf, and has a very similar sedimentary succession as Hole U1547A. In Hole U1547B, Core 23X recovered a 60 cm thick sill interval from

~120 mbsf, consisting of hypocrystalline and holocrystalline basalt that is moderately altered. Core 29X was the last core that recovered sediment, consisting of siliceous claystone. Core 30X then recovered the top glassy margin of an igneous body from ~151 mbsf. Below this margin, Cores 30X to 40X consist of moderately altered, very fine-grained, sparsely to highly vesicular basalt. The alteration is generally expressed by vesicle and vein filling, showing mainly pyrite and calcite, and minor zeolite as alteration minerals. A few minor faults were seen in the sediments above the deeper igneous body, and many steeply dipping faults, fractures, and veins were observed in the igneous rocks.

Biostratigraphy

This week, the micropaleontologists finished analyzing core catcher and split samples from Holes U1547A and U1547B. Diatoms are abundant to dominant above 131.2 mbsf and 101.2 mbsf, respectively, with good to poor preservation. In contrast, diatoms are barren below 136.3 mbsf in Hole U1547A, and from 119.2 to 129.7 mbsf in Hole U1547B. No diatom age markers were found. The occurrence of calcareous nannofossil *Emiliania huxleyi* in Sections U1547A-27X-CC (137.5 mbsf) and U1547B-24F-CC (130.1 mbsf) was confirmed, suggesting that the sediments at the bottom of Hole U1547A and in Core U1547B-24F are younger than 0.29 Ma.

Paleomagnetism

The paleomagnetism team completed the analysis of archive-half sections from Cores U1546C-10R to 42R with the superconducting rock magnetometer (SRM). This interval mainly contains of igneous rocks. The team performed a few tests with high alternating field demagnetization values up to 80 mT. The tests were not conclusive and the team decided to measure only the natural remanent magnetization on the remaining sections. Discrete samples, shared with the physical properties team, were thermally demagnetized up to 600°C. The team also completed the analysis of archive-half sections and discrete samples from Cores U1547A-1H to 27X. As in previous sites, the magnetostratigraphy relies on APC/HLAPC cores and associated discrete samples. The analyzed cores were assigned to the normal Brunhes Chron C1n (<0.78 Ma), in agreement with the biostratigraphy datums. No excursions could be identified in the paleomagnetic record of the measured sections.

Inorganic Geochemistry

During this week, the inorganic geochemistry team collected 41 interstitial water (IW) samples, as well as mudline water and borehole fluid samples from Hole U1547A, and 18 IW and two borehole fluid samples from Hole U1547B. The maximum extracted water volume was 145 mL. The IW samples were distributed for shipboard and postexpedition shore-based analyses. We also finished onboard analyses (alkalinity, salinity, cations, anions, and nutrients) of IW samples (65 samples) from Holes U1546C, U1547A, and U1547B. The results from Holes U1547A and U1547B show that (1) sulfate decreases and sulfide increases gradually around 115 mbsf just

above the upper sill (~120 mbsf), but 13 mM of sulfate still remains at that depth; (2) sulfate dramatically decreases between 113 and 117 mbsf toward <1 mM; and (3) the variation in concentration of major ions is generally limited from the seafloor to the upper sill, and then abruptly changes just above the sill (mainly for Mg^{2+}, K^{+}, Ca^{2+}, PO_4^{3-}, Li^{+}, B, Sr^{2+}, Ba^{2+}, $H_4Si(OH)_4$, and alkalinity). This trend is similar to the one observed around the sill at Site U1546.

Organic Geochemistry

This week, the organic geochemists performed safety gas monitoring in Holes U1546C, U1547A, and U1547B. In Hole U1546C, we observed anomalous headspace gas C_1/C_2 values in Core 42R, leading to the termination of coring. The Kuster FTS tool was then deployed, and subsamples of gas and liquid were taken for both shipboard and shore-based analyses. Very low concentrations of methane were noted in the gas phase (~28 ppmv). In Hole U1547B, an extensive suite of sediment and gas samples were taken for both shipboard and shore-based analyses. When recovery permitted, igneous rocks were taken directly from the whole-round (WR) cores before splitting, sealed in trilaminated foil barrier bags, and incubated at 70°C. After degassing for 24 h, gases were sampled from these bags with a gas-tight syringe. Other laboratory activities that the organic geochemists performed were the continued subsampling of WR cores for shore-based analyses and the preparation and analysis of solid phase samples for elemental and source rock analysis.

