IODP Expedition 385: Guaymas Basin Tectonics and Biosphere

Week 6 Report (20–26 October 2019)

The sixth week of International Ocean Discovery Program (IODP) Expedition 385, Guaymas Basin Tectonics and Biosphere, comprised (1) APC/HLAPC/XCB coring to 103 mbsf in Hole U1548A, (2) APC/HLAPC/XCB coring to 95 mbsf in Hole U1548B, (3) drilling without core recovery to 81 mbsf and RCB coring from 81 to 150 mbsf in Hole U1547C, (4) drilling without core recovery to 81 mbsf and RCB coring from 81 to 193 mbsf in Hole U1547D, (5) APC coring to 168 mbsf in Hole U1549A, and (6) APC coring to 167 mbsf in Hole U1549B. All times in this report are in ship local time (UTC – 7 h).

Operations

The week began with completing a seafloor survey over Site U1548. We did not find any vent communities at the location of Site U1548. We retrieved and secured the subsea camera by 0230 h on 20 October 2019. We then picked up the top drive, positioned the bit above the seafloor, and spudded Hole U1548A at 0350 h. Mudline Core U1548A-1H recovered 1.9 m. This established a seafloor depth of 1739.9 mbsl. While coring with the advanced piston corer (APC) tool, we had to deploy the extended core barrel (XCB) tool to penetrate hard layers at several depths (Cores 11X, 13X, 15X, and 17X). After recovering Core 18H from 99.4 mbsf, we switched to XCB coring permanently. Cores 1H to 20X penetrated from the seafloor to 103.4 mbsf and recovered 114.0 m (110%). We terminated coring upon recovering Core 20X due to slow penetration rates. We then pulled the drill string out of the hole and the bit cleared the seafloor at 2140 h on 20 October, ending Hole U1548A at a final depth of 103.4 mbsf.

We moved the vessel 20 m to the northwest and arrived at the coordinates of Hole U1548B at 2200 h on 20 October. We positioned the bit above the seafloor to start APC coring and spudded Hole U1548B at 2215 h. Mudline Core U1548B-1H recovered 5.9 m. This determined a seafloor depth of 1738.9 mbsl. By the end of 20 October, Cores 1H to 2H had penetrated from the seafloor to 15.4 mbsf. On 21 October, we continued coring, alternating between the APC and XCB coring systems. Cores 3H to 12X penetrated from 15.4 to 95.1 mbsf. Upon encountering a partial stroke on Core 9H, we switched to the XCB coring system on Core 10X at a depth of 80.4 mbsf. We then continued coring until XCB refusal at a final depth of 95.1 mbsf. Cores 1H to 12X penetrated from the seafloor to 95.1 mbsf and recovered 87.7 m (92%). We deployed perfluorocarbon tracers (PFTs) for drilling fluid (seawater) contamination monitoring on all cores. At 1345 h, we raised the end of the drill string to 58 mbsf and rigged up the Kuster Flow Through Sampler (FTS) tool. Upon lowering the bit to 70 mbsf, we deployed the Kuster FTS tool and recovered a borehole fluid sample from the same depth. We then pulled the drill string out of the hole and the bit cleared the seafloor at 1622 h on 21 October, ending Hole U1548B and Site U1548.

The vessel then moved back to Site U1547, arriving at the coordinates of Hole U1547C at 1806 h on 21 October. We made up the rotary core barrel (RCB) bottom-hole assembly (BHA) and started lowering the drill string to the seafloor in preparation for spudding Hole U1547C. Upon reaching a water depth of 1706.9 mbsl, we picked up the top drive, dropped the center bit, and the end of the drill string tagged the seafloor at 1732.2 mbsl. We then spudded Hole U1547C at 0300 h on 22 October and drilled without core recovery from the seafloor to 81.3 mbsf. Upon retrieving the center bit, we began RCB coring at 0545 h. Cores 2R to 9R penetrated from 81.3 to 159.2 mbsf and recovered 9.0 m (12%). We pumped PFTs for drilling fluid (seawater) contamination monitoring on Cores 3R to 9R. Hole problems led to strong overpull force from 139.7 to 149.5 mbsf. While recovering Core 9R, we determined that our coring location should be shifted to the southwest of Hole U1547B. We thus terminated coring in Hole U1547C at 1830 h at a final depth of 149.5 mbsf. We pulled the drill string out the hole and the bit cleared the seafloor at 1927 h on 22 October, ending Hole U1547C.

