IODP Expedition 385: Guaymas Basin Tectonics and Biosphere

Week 4 Report (6–12 October 2019)

The fourth week of International Ocean Discovery Program (IODP) Expedition 385, Guaymas Basin Tectonics and Biosphere, comprised (1) HLAPC/XCB coring from 283 to 361 m below seafloor (mbsf) in Hole U1546A, (2) APC/HLAPC/XCB coring to 334 mbsf in Hole U1546B, (3) drilling without core recovery to 308 mbsf in Hole U1546C, and (4) RCB coring from 308 to 474 mbsf in Hole U1546C. All times in this report are in ship local time (UTC – 7 h).

Operations

This week began with half-length advanced piston corer/extended core barrel (HLAPC/XCB) coring in Hole U1546A. On 6 October 2019, Cores 51F to 64X penetrated from 283.0 to 361.2 mbsf. Formation temperature measurements were made through deployment of the Sediment Temperature 2 Tool (SET2) after Cores 51F and 57X. We switched to XCB coring to penetrate through a hard carbonate layer on Core 53X. After Core 54F, we permanently deployed the XCB coring tool in stiffer sediment formations. Our goal was to deepen the hole to the top contact of a seismically imaged sill at around 350 mbsf. We eventually intersected the sill contact on Core 63X at ~358.5 mbsf. Upon recovering another interval of the same sill in Core 64X at 2120 h, we started pulling the drill string out of Hole U1546A from a final depth of 361.2 mbsf. The bit cleared the seafloor at 2320 h on 6 October, ending Hole U1546A. Cores U1546A-1H to 64X penetrated from the seafloor to 361.2 mbsf and recovered 365.7 m (101%).

We then moved the vessel 20 m to the east to position the bit for spudding Hole U1546B. After installing the sinker bars, we lowered the bit to the seafloor to start advanced piston coring (APC) in Hole U1546B. We spudded Hole U1546B at 0050 h on 7 October. Mudline Core 1H recovered 4.3 m. This established a seafloor depth of 1585.6 mbsl. Cores 1H to 23H penetrated from the seafloor to 202.5 mbsf. We switched to the XCB coring tool to core through a hard layer at 134.8 mbsf (Core 16X). We pumped perfluorocarbon tracers (PFTs) downhole on all cores for monitoring drilling fluid (seawater) contamination. As in Hole U1545B, Hole U1546B was dedicated to extensive collection of whole-round (WR) cores for microbiology and biogeochemistry research. Throughout 7 October, the pacing of coring was adjusted to the complex microbial sampling program conducted on the core-receiving platform. On 8 October, we continued coring using the HLAPC and XCB coring systems. Cores 24X to 58X penetrated from 202.5 to 331.3 mbsf. We mainly deployed the HLAPC coring tool to a depth of 293.3 mbsf (Core 54F) and switched to the XCB coring tool whenever we had to core through hard carbonate layers. This happened at several depths, corresponding to Cores 24X, 27X, 31X, 34X, 36X, 40X, 42X, 46X, 48X, and 53X. Starting with Core 55X, we deployed the XCB system permanently. We continued deploying PFTs downhole on all cores. On 9 October, we started the day with XCB coring in Hole U1546B. Core 59X penetrated from 331.3 to 333.8 mbsf. We then

terminated coring at 0045 h and pulled the drill string out of the hole to prepare for transit to Guaymas, Mexico, to conduct a medical repatriation of a crew member. The bit cleared the seafloor at 0215 h, ending Hole U1546B. In this hole, Cores U1545B-1H to 59X penetrated from the seafloor to a final depth of 333.8 mbsf and recovered 351.2 m (105%). After the bit had arrived on the rig floor at 0530 h, we secured the vessel for transit. At 0600 h, we began our transit to Guaymas. We arrived at the pilot station at 1215 h, and the patient disembarked the vessel at 1225 h. After the pilot boat had left, we began the sea passage back to Site U1546.

