IODP Expedition 385: Guaymas Basin Tectonics and Biosphere

Week 8 Report (3–9 November 2019)

The eighth week of International Ocean Discovery Program (IODP) Expedition 385, Guaymas Basin Tectonics and Biosphere, comprised (1) APC/HLAPC coring to 120 mbsf in Hole U1551A, (2) APC coring to 49 mbsf in Hole U1551B, (3) drilling without core recovery to 62 mbsf and RCB coring from 62 to 191 mbsf in Hole U1547E, (4) APC/XCB coring to 70 mbsf in Hole U1548C, (5) APC/HLAPC coring to 110 mbsf in Hole U1548D, (6) APC/HLAPC coring to 110 mbsf in Hole U1548E, (7) APC coring to 108 mbsf in Hole U1552A, (8) APC coring to 55 mbsf in Hole U1552B, and (9) APC coring to 52 mbsf in Hole U1552C. All times in this report are in ship local time (UTC – 8 h).

Operations

The week began with advanced piston corer (APC) coring in Hole U1551A (proposed Site GUAYM-15A). Cores U1551A-9H to 19F penetrated from 53.9 to 120.3 mbsf. Partial strokes were encountered on Cores 4H to 9H, 11H, and 13H to 15H. We made formation temperature measurements with the advanced piston corer temperature tool (APCT-3) on Cores 4H, 7H, 10H, and 13H. We switched to the half-length APC (HLAPC) coring system after Core 15H at 108.2 mbsf. We terminated coring in Hole U1551A after recovering Core 19F because unconsolidated sand layers prevented us from reaching our deeper drilling objectives. We pulled the drill string out of the hole and the bit cleared the seafloor at 1025 h on 3 November 2019, ending Hole U1551A. Cores U1551A-1H to 19F penetrated from the seafloor to a final depth of 120.3 mbsf and recovered 122.1 m (102%).

The vessel then moved 20 m east to start APC coring in Hole U1551B. We spudded Hole U1551B at 1130 h on 3 November. Mudline Core U1551B-1H recovered 4.9 m, which established a seafloor depth of 1843.9 mbsl. Cores U1551B-1H to 6H penetrated from the seafloor to 48.5 mbsf and recovered 50.0 m (103%). We encountered partial strokes on Cores 3H to 6H. We terminated coring in Hole U1551B after recovering Core 6H at a final depth of 48.5 mbsf. We pumped perfluorocarbon tracers (PFTs) for drilling fluid (seawater) contamination monitoring on all cores. At 1645 h, we started pulling the drill string out of the hole. The bit cleared the seafloor at 1700 h and arrived at the rig floor at 2100 h. The vessel was then secured for the return to Site U1547. We switched from dynamic positioning (DP) to cruise mode at 2130 h, ending Hole U1551B and Site U1551. The thrusters were raised and our sea passage began at 2200 h on 3 November.

On 4 November, we continued our transit to Site U1547 (proposed Site GUAYM-12A) and arrived at the site coordinates at 0115 h. We lowered the thrusters and switched to DP mode at 0137 h to start operations at Hole U1547E (located 77 m southwest of Hole U1547D). We made

up the rotary core barrel (RCB) bottom-hole assembly (BHA) and started lowering the drill string to the seafloor. At 0645 h, we picked up the top drive, dropped the center bit, and the end of the drill string tagged the seafloor at 1732.1 mbsl. We spudded Hole U1547E at 0800 h and drilled ahead without core recovery to 61.8 mbsf (Core U1547E-11). At 0915 h on 4 November, we retrieved the center bit and started RCB coring. Cores 2R to 10R penetrated from 61.8 to 134.8 mbsf. On 5 November, Cores 11R to 20R penetrated from 134.8 to 177.3 mbsf. Finally, Cores 21R to 24R penetrated from 177.3 to 191.2 mbsf by 0900 h on 6 November. In view of the remaining science objectives of the expedition, we decided to stop coring in Hole U1547E after retrieving Core 24R. We then started pulling the drill string out of the hole, and the bit cleared the seafloor at 1045 h on 6 November. Cores U1547E-2R to 24R penetrated from 61.8 to 191.2 mbsf and recovered 44.9 m (35%).

