IODP Expedition 385: Guaymas Basin Tectonics and Biosphere

Week 3 Report (29 September–5 October 2019)

The third week of International Ocean Discovery Program (IODP) Expedition 385, Guaymas Basin Tectonics and Biosphere, comprised (1) XCB coring from 372 to 503 m below seafloor (mbsf) in Hole U1545A, (2) downhole logging in Hole U1545A, (3) APC/HLAPC/XCB coring to 387 mbsf in Hole U1545B, and (4) APC/HLAPC/XCB coring to 283 mbsf in Hole U1546A. All times in this report are in ship local time (UTC – 7 h).

Operations

This week began with extended core barrel (XCB) coring in Hole U1545A. On 29 September 2019, Cores U1545A-60X to 73X penetrated from 372.1 to 498.6 mbsf. We made formation temperature measurements using the Sediment Temperature 2 (SET2) tool after Cores 61X, 66X, and 70X. Prior to each SET2 tool deployment, we circulated 20 barrels of mud for hole cleaning. On 30 September, the day started with Core 74X penetrating from 498.6 to 503.3 mbsf. This was followed by circulation of 20 barrels of mud for hole cleaning and a formation temperature measurement (SET2 tool). At 0345 h, coring was terminated in Hole U1545A based on the safety monitoring protocol as a result of a low methane/ethane (C_1/C_2) value. Upon circulating high-viscosity mud in the hole, we ran the Kuster Flow Through Sampler (FTS) tool and successfully recovered a borehole fluid sample from 490 mbsf at 0530 h. After circulating another sweep of high-viscosity mud, we started the deployment of the wireline logging tool strings. We raised the end of the drill string to a logging depth of 75 mbsf, made up the triple combination (triple combo) logging tool string (with natural gamma ray, porosity, and density sondes), and lowered it into the hole. Once the tool string tagged fill at ~488 mbsf, we performed a short calibration pass followed by a full logging run up to the seafloor. The tool string returned to the rig floor at 1500 h. After disassembling the triple combo tool string, we rigged up the Formation MicroScanner (FMS)-sonic (resistivity imaging) logging tool string. The tool string was lowered in the hole until it reached the fill at the bottom of the hole. The FMS-sonic tool string returned to the rig floor at 2300 h and was disassembled. While we were rigging down the logging tools, we deployed the subsea camera system to the seafloor to survey Hole U1545A, and we did not observe any gas release from the subseafloor through the drilled hole. The subsea camera system was recovered at 0200 h on 1 October. We then pulled the drill string out of the hole and the bit cleared the seafloor at 0225 h, ending Hole U1545A, which advanced to a total depth of 503.3 mbsf with a core recovery of 389.0 m (77%).

After the drill string was raised to a water depth of 1567.1 mbsl, we picked up the top drive, moved the vessel 20 m to the east, and lowered the bit to the seafloor to spud Hole U1545B. We then installed the sinker bars and started advanced piston corer (APC) coring at 0410 h on 1 October. This hole was dedicated to extensive collection of whole-round (WR) core samples for