We then offset the vessel to the coordinates for Hole U1547D. At 1945 h on 22 October, we dropped the center bit and positioned the drill string above the seafloor. A tagged seafloor depth of 1732.2 mbsl was determined. We spudded Hole U1547D at 2005 h on 22 October and drilled without core recovery from the seafloor to 81.3 mbsf. After retrieving the center bit, we began RCB coring at 2130 h. Cores 2R to 3R penetrated from 81.3 to 100.8 mbsf by the end of the day. Cores 4R to 17R penetrated from 100.8 to 173.6 mbsf on 23 October. Cores 18R to 21R penetrated from 173.6 to 193 mbsf on 24 October. We pumped PFTs for drilling fluid (seawater) contamination monitoring on all cores. Upon accomplishing the microbiology sampling objectives for Hole U1547D, we terminated coring at a final depth of 193.0 mbsf. Cores 2R to 21R penetrated from 81.3 to 193.0 mbsf and recovered 34.0 m (30%). At 0815 h on 24 October, we deployed the Elevated Temperature Borehole Sensor (ETBS) tool to make a temperature measurement at the bottom of the hole. We retrieved the ETBS tool at 0945 h and pulled the drill string out of the hole. The bit cleared the seafloor at 1130 h on 24 October, ending Hole U1547D and Site U1547.

The bit arrived on the rig floor at 1445 h, and we secured the vessel for transit to Site U1549 (proposed Site GUAYM-16A), located ~9.5 km northwest of the northern axial graben of Guaymas Basin. While in transit, we performed a precision depth recorder (PDR) survey of the transect seismic line between Sites U1547 and U1548 across Ringvent and during the ~11 nmi sea passage to Site U1549. We switched from dynamic positioning (DP) to cruise mode at 1519 h, raised the thrusters, began the PDR survey at 1528 h, and started the sea passage at 1554 h on 24 October.

We arrived at the coordinates of Site U1549 at 1706 h on 24 October, lowered the thrusters, and switched back to DP mode. We then made up the APC/XCB coring BHA and started lowering the drill string to the seafloor. We picked up the top drive, positioned the bit at 1837.1 mbsl, and spudded Hole U1549A at 2355 h on 24 October. At 0030 h on 25 October, mudline Core 1H recovered 6.5 m. This established a seafloor depth of 1840.1 mbsl. On 25 October, Cores 1H to

18H penetrated from the seafloor to 168.0 mbsf and recovered 166.9 m (99%). We made formation temperature measurements on Cores 4H, 7H, 10H, and 13H. Upon reaching the target depth objective of 168.0 mbsf in Hole U1549A, we pulled the drill string out of the hole and the bit cleared the seafloor at 1515 h on 25 October, ending Hole U1549A.

We then moved the vessel 20 m to the northwest to spud Hole U1549B. We positioned the bit above the seafloor and spudded Hole U1549B at 1640 h on 25 October. Mudline Core 1H recovered 5.48 m. This determined a seafloor depth of 1841.2 mbsl. On 25 October, Cores 1H to 6H penetrated from the seafloor to 52.9 mbsf. On 26 October, Cores 7H to 18H penetrated from 52.9 to 166.9 mbsf. We pumped PFTs for drilling fluid (seawater) contamination monitoring on all cores. The pacing of coring was adjusted to the complex high-resolution microbial and geochemical sampling program conducted on the core receiving platform. Upon accomplishing the sampling and target depth objectives for Hole U1549B, we terminated coring at a final depth of 166.9 mbsf. Cores 1H to 18H penetrated from the seafloor to 166.9 mbsf and recovered 164.4 m (99%). We pulled the drill string out of the hole and the bit cleared the seafloor at 1550 h on 26 October, ending Hole U1549B and Site U1549.

Upon implementing a routine cut and slip of 115 ft of the drilling line, we pulled the drill string up to the surface and reassembled the rig floor. At 2025 h, we secured the vessel for transit to Site U1550 (proposed Site GUAYM-06B), located in the northern axial graben of Guaymas Basin. We switched from DP to cruise mode at 2034 h, raised the thrusters, and started the ~13 nmi sea passage. We arrived at the coordinates of Site U1550 at 2209 h on 26 October, lowered the thrusters, and switched back to DP mode. At 2230 h, we started lowering the drill string with the APC/XCB BHA to the seafloor. The bit reached a water depth of 124.9 mbsl by the end of the day.

Science Results

Scientists described and analyzed cores recovered from Holes U1547C, U1547D, U1548A, U1548B, U1549A, and U1549B.