While we were continuing to raise the drill string to the surface, the vessel moved to Site U1548 (proposed Site GUAYM-03B) on 6 November to recover another set of microbiology samples from the hydrothermally influenced sediments associated with the Ringvent structure. At 1440 h, the bit arrived at the rig floor, ending Hole U1547E and Site U1547. We then made up an advanced piston corer/extended core barrel (APC/XCB) BHA and started lowering the drill string to the seafloor. At 2100 h, we pulled the upper guide horn and deployed the subsea camera to conduct a survey of the seafloor at the intended location of Hole U1548C. At 2223 h, we moved the vessel to new hole coordinates 5 m to the southwest from the original coordinates to avoid a clam bed. By the end of the day, the subsea camera was retrieved and the drill string was positioned above the seafloor to start coring with the APC system. We spudded Hole U1548C at 0055 h on 7 November. Mudline Core U1548C-1H recovered 7.6 m, which established a seafloor depth of 1737.0 mbsl. Cores U1548C-1H to 10X penetrated from the seafloor to a final depth of 69.8 mbsf and recovered 71.0 m (102%). We made formation temperature measurements on Core 4H with the APCT-3 tool and following Cores 5H, 6H, and 7H with the Sediment Temperature 2 (SET2) tool. The third deployment of the SET2 tool bent the tip of the tool upon encountering a hard formation at ~65 mbsf. We then switched to the XCB coring tool on Core 8X, which recovered a sediment/sill contact. Upon recovering Core 10X, we terminated coring in Hole U1548C, as our microbiology sampling and target depth objectives were accomplished. We started pulling the drill string out of the hole and the bit cleared the seafloor at 1610 h on 7 November, ending Hole U1548C.

Upon offsetting the vessel to the coordinates of Hole U1548D, we positioned the bit above the seafloor to start APC coring. We spudded Hole U1548D at 1902 h on 7 November. Mudline Core U1548D-1H recovered 6.4 m, which determined a seafloor depth of 1729.3 mbsl. Cores 1H to 8H penetrated from the seafloor to 72.8 mbsf. On 8 November, Cores 9H to 13F penetrated from 72.8 to a final depth of 110.0 mbsf. We made a formation temperature measurement with the APCT-3 tool on Core 12H. We deployed the HLAPC tool on Core 13F. After recovering this core that reached the target depth, we terminated coring in Hole U1548D. The drill string was pulled out of the hole and the bit cleared the seafloor at 0450 h, ending Hole U1548D. Cores U1548D-1H to 13F penetrated from the seafloor to 110.0 mbsf and recovered 120.5 m (110%).

We then offset the vessel to the Hole U1548E coordinates, while cutting and reheading the core line. The bit was positioned above the seafloor and Hole U1548E was spudded at 0655 h on 8 November. Mudline Core U1548E-1H recovered 5.7 m, which established a seafloor depth of 1729.9 mbsl. Cores U1548E-1H to 12H penetrated from the seafloor to a final depth of 110.0 mbsf and recovered 115.2 m (105%). The APCT-3 tool was deployed to make formation temperature measurements on Cores 4H, 7H, and 10H. Coring was terminated upon reaching the target depth of 110 mbsf. We pulled the drill string out of the hole and the bit cleared the seafloor at 1705 h on 8 November. We began to move the vessel in DP mode to Site U1552 at 1715 h, ending Hole U1548E and Site U1548.

We arrived at Site U1552 (proposed Site GUAYM-10B), located ~22 km northwest of the northern axial graben of Guaymas Basin, at 0200 h on 9 November. The drill string with the APC coring system was lowered to the seafloor, and at 0315 h we deployed the subsea camera to conduct a survey of the seafloor. The survey did not find any vent communities. Upon retrieving the subsea camera by 0615 h, we picked up the top drive and spudded Hole U1552A at 0730 h on 9 November. Mudline Core U1552A-1H recovered 3.1 m, which established a seafloor depth of 1841.6 mbsl. Cores U1552A-1H to 12H penetrated from the seafloor to a final depth of 107.5 mbsf and recovered 73.9 m (69%). Gas hydrates were recovered in Core 4H. The APCT-3 tool was deployed to make formation temperature measurements on Cores 4H, 7H, 10H, and 12H. Coring was terminated upon reaching the target depth objective. We pulled the drill string out of the hole and the bit cleared the seafloor at 1547 h on 9 November, ending Hole U1552A.