microbiology and biogeochemistry research. Hole U1545B started with mudline Core U1545B-1H recovering 3.7 m. This established a seafloor depth of 1594.2 mbsl. Cores 1H to 17H penetrated from the seafloor to 147.6 mbsf by the end of 1 October. We made formation temperature measurements using the advanced piston corer temperature (APCT-3) tool on every third core starting with Core 4H. A partial stroke was encountered on Core U1545B-16H. On 2 October, we switched from APC to half-length APC (HLAPC) coring in Hole U1545B. Cores 18F to 39F penetrated from 147.6 to 245.8 mbsf. For formation temperature measurements, we deployed the APCT-3 tool on Cores 20F, 27F, 33F, and 39F, and the SET2 tool following Cores 27F, 33F, and 39F. Partial strokes were recorded on Cores 18F, 23F, 24F, 26F, 27F, 35F, and 36F. On 3 October, operations required alternating between the HLAPC and XCB coring tools. Cores 40F to 62X penetrated from 245.8 to 347.9 mbsf. We mainly used HLAPC coring to a depth of 328.5 mbsf (Core 60F) and switched to XCB coring on Cores 48X, 54X, and 57X after recording partial strokes caused by several hard carbonate layers. Starting with Core 61X, we deployed the XCB coring tool permanently after we had to drill over the core barrel on Core 60F. For formation temperature measurements, we deployed the APCT-3 tool on Cores 45F and 49F, and the SET2 tool following Cores 45F, 49F, and 60F. On 4 October, Cores 63X to 67X penetrated from 347.9 to 387.3 mbsf, and we made a formation temperature measurement following Core 63X with the SET2 tool. After the XCB bit was destroyed with Core 66X and we had advanced only 0.5 m in 45 min of coring Core 67X, we decided to terminate coring in Hole U1545B. At 0815 h on 4 October, we started pulling the drill string out of the hole. The bit cleared the seafloor at 0945 h and was pulled to a water depth of 1511 mbsl, ending Hole U1545B and Site U1545. Coring in Hole U1545B advanced to 387.3 mbsf with a core recovery of 340.1 m (88%). We pumped perfluorocarbon tracers (PFTs) downhole on all cores for monitoring drilling fluid (seawater) contamination. During the first two days of coring in Hole U1545B, the pacing of coring was adjusted to the complex microbial sampling program conducted on the core-receiving platform on all cores.

At 1005 h on 4 October, we started moving the vessel to Site U1546 (proposed primary Site GUAYM-02B) in dynamic positioning mode. The vessel completed the 0.6 nmi transit in 45 min, arriving at the site coordinates at 1045 h. Upon arrival, we started preparations for APC coring operations. We lowered the drill string to a water depth of 1558 mbsl and picked up the top drive. The bit was then positioned at 1581.4 mbsl (5 m above the seafloor depth obtained from the precision depth recorder) for taking the first core. Hole U1546A was spudded at 1230 h. Mudline Core U1546A-1H arrived on deck at 1250 h, recovering 3.8 m. This established a seafloor depth of 1586.1 mbsl. Cores 1H to 17H advanced from the seafloor to 155.8 mbsf by the end of the day. We made temperatures measurements on every third core using the APCT-3 tool, starting with Core 4H. On 5 October, we continued coring using the APC, HLAPC, and XCB coring tools. Cores 18H to 50F penetrated from 155.8 to 283.0 mbsf. After having to apply a strong overpull force of 80 klb (356 kN) to retrieve Core 21H, we switched to HLAPC coring. While using the HLAPC coring tool, we occasionally switched to the XCB coring tool to penetrate through hard layers. This happened on Cores 26X, 31X, 34X, 37X, 41X, 45X, and

47X. All APC cores were oriented. At several depths, we made formation temperature measurements using both the APCT-3 tool (on Cores 19H, 22F, and 28F) and the SET2 tool (following Cores 28F, 35F, and 43F). By the end of 5 October, Hole U1546A had penetrated to 283.0 mbsf and recovered 304.3 m (108%).

Science Results

Scientists processed cores recovered from Holes U1545A, U1545B, and U1546A, and started preparing their Site U1545 reports. We held the first science summary meeting for Site U1545 on 5 October, with half of the laboratory groups presenting their results to the entire science party.

Core Description

During the past week, the core description team (sedimentologists, petrologists, and structural geologists) described Cores U1545A-31F (202.9 mbsf) to 74X (target depth of 503.3 mbsf) and U1545B-1H to 67X (0–387.23 mbsf). Generally, the recovered sediments at Site U1545 are correlative and comprise a single unit: lithostratigraphic Unit I. The sediments are mostly laminated and represent primarily a biogenic (mainly diatoms) and siliciclastic (mostly clay minerals, with minor terrigenous silt) mixture. Other components include authigenic carbonates that locally form dolostone concretions, and an ~80 cm thick subvolcanic interval of microcrystalline basalt in Core U1545A-71X. Lithostratigraphic Unit I consists of four subunits (IA through ID) based on diagenetic evidence, including precipitation of micrite (dolomite) and the opal A/CT transition as defined by smear slide, X-ray diffraction (XRD), and other analyses. Structural observations include tilted bedding and folds, derived from soft-sediment deformation, and preexisting brittle fractures. Fractures are mineralized in the basalt that is part of Subunit ID. At the end of the week, we started describing cores from Hole U1546A, which contain diatom ooze and clay lithofacies and sedimentary/tectonic structures similar to those observed in the upper ~150 m at Site U1545.