Core Description

The core description team (sedimentologists, petrologists, and structural geologists) worked on X-ray diffraction analyses and microscopic description of smear slides and thin sections from Holes U1547A and U1547B. Also, we described and analyzed cores recovered from Holes U1547C, U1547D, U14548A, U1548B, U1549A, and U1549B. Similar to Sites U1545 and U1546, the sediments recovered at Sites U1547, U1548, and U1549 are mostly biogenic diatom ooze mixed with different proportions of clay minerals and authigenic carbonate precipitates, and the recovered material has experienced different degrees of silica diagenesis. These biogenic sediments are associated with minor terrigenous inputs identified by the presence of light to dark

gray silt and sand layers. The siliciclastic contribution, probably resulting from deposition by gravity flows, is more important in these three sites than in the two previous sites. At Site U1547, igneous sill material was recovered in all four holes. All the igneous cores from Site U1547 mainly consist of moderately to highly altered, highly vesicular, aphyric basalt. Vesicle size usually ranges from 1 to 15 mm. The vesicles are either empty or partially to fully filled with carbonate. Small crystals of pyrite (<1 mm) are also present as coating or inside the vesicles. Alteration halos are visible in some core sections. Injected sediment veins and small angular fragments of basalt within the sediment near the basalt/sediment interface are other common features observed in the cores. An 89 cm thick interval of plagioclase-phyric basalt appears in Core U1547B-44X. Igneous sill material at Site U1548 is somewhat different. These rocks represent slightly altered, nonvesicular, dark gray basalt. Glassy margins are occasionally present in cores from both Sites U1547 and U1548.

Biostratigraphy

The biostratigraphy team finished analyzing core catcher and split core samples from Holes U1547C, U1547D, U1548A, and U1549A. Diatoms are common in Samples U1547C-2R-CC through 6R-CC (91–130 mbsf), and barren in Samples U1547D-3R-CC (100 mbsf) and U1547D-4R-1, 53 cm (~110 mbsf). In Hole U1548A, diatoms are abundant to dominant above ~99 mbsf (Sample U1548A-18H-1, 60 cm) with good to moderate preservation, and frequently present at the same depth with poor preservation. Diatoms are abundant to dominant throughout the Hole U1549A (0–168 mbsf) sediments, with good to moderate preservation. No age diagnostic diatoms were found in Holes U1547C, U1547D, U1548A, and U1549A. The occurrence of the calcareous nannofossil age marker *Emiliania huxleyi* in the bottom sections of Holes U1547C, U1547D, U1548A, and U1549A was confirmed, suggesting they are younger than 0.29 Ma.

Paleomagnetism

The paleomagnetism team completed the analysis of archive-half sections from Sites U1547, U1548, and U1549 (Cores U1547B-31X to 49X, U1547C-3R to 9R, U1547D-6R to 20R, U1548A-1H to 19X, and U1549A-1H to 18H) by using the superconducting rock magnetometer (SRM). In intervals with igneous rocks, only the natural remanent magnetization was measured (Cores U1547B-31X to 49X, U1547C-7R to 9R, U1547D-6R to 20R, and U1548A-19X). The remaining sedimentary core sections were demagnetized up to alternating fields (AF) of 20 mT. Detailed AF demagnetization (up to 60 mT) on discrete samples taken from the sediments supports the data obtained from the archive halves. These samples show two magnetic components, the first of which is removed by 10 mT and corresponds to a drilling overprint. The second component is stable and has a normal polarity. Combining the section and discrete sample results, these core intervals were assigned to the normal Brunhes Chron C1n (<0.78 Ma), in agreement with the biostratigraphic datums.

Inorganic Geochemistry

The inorganic geochemistry team collected 42 interstitial water (IW) samples, one mudline water sample, and one borehole fluid sample from Holes U1548A and U1548B; and 64 IW samples and one mudline water sample from Holes U1549A and U1549B using the Carver hydraulic squeezer and Rhizons. The IW samples were distributed for shipboard and postexpedition analyses. We finished the analyses (alkalinity, salinity, cations, anions, and nutrients) of the IW samples from Site U1548, and continued analyzing the IW samples from Site U1549.

The results from Holes U1548A and U1548B show that (1) sulfate concentration decreases and sulfide increases gradually from the seafloor to 80 mbsf; (2) sulfate then sharply decreases below that depth toward values <1 mM; and (3) the overall variation in concentration of major ions is limited from the seafloor to the sill at ~99 mbsf (Hole U1548A) and ~87 mbsf (Hole U1548B), respectively, 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). At Site U1549, the maximum concentration of alkalinity is 85 mM at 105 mbsf.

Organic Geochemistry

The organic geochemists performed safety gas monitoring in Holes U1548A, U1548B, U1547C, U1547D, U1549A, and U1549B. No anomalous headspace gas C_1/C_2 values were observed. The Kuster FTS tool was deployed near the bottom of Hole U1548B, and subsamples of gas and liquid were taken for both shipboard and shore-based analyses. In Holes U1548B and U1549B, an extensive suite of sediment and gas samples were taken for both shipboard and shore-based analyses. In Hole U1547D, 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. At Site U1549, large gas voids were noted in the cores and their extent was quantified. Other laboratory activities included 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