We then shifted the vessel to Hole U1552B to recover cores for extensive microbiology and biogeochemistry sampling. Hole U1552B was spudded at 1620 h on 9 November. Mudline Core U1552B-1H recovered 7.6 m, which determined a seafloor depth of 1841.1 mbsl. Cores U1552B-1H to 6H penetrated from the seafloor to a final depth of 55.0 mbsf and recovered 40.0 m (73%). Gas hydrates were recovered in Cores 4H and 5H. Upon accomplishing the target depth and microbial sampling objectives, coring was terminated after recovering Core 6H. We pulled the drill string out of the hole and the bit cleared the seafloor at 1957 h, ending Hole U1552B.

After moving the vessel to the Hole U1552C coordinates, we positioned the bit above the seafloor to start coring the final hole of Expedition 385. We spudded Hole U1552C at 2037 h on 9 November. Mudline Core U1552C-1H recovered 4.4 m, establishing a seafloor depth of 1844.3 mbsl. Cores U1552C-1H to 6H penetrated from the seafloor to 51.8 mbsf and recovered 36.4 m (70%). We made a formation temperature measurement with the APCT-3 tool on Core 4H.

Science Results

Scientists described and analyzed cores recovered from Holes U1546D, U1551A–U1551B, U1547E, U1548C–U1548E, and U1552A–U1552C. The laboratory groups presented their Site U1549 and U1550 results at two science meetings on 6 and 7 November, and submitted their Site U1550 and U1551 reports.

Core Description

The core description team (sedimentologists, petrologists, and structural geologists) described and analyzed cores from Holes U1546D, U1550A–U1550B, U1551A–U1551B, U1547E, U1548C–U1548E, and U1552A.

The sediments recovered in Hole U1546D are mostly biogenic (mainly diatoms) and siliciclastic (mainly clay minerals and minor silt-sized siliciclastic particles), with micrometer-sized authigenic carbonate particles (micrite) and carbonate nodules being a significant subordinate component. The Subunit IA/IB and IB/IC boundaries were observed in Hole U1546D at depths similar to those identified in Holes U1546A–U1546C.

Sediment recovered at Site U1551, the easternmost site drilled in the Guaymas Basin, represents a combination of biogenic (diatom ooze to diatom clay) and terrigenous (sand-/silt-/clay-size) components with the highest overall proportion of silt and sand intervals (~60%) cored at any of the Expedition 385 sites. Some of the unconsolidated sandy intervals could represent drilling-induced flow-in material rather than in situ material. Sandy intervals were locally rich in terrestrial organic matter.

The target of Hole U1547E was to drill the sill and its upper contact zone with sediments. The first three cores recovered from Hole U1547E contained a total of 40 cm of sedimentary rocks from the contact zone on top of the sill. They mainly consist of siliceous claystone and limestone/dolostone. The sill intrusion that was recovered in Sections U1547E-4R-2 to 24R-3 consists of (1) slightly to highly altered, nonvesicular to sparsely vesicular, plagioclase phyric to aphyric basalt and (2) slightly altered, nonvesicular to sparsely vesicular, clinopyroxene-plagioclase phyric dolerite. The latter porphyritic lithology shows subophitic textures. Glass margins and sediment mingling occur in both textural types of recovered basalt.

The sediments recovered in Holes U1548C–U1548E are similar to the succession recovered in the previously drilled Holes U1548A and U1548B in that they are mostly biogenic with clay minerals as the main detrital siliciclastic components. The Subunit IA/IB and IB/IC boundaries were observed at variable depths. The first occurrence of micrite-rich diatom ooze, which characterizes the Subunit IA/IB boundary, is shallower in Hole U1548C (26.6 mbsf) and is deeper in Hole U1548D (60.1 mbsf) compared to the same boundary in Holes U1548A and U1548B (~40 mbsf).

The sediments recovered in Hole U1552A revealed high lithologic variability over a relatively small depth interval. Over the uppermost 22 m of penetration (Cores U1552A-1H to 3H), they contain homogenous diatom clay with shell fragments; clay-rich, laminated diatom ooze; subordinate micrite concretions and disseminated accessory micrite mixed with diatom and clay; and diatom-rich silt that constitutes the top of a ~6 m thick depositional unit that has a sandy base. Visible deformation and gas expansion distinguish the clay-rich diatom ooze recovered in Core U1552A-4H. Gas hydrates were observed during core retrieval at this depth.