We arrived on site at 1730 h and switched to dynamic positioning mode. At 1815 h on 9 October, we started preparations to spud Hole U1546C. We assembled the rotary core barrel (RCB) coring tool and made up the RCB bottom-hole assembly. We then began lowering the drill string to the seafloor. After the bit had reached a water depth of 1564 mbsl, we picked up the top drive, deployed the center bit, and positioned the end of the drill string for spudding Hole U1546C. At 0305 h on 10 October, we spudded Hole U1546C (40 m south and 20 m east of Hole U1546B). We then drilled without core recovery from the seafloor to 308.2 mbsf, while pumping 20 barrels of high-viscosity mud. Upon recovering the center bit at 1330 h, we began RCB coring. Cores 2R to 7R penetrated from 308.2 to 360.4 mbsf. The recovery increased substantially after a formation change from the sedimentary overburden (16%) to the underlying sill (69%) at the bottom of Core 6R at ~356 mbsf. On 11 October, Cores 8R to 14R penetrated from 360.4 to 405.5 mbsf. To monitor drilling fluid (seawater) contamination, PFTs were pumped downhole on the first two entirely igneous Cores 7R and 8R that were critical for microbiology sampling. We then stopped PFT deployment at 366.6 mbsf. On 12 October, Cores 15R to 28R penetrated from 405.5 to 473.6 mbsf. Core 20R intersected the bottom sill/sediment contact at 431.7 mbsf. We pumped PFTs on Cores 21R and 22R, the first two sediment cores below the sill. By the end of 12 October, Hole U1546C had penetrated to 473.6 mbsf and recovered 95.5 m (58%).

Science Results

Scientists described and analyzed cores recovered from Holes U1546A, U1546B, and U1546C. Scientists also submitted their Site U1545 reports and summaries. We held the second science summary meeting for Site U1545 on 6 October, with half of the laboratory groups presenting their results to the entire science party.

Core Description

During the past week, we described and analyzed cores from Holes U1546A to U1546C. At this site, we recovered both sediments and igneous rocks (sill). In general, the sediments recovered above the sill are correlative between the three holes at Site U1546 and comprise one unit (Lithostratigraphic Unit I).

The sediments are mostly laminated and primarily a mixture of biogenic (mainly diatoms) and siliciclastic (mainly clay minerals, with minor terrigenous silt). Other components include authigenic carbonates that locally form micritic/dolostone concretions. We have so far defined four subunits (IA through ID) mainly based on diagenetic boundaries, including a depth interval (Subunit IB) characterized by the abundance of micrite (dolomite; Subunit IA/IB and IB/IC boundaries) and the dissolution of diatoms and the opal A/opal CT transition (Subunit IC/ID boundary). Structural observations included soft-sediment deformation such as tilted bedding, faults, and folds in the upper two subunits. Brittle fractures and faults were observed in Subunits IC and ID, indicating preexisting brittle phenomena, with some mineralized veins in the sill.

A ~75 m thick mafic sill was encountered at the base of Hole U1546A and was fully penetrated in Hole U1546C. The top sediment/sill contact zone was recovered in Holes U1546A and U1546C (between ~356 and 358 mbsf), and the bottom sill/sediment contact zone was only penetrated in Hole U1546C at 431.7 mbsf. The sill was identified as part of lithostratigraphic Subunit ID. The top of the sill and the overlying claystone are separated by a contact zone (0.5–1 m thick) in which igneous and (meta)sedimentary rocks coexist. The sill is dominantly composed of plagioclase phyric dolerite and equigranular gabbro. The two lithologies show both gradational and sharp contacts. While the gabbro contains abundant vesicles, the doleritic part of the sill does not show vesicles except near the contact zone with the overlying claystone. The entire recovered section shows slight to moderate alteration, with plagioclase and pyroxene slightly altered to sericite and chlorite, respectively. Observed veins and vesicles are mostly filled with carbonates, zeolite, and clay minerals.