WR core samples were collected on the core receiving platform for microbiological analyses in Holes U1547C, U1547D, U1548B, and U1549B. Syringe samples for cell counts (deposited in fixative), RNA analysis (flash frozen in liquid nitrogen and stored at −80°C), and contamination tracer analysis were taken directly on the core receiving platform. The WR core samples were immediately frozen or flushed with nitrogen and stored in trilaminated foil barrier bags at 4°C until further processing. Cultivation, as well as radiotracer and stable isotope incubation experiments, were started on board. Preliminary cell counts were done for Holes U1547B and U1548B via epifluorescence microscopy. Mudline water from each hole was filtered or frozen as a contamination control. In addition, borehole fluid from Hole U1547B was collected from the Kuster FTS tool and fixed for cell counts or filtered for molecular analysis. Select sill samples

from Holes U1547C, U1548D, U1548A, and U1548B were processed and allocated for high temperature cultivation, stable isotope probing, lipid biomarker analysis, cell counts, thin section staining, scanning electron microscopy coupled with Raman spectroscopy and mRNA analysis, ion microprobe analysis, and DNA analysis.

Physical Properties

The petrophysics team measured eight cores from Hole U1547C and 20 cores from Hole U1547D on the Whole-Round Multisensor Logger (WRMSL) and Natural Gamma Radiation Logger (NGRL). Thermal conductivity (TCON), density and porosity (discrete moisture and density [MAD]), as well as *P*-wave velocity were measured on section halves and cubes of the igneous rocks recovered from Holes U1547A–U1547D. In Holes U1548A and U1548B, 20 and 12 sediment cores, respectively, were processed through the whole-round and section-half measurements sequence (WRMSL, NGRL, thermal conductivity, strength, *P*-wave velocity, and MAD). In Hole U1549A, 18 cores were measured on the WRMSL, NGRL, and TCON instruments, and every section half was sampled and analyzed for MAD, *P*-wave velocity, and strength properties. In Hole U1549B, 18 cores from have been measured through the WRMSL. Using the core thermal conductivity data and the formation temperature measurements, we calculated the geothermal gradient at every hole of every site cored this week.

Outreach

During the sixth week of Expedition 385, we released 11 posts on Facebook (https://www.facebook.com/joidesresolution), which produced 2,878 engagements and 44 new followers. On Twitter (https://twitter.com/TheJR), 16 tweets generated 24 new followers and 371 engagements. The Instagram account (http://instagram.com/joides_resolution) released six posts that produced 785 engagements and 36 new followers. Our weekly takeover of the AGU Instagram account on 24–25 October included six posts that gained 915 engagements and 877 likes. We published five blog posts with 451 views combined. The expedition's website (https://joidesresolution.org/expedition/385/) had 285 new views.

We conducted six ship-to-shore live events. Three broadcasts connected with high schools in Mexico and Australia, respectively. One event connected with the Papalote Museo del Niño (Mexico) again. Two broadcasts connected with Mexican academic institutions, Centro de Investigación Científica y de Educación Superior de Ensenada (CICESE) and Universidad Autónoma de Baja California (UABC). The total number of people in attendance was 359.

Technical Support and HSE Activities

The IODP JRSO technical staff supported the science operations at Sites U1547, U1548, and U1549.

Laboratory Activities

- Curation of sediment cores and igneous rocks from multiple holes.
- Extensive sampling of cores 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 U1548B.
- Deployment of the Elevated Temperature Borehole Sensor (ETBS) tool in Hole U1547D.
- Conducted 3.5 kHz sonar survey of Ringvent Sites U1547–U1548 after coring.
- Issue reported last week with the source rock analyzer (SRA) was resolved.

IT Support Activities

- Worked with shore personnel in implementing *JOIDES Resolution* web page changes. New printing section established.
- Engineering PC without Rigwatch dongle was successfully tested. Also, performed same test on Windows XP rackmount PC in Telemetry successfully.
- Busy week for our new plotter, which printed a dozen plots successfully.
- Performed equipment inventory location verification per request from shore.
- Recovered all spare VSAT/Rignet parts and boxes for shipping preparation.
- Investigating Windows 7 installations on ship per request from shore.

Application Support Activities

- Continued work on the Launcher application.
- Continued work on the Catwalk sampling application.
- Worked with the Marine Computer Specialists to solve a recurring issue with the Section Half Imaging Logger (SHIL) losing connection to LIMS. We removed McAfee from the instrument computer, and this seems to have solved the problem.
- Assisted the Imaging Specialist with sever WRLSC and close-up uploads.
- Assisted geochemists with removing duplicate NGA and CHNS results from LIMS.
- Created custom DESClogik packages for use on scientists' personal computers, which lack the necessary tools for ClickOnce applications.
- Assisted chemistry technicians in uploading PFT data.
- Assisted drill shack with creating cores in SampleMaster several times.
- Solved an issue with the NGA gas chromatograph where an incorrectly parented sample was causing upload issues.

HSE Activities

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