Structural geologists focused on analysis of the faulting seen at Site U1550 and the folding seen at Site U1551 in Subunit IB. More than 250 planar structures in the igneous rocks from Hole U1547E (fractures, joints, chilled margins, and veins) were measured and analyzed. In Hole U1548C, 65 planar structures were measured in the recovered sill material. Several samples of probable columnar jointing with two preserved vertical faces at angles of 110°–120° were found in the cores. Glassy chilled margins measured as planar features in several samples show that the margins of the sills locally had a variety of dips relative to the drill hole axis, including shallow, steep, vertical, and inverted.

Biostratigraphy

The biostratigraphy team worked on split core and core catcher samples from Holes U1551A, U1548D, U1548E, U1552A, and U1552C for analysis of calcareous nannofossils and marine diatoms to obtain a temporal framework for the sedimentary succession of each hole. The occurrence of calcareous nannofossil *Emiliania huxleyi* and the absence of nannofossil *Pseudoemiliania lacunosa* and marine diatom age marker *Fragilariopsis reinholdii* at the bottom of all holes suggests an age younger than 0.29 Ma for the bottom of the cored sedimentary sequence at Sites U1548, U1551, and U1552.

Paleomagnetism

The paleomagnetism team completed the analysis of archive-half sections from Cores U1551A-1H to 19F by using the superconducting rock magnetometer (SRM). Detailed alternating field (AF) demagnetization (up to 60 mT) on 19 discrete samples supports the data obtained from the archive-half sections. Similar to previously drilled sites, these samples show two magnetic components, the first of which is removed by 10 mT and corresponds to a drilling-induced overprint. The second component is stable and has a normal polarity. Combining the SRM and discrete sample results, the analyzed cores at Site U1551 were assigned to the normal Brunhes Chron C1n (<0.78 Ma), in agreement with the biostratigraphic datums.

The Ringvent structure was revisited and new holes were cored. In Hole U1548E, archive-half sections from Cores U1548E-4R to 24R contain igneous rocks of which only the natural remanent magnetization (NRM) was measured. Archive-half sediment sections from Cores U1548C-1H to 7H and U1548D-1H to 13H were analyzed. The AF demagnetization results from 7 and 13 discrete samples, respectively, support the SRM results. Sediment cores from Holes

U1548C and U1548D were assigned to the normal Brunhes Chron. Demagnetization of Hole U1548E cores is ongoing.

Inorganic Geochemistry

The inorganic geochemistry team collected interstitial water (IW) samples from Site U1551, Holes U1548C–U1548E, and Hole U1552A. Analyses of IW samples for all these holes are ongoing. Since the collected IW samples are limited due to thick layers of unconsolidated sand at Site U1551, it is hard to decipher the IW downhole properties. However, as evidenced by a nearly complete sulfate depletion coinciding with concentration peaks for dissolved sulfide, as well as methane and alkalinity, the sulfate/methane transition zone (SMTZ) is located ~25 mbsf at Site U1551. Authigenic carbonate precipitation is visually observed at Site U1551, and is reflected in IW composition by a sharp decrease in Ca^{2+} concentration.

Organic Geochemistry

The organic geochemists performed safety gas monitoring in Holes U1551A–U1551B, U1547E, U1548C–U1548E, and U1552A–U1552C. Anomalous headspace gas C_1/C_2 values were observed at Sites U1548 and U1552, but hydrocarbon concentrations were low. In Holes U1551B, U1547E, U1548C–U1548E, and U1552B, an extensive suite of sediment and gas samples were taken for both shipboard and shore-based analyses. In Holes U1547E and U1548C, 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. In holes where gas voids were noted in the cores, their extent was quantified and they were subsampled on the core receiving platform with a gas-tight syringe for hydrocarbon, H_2, and CO analyses. 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

For Holes U1548D and U1548E, syringe samples for cell counts (deposited in fixative) were taken paired with IW samples. In Holes U1552A and U1552B, WR core samples for the IODP archive and syringe samples for cell counts were taken. In Holes U1551B, U1548C, and U1552B, WR core samples were collected on the core receiving platform for a full set of microbiological studies. Syringe samples for cell counts (deposited in fixative), RNA analysis (flash frozen in liquid nitrogen and stored at −80°C), and samples for assessment of contamination using PFTs were taken directly on the core receiving platform. The WR core samples were immediately frozen or flushed with nitrogen and stored in gas-tight laminated foil bags at 4°C until further processing. Preliminary cell counts were done for Hole U1551B using epifluorescence microscopy. Samples of igneous rock were collected from Hole U1547E. Based on visual inspection of the recovered cores, selected parts of or full sections were imaged and temporally stored in gas-tight laminated foil bags after flushing with N_2 gas. Selected section

pieces were opened in an anaerobic glove box, sampled, and allocated for high-temperature cultivation, stable isotope probing, lipid biomarker analysis, cell counts, thin section staining, scanning electron microscopy coupled with Raman spectroscopy, mRNA analysis, ion microprobe analysis, and DNA analysis.