Microbiology

In Hole U1547A, microbiologists sampled drilling fluid (seawater) and mudline water from the top of the first section of the first core. On the core receiving platform, immediately after cutting the core into sections, sterile cut-end syringes were used to collect sediment plugs from the center of WR cores for total cell counts and to trace and quantify the potential microbial contamination during drilling. In addition, mudline water was filtered or frozen to monitor potential surface microbial contaminants. Borehole fluid was also collected from the Kuster FTS tool and fixed for cell counts or filtered for molecular analysis. In Hole U1547B, WR sediment samples were also collected on the core receiving platform and instantaneously transferred to a cold room (4°C) and fixed, stored anaerobically at 4°C in trilaminated foil barrier bags, and flushed with nitrogen or directly frozen at –80°C for shore-based analyses. Fixed cells were stained and counted by using epifluorescence microscopy. Incubations as well as radiotracer and stable isotope experiments were carried out on board.

Physical Properties

During the past week, the Petrophysics team measured 41 Hole U1546C cores on the Whole-Round Multisensor Logger (WRMSL; without *P*-wave velocity) and Natural Gamma Radiation Logger (NGRL). Our data are consistent with the presence of a ~75 m thick sill alternating with sediments in the recovered Hole U1546C succession. For the section halves of igneous rocks, cubes collected for paleomagnetic measurements were used for moisture and density (MAD)

analyses and discrete *P*-wave velocity measurements. Coherent igneous rock pieces 10–20 cm in length were selected for *P*-wave velocity and thermal conductivity measurements. The downhole logging data enabled the exact determination of the sill and contact zone thickness. For Hole U1547A, 27 cores (penetrating to a depth of ~140 mbsf), were measured with the WRMSL, NGR, and Thermal Conductivity Meter (TCON). We finished discrete MAD measurements (every other core), rheology, and *P*-wave velocity (one section per core). For Hole U1547B, 49 cores were recovered to a depth of ~200 m. We measured physical properties (WRMSL, NGRL, and TCON) on the cores left behind from the extensive microbiology sampling on the core receiving platform. MAD samples were taken from every other core after splitting to correlate with the headspace gas analysis except on the disturbed sediments from Cores 23F to 27F. Beneath a depth of ~140 mbsf, selected cubes and pieces of igneous rocks were sampled for discrete *P*-wave velocity, MAD, and TCON analyses according to the hard rock measurement protocol.

Outreach

During the fifth week of Expedition 385, we released 16 posts on Facebook (https://www.facebook.com/joidesresolution), which produced 2,439 engagements and 26 new followers. On Twitter (https://twitter.com/TheJR), 12 tweets generated 13 new followers and 365 engagements. The Instagram account (http://instagram.com/joides_resolution) released eight posts that produced 506 engagements and 35 new followers. Our weekly takeover of the AGU Instagram account on 17–18 October included seven posts that gained 1,425 engagements and 1,305 likes. We published three blog posts with 479 views combined. The expedition's website (https://joidesresolution.org/expedition/385/) had 249 new views.

We conducted three ship-to-shore live events. Two broadcasts connected with high schools in Mexico and Australia, respectively, and the third event connected with a museum (Papalote Museo del Niño, Mexico). The total number of people in attendance was 145, plus 2,070 virtual views via Facebook Live for the connection with the National Autonomous University of Mexico (UNAM) high schools. We also conducted one separate Facebook Live event in Spanish.

Technical Support and HSE Activities

The IODP JRSO technical staff supported the science operations at Sites U1546 and U1547.

Laboratory Activities

- Extensive sampling of cores from Hole U1547B on the core receiving platform for microbiology and geochemistry.
- Extensive processing of samples in the Microbiology and Geochemistry Laboratories.

- Deployment of the Kuster FTS tool in Hole U1547B.
- Issue reported with the source rock analyzer (SRA) not functioning properly. Troubleshooting is ongoing.

IT Support Activities

- Prepared TVs, plotter, and plotter cartridges for freight.
- Downloaded new plotter drivers and configured iPrint server for user installation.
- Created Expedition 378T email and file server accounts.
- Contacted McAfee and reopened closed service request concerning removed repository setup capability. Capability has been restored to software, but problems persist. Work with vendor is ongoing.
- Setup Mac laptop for developer testing of new software.

Application Support Activities

- Continued work on the Launcher application.
- Continued work on the Catwalk sampling application.
- Deployed a new version of MUT.
- Continued to work with Geochemistry Laboratory team to remove duplicate gas chromatograph NGA data following reintegration.
- Investigated an issue with SampleMaster involving entered samples being uploaded to incorrect parents. Work is in progress.
- Canceled a number of duplicate P-WAVE velocity results.
- Assisted the Publications Specialist with Layer 2 Ethernet (L2E) service data and image processing issues.
- Worked to resolve issues with the Section Half Imaging Logger losing database connection.

HSE Activities

- Held weekly abandon ship and life boat safety drill.
- Safety showers and eye wash stations were tested.