Biostratigraphy

This week, the micropaleontologists finished analyzing core catcher samples from Hole U1545A and samples from split cores in Hole U1545B for calcareous nannofossil and diatom biostratigraphic markers. Calcareous nannofossils occur in most samples examined with various abundances, and the degree of preservation is substantially higher in samples from within the cores compared to the core catcher at the very bottom of each core. Marine diatoms are abundant above 296 mbsf at Site U1545 with good to moderate preservation. The bottom occurrence of calcareous nannoplankton taxa *Emiliania huxleyi* dates the upper part of both holes as Holocene to middle Pleistocene (0–0.29 Ma; Hole U1545A: 0–248.6 mbsf; Hole U1545B: 0–249.6 mbsf), whereas the absence of *Pseudoemiliania lacunosa* and *Fragilariopsis reinholdii* in the

underlying interval indicates a middle Pleistocene age (<0.44 Ma) for the bottom of both holes. The estimated average sedimentation rate is 857 m/Ma (85.7 cm/ka).

Paleomagnetism

The paleomagnetism team measured archive-half sections from Hole U1545A (Cores U1545A-33F to 74X) with the superconducting rock magnetometer (SRM). XCB cores were too disturbed and overprinted to yield reliable paleomagnetic data. Therefore, our interpreted magnetostratigraphy relies only on APC and HLAPC cores (from the top to ~280 mbsf), and on the analysis of discrete samples from working-half sections. The analyzed cores are assigned to the normal Brunhes Chron C1n (<0.78 Ma), in agreement with the biostratigraphic datums. We could not identify any magnetic excursions. Thus, no robust age model can be established for Site U1545. Cores U1545B-46F to 60F were measured with the SRM for possible correlation with Hole U1545A, as HLAPC cores were recovered deeper in Hole U1545B. This correlation is underway. At the end of the week, we started demagnetization measurements on archive-section halves and discrete samples from Hole U1546A (Cores U1546A-2H to 11H).

Inorganic Geochemistry

During this week, the inorganic geochemistry team finalized the Site U1545 analyses and started interstitial water (IW) extraction and analyses for Hole U1546A. The results for Site U1545 show (1) the sulfate/methane transition zone around 50 mbsf, (2) silica dissolution in the uppermost 300 m, and (3) authigenic carbonate precipitation in Subunit IA (0–70 mbsf) followed by carbonate dissolution and dolomite formation below. In Hole U1546A, we collected 19 IW samples (down to ~175 mbsf) and conducted chlorinity and alkalinity measurements. Chlorinity increases slowly from 550 to 580 mM from the seafloor to ~150 mbsf. Alkalinity reaches a maximum value of 31 mM around 70–80 mbsf and then starts decreasing below.

Organic Geochemistry

This week, the organic geochemists analyzed headspace gas and sediment samples from Hole U1545A while preparing for biogeochemistry sampling in Hole U1545B. Low C_1/C_2 values were observed from ~400 to 450 mbsf, dropping to very low values ~500 mbsf in Hole U1545A. Upon termination of coring in Hole U1545A, organic geochemists assisted in preparing the Kuster FTS tool for a test run. 600 mL of borehole water was collected from Hole U1545A, and this test run resulted in steps to minimize contamination from lubricants and the atmosphere. Upon beginning coring operations in Hole U1545B, an extensive sampling plan was initiated for both shipboard and shore-based analyses to facilitate the planned microbiological and biogeochemical objectives. Regular safety gas monitoring continued with void gas also being sampled and analyzed to monitor hydrocarbon content. Molecular hydrogen and carbon monoxide gas were also monitored using a third-party photometer gas chromatograph. Sediment samples from Site U1545 continued to be processed and analyzed for carbon, nitrogen, and sulfur content. At the start of Hole U1546A, WR core samples for shore-based culturing and

organic matter analysis were sampled in cold rooms and anaerobic chambers. Safety gas monitoring continued with no observations of low C_1/C_2 values in Hole U1546A.