Biostratigraphy

This week, we finished analyzing samples from Hole U1546A split cores to examine calcareous nannofossil and marine diatom biostratigraphic markers. Calcareous nannofossils occurred in most samples examined, at various abundances and with primarily moderate to good preservation. Marine diatoms are abundant above 312 mbsf at Site U1546 with good to moderate preservation. The bottom occurrence of calcareous nannoplankton taxon *Emiliania huxleyi* dates the upper part of Hole U1546A as Holocene–Middle Pleistocene in age (0–0.29 Ma; 0–248.28 mbsf), whereas the absence of *Pseudoemiliania lacunosa* and *Fragilariopsis reinholdii* in samples from the underlying interval indicates a Middle Pleistocene age (<0.44 Ma) for the bottom of Holes U1546A and U1546C. The estimated average sedimentation rate is 856 m/My (85.6 cm/ky).

Paleomagnetism

The paleomagnetism team completed the analysis of archive-half Sections 385-U1546A-12H to 62X using the superconducting rock magnetometer. As most XCB cores were too disturbed to provide reliable paleomagnetic data, only the XCB sections that included longer, undisturbed intervals were measured. As in Hole U1545A, the magnetostratigraphy relies on (HL)APC cores (recovered from the seafloor to Core 54F) and associated discrete samples. No discrete samples

were taken from XCB cores as they proved too fractured to sample. The analyzed cores were assigned to the normal C1n (Brunhes) Chron (<0.78 Ma), in agreement with the biostratigraphy datums. No excursions could be identified in the paleomagnetic record of the measured sections. Therefore, we were not able to provide a robust age model for Hole U1546A. We have started demagnetization measurements on archive-half sections and discrete samples from Hole U1546C (Cores 385-U1546C-2R to 10R). From Core U1546C-7R onwards, the paleomagnetism and physical properties teams have been sharing their discrete samples.

Inorganic Geochemistry

We collected 34 interstitial water (IW) samples from Hole U1546B, and one IW sample from Hole U1546C using the Carver hydraulic squeezers. The maximum extracted water volume was 155 mL. Aliquots of the IW samples were distributed for shipboard and shore-based analyses. We also finished alkalinity, salinity, cation, anion, and nutrient analyses of 53 IW samples from Holes U1546A and U1546B. The results show that (1) the depth of the sulfate/methane transition zone (SMTZ) is around 120 mbsf; (2) alkalinity, sulfide, and phosphate show maximum values around the SMTZ; (3) ammonium (NH_4^+) increases with depth to a maximum value of 22.6 mM at the bottom of Hole U1546A at ~335 mbsf; and (4) dissolved silica, Sr^{2+}, Li^+, and B gradually increase with depth.

Organic Geochemistry

This week, we performed safety gas monitoring at Holes U1546A to U1546C with no observations of anomalous C_1/C_2 values. In Hole U1546B, we executed an extensive gas and solid phase sampling plan for both shipboard and shore-based analyses to complement the planned microbiological and biogeochemical objectives. We analyzed samples from Holes U1545A and U1546A on the source rock analyzer and completed carbonate and elemental analysis on samples from all holes of Site U1546. We worked with the developer team to facilitate the automatic upload to the Laboratory Information Management System (LIMS) database of gas chromatography peaks we were able to identify beyond the usual scope of C1–C6 hydrocarbons, including compounds such as 2-2-dimethylbutane and others. Personal samples for microbiology and biogeochemistry from Sites U1545 and U1546 were sampled and stored as necessary. Analysis of Site U1546 data is ongoing.

Microbiology

This week, the microbiologists sampled WR cores on the core receiving platform from Holes U1546B and U1546C. Samples were immediately processed (fixed, stored anaerobically at 4°C, or frozen). Incubations were set up for cultivation, radiotracer, and stable isotope experiments. Cell count samples were taken from the center of WR core samples using sterile cutoff syringes for sediments or ceramic knives for igneous rock samples. Fixed cells were stained and counted on board using epifluorescence microscopy. Tracer testing continued to monitor and quantify potential contamination from drilling fluid and mud.