Physical Properties

The physical properties team measured cores from Site U1551. For Hole U1551A, the 19 cores that were recovered to a depth of ~120 mbsf were passed through the Whole-Round Multisensor Logger (WRMSL) and Natural Gamma Radiation Logger (NGRL). Thermal conductivity (TCON), moisture and density (MAD), *P*-wave velocity, and strength were measured on sediment sections halves. A similar procedure was applied to the six cores that were recovered to a depth of ~50 mbsf in Hole U1551B. For Hole U1547E, the 23 recovered cores that penetrated to a depth of ~190 mbsf were measured on the WRMSL and NGRL. Cubes and pieces were collected from the Hole U1547E igneous rocks for discrete *P*-wave, TCON, and MAD analyses. In Hole U1548D, physical properties were measured on WR and working-half sections from 13 cores, representing 110 m of penetration. The 12 cores from Hole U1548C were measured on the WRMSL and NGRL. Initial WRMSL and NGRL measurements commenced on WR core sections from Hole U1552A.

Outreach

During the eighth week of Expedition 385, we released ten posts on Facebook (https://www.facebook.com/joidesresolution), which produced 1,063 engagements and 10 new followers. On Twitter (https://twitter.com/TheJR), 13 tweets generated seven new followers and 294 engagements. The Instagram account (http://instagram.com/joides_resolution) released two posts that produced 176 engagements and 27 new followers. Our weekly takeover of the AGU Instagram account on 7 and 8 November included seven posts that gained 1,288 engagements and 1,234 likes. We published six blog posts with 542 views combined. The expedition's website (https://joidesresolution.org/expedition/385/) had 181 new views.

We conducted four ship-to-shore live events that connected with Indonesia, South Korea, and the United States. One broadcast connected with a French-speaking high school in South Korea. In Indonesia, we connected with a teacher meeting in Jakarta. In the US, we connected with the Smithsonian National Museum of Natural History and Texas A&M University. The total number of people in attendance was 77.

Technical Support and HSE Activities

The IODP JRSO technical staff supported science operations at Sites U1547, U1548, U1551, and U1552.

Laboratory Activities

- Curation of igneous rock cores and WR pieces that were returned to sections after special shipboard analyses were completed.
- Extensive sampling of cores from multiple holes on the core receiving platform for microbiology and geochemistry, and extensive processing of samples in the Microbiology and Geochemistry Laboratories.
- High-resolution multiquadrant images taken by the imaging specialist of core pieces from Hole U1548C for use in a 3-D tomography science project.
- Collection and preservation of gas hydrate samples from Site U1552.
- Preparations for shipments.

IT Support Activities

- Investigated several instrument workstations that did not show a good backup status. A reboot of workstations cleared most issues. One workstation had to have its status manually cleared. All workstations are currently showing good backup status.
- Follow-up with McAfee about repository issues, but no current status updates. Their software development group is still investigating the matter and will contact the Marine Computer Specialists when they have a solution.
- Encountered multiple short duration VSAT outages on 6 November. All ship equipment indicated normal operations during outages. Suspected weather- or shore-related issues as the culprit.
- Transferred ~7.3 GB of requested Oracle files to shore.
- Server preparations for end-of-expedition activities started.

Application Support Activities

- Continued work on the Launcher application, starting the testing phase.
- Continued work on the Catwalk sampling application that has been deployed for testing, including fixing of bugs that had resulted from shipboard testing.
- Resolved an issue with SampleMaster where all section top/bottom depths for a hole were off by exactly 1 cm.
- Continued to assist geochemists with removing duplicate NGA results from LIMS.
- Fixed an issue with DrillReport that was caused by the change from daylight saving to standard time.
- Solved several minor routine issues with various software products.

HSE Activities

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