Physical Properties

During the past week, we measured cores from Holes U1546A to U1546C. We measured the physical properties of 64 WR cores from Hole U1546A (to a depth of 360 mbsf) with the Whole-Round Multisensor Logger (WRMSL), Natural Gamma Radiation Logger (NGRL), and the Thermal Conductivity Meter (TCON). The preliminary data from these measurements show a correlation between bulk density (GRA), natural gamma ray (NGR), and magnetic susceptibility (MS). Noticeable depth intervals with distinct variations in material properties are clearly visible and are currently investigated in correlation with Hole U1546B. We also collected suitable formation temperature data to calculate a thermal gradient in Hole U1546A. Moisture and density (MAD), shear strength, and *P*-wave velocity measurements have been conducted on all section halves from Hole U1546A. For Hole U1546B, we recovered 59 cores to a depth of ~350 mbsf. We measured the physical properties on all WR core sections that remained following microbiology sampling. MAD samples were collected from every core after splitting to correlate with the headspace gas analysis. Finally, 18 cores from Hole U1546C have been measured with the WRMSL (without *P*-wave velocity) and NGRL. The contact zone between the sediments and the sill has been carefully measured by nondestructive petrophysical methods including discrete *P*-wave velocity measurements and TCON. Cubes collected for paleomagnetic measurements are currently processed for discrete *P*-wave velocity and MAD analyses following the hard rock measurement protocol.

Outreach

During the fourth week of Expedition 385, we released ten posts on Facebook (https://www.facebook.com/joidesresolution) producing 1,649 engagements and 14 new followers. On Twitter (https://twitter.com/TheJR), 15 tweets generated 14 new followers and 613 engagements. The *JOIDES Resolution* Instagram account (http://instagram.com/joides_resolution) released four posts that produced 403 engagements and 54 new followers. Our weekly takeover of the AGU Instagram account on 10–11 October included six posts that gained 969 engagements. We published three blog posts with 1,211 views combined. The expedition's website (https://joidesresolution.org/expedition/385/) had 1,087 new views.

We conducted four ship-to-shore live events this week, with a wide variety of audiences from Mexico and the United States. Two broadcasts were addressed to high schools, one connected to college undergraduate classes, and one toured the vessel for the Universum Science Museum in Mexico City. The total number of people in attendance was 99, plus 37 through YouTube and 2,200 via Facebook Live for the connection with the Universum Science Museum. We also conducted one separate Facebook Live event.

Technical Support and HSE Activities

The IODP JRSO technical staff supported the science operations at Site U1546.

Laboratory Activities

- Extensive sampling of cores from Holes U1546B and U1546C on the core receiving platform for microbiology and geochemistry.
- Extensive processing of samples in the Microbiology and Geochemistry Laboratories.
- On the Section Half Multisensor Logger (SHMSL), the QEPro spectrophotometer lost power due to a broken power cable. The cable was repaired and logging resumed.

IT Support Activities

- Replaced large screen display monitors in Bridge Planning, EPM, and OPS offices with new Samsung 58 inch UHD TVs.
- Replaced HP800PS plotter with new HP T1700 plotter in User Room.
- Worked with shore personnel and resumed antivirus software updates. Campus-implemented firewall configuration changes combined with new threat scanning capabilities blocked our usual updating scheme.
- Encountered Exchange/Outlook issues where password changes were not updating correctly. Worked with the central TAMU Help Desk to resolve the problem.
- Encountered VSAT outages due to the fall equinox between 29 September and 8 October.

Application Support Activities

- Worked extensively on the Catwalk sampling application.
- Added columns to the LORE Gas Report for the geochemistry team.
- Continued to work on getting all the data from the NGA gas chromatograph properly formatted and uploaded to LIMS.
- Working on an issue where the Section Half Imaging Logger (SHIL) loses connection to the LIMS database. This seems to be an IMS-wide issue.
- Solved a DESClogik issue caused by a column being renamed.

HSE Activities

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