Microbiology

The microbiologists took WR core samples from Hole U1545B for shipboard and shore-based laboratory research at the core-receiving platform. These samples were immediately frozen, fixed, or stored anaerobically at 4°C until further processing. We also processed WR samples for cultivation, and radiotracer and stable isotope incubations. These incubations were subsampled for their initial time points. Preliminary cell counts were performed from a subset of Hole U1545B samples. Monitoring of potential contamination continued by tracer testing, and sampling drilling fluid and mud for 16S rRNA amplicon sequencing and stable isotope incubations. Microbiologists also worked on the next WR sampling scheme for Hole U1546B.

Physical Properties

This week, we measured physical properties on WR core sections and discrete samples through Core U1545B-65X at a depth of 370.42 mbsf. Whole-Round Multisensor Logger (WRMSL), Natural Gamma Ray Logger (NGRL), and Thermal Conductivity Meter (TK04) measurements provided consistent data that are in line with the trends identified in Hole U1545A. Intact core section segments that remained after microbial WR sampling were measured with the WRMSL, NRGL, and TK04. Discrete samples for moisture and density analysis were taken from every second core near intervals where headspace gas samples were collected from the Hole U1545B WR samples. Downhole logging data from Hole U1545A were received following initial shore-based processing and are currently being evaluated. The petrographically confirmed basaltic composition of the microcrystalline sill recovered in Core U1545A-71X is consistent with its physical properties, including a thermal conductivity of ~1.6 W/(m·K). The week ended with processing of the first cores recovered from Hole U1546A.

Outreach

Our expedition continued to make headlines in Mexico and other countries. Eight posts on Facebook (https://www.facebook.com/joidesresolution) produced 1,087 engagements and 21 new followers. On Twitter (https://twitter.com/TheJR), 10 tweets generated 23 new followers and 258 engagements. The *JOIDES Resolution* Instagram account (http://instagram.com/joides_resolution) released eight posts that produced 740 engagements and 35 new followers. One Instagram story had 260 views. On 3–4 October, we took over the AGU Instagram account with six posts that gained 1,037 engagements and 24 new followers. We published four blog posts with 614 views combined. The expedition's website (https://joidesresolution.org/expedition/385/) had 304 new views.

We conducted six ship-to-shore live events this week, with a wide variety of audiences from Mexico and the United States. Three broadcasts were directed to elementary and high school students, two to college undergraduate classes, and one included a tour of the vessel for high school teachers. The total number of people in attendance was 165.

An overview of media coverage during this week is provided below.

Mexico

- UABC newsletter: http://gaceta.uabc.mx/notas/academia/participa-estudiante-de-doctorado-de-uabc-en-expedicion-oceanografica

Turkey

- Jeotermal Haberler (From *Think Geoenergy*, *El Universal*): http://www.jeotermalhaberler.com/jeotermal-potansiyeli-kesfetmek-icin-acik-deniz-arastirma-sondaji-kaliforniya-korfezi-meksika/

Technical Support and HSE Activities

The IODP JRSO technical staff supported the science operations at Sites U1545 and U1546.

Laboratory Activities

- We conducted extensive sampling of cores from Hole U1545B on the core-receiving platform for microbiology and biogeochemistry. It was a coordinated effort between the technical staff and science participants to mark, cut, catalogue, and preserve the samples.
- Routine deployment of the APCT-3 and SET2 temperature tools.
- Successful deployment of the Kuster FTS tool at the bottom of Hole U1545A.

IT Support Activities

- Encountered VSAT communication outages every day since 29 September at ~0745 h. Outages lasted ~15–20 min, possibly being related to the fall equinox time.
- Encountered situation where users lost Domain Name System (DNS) routing services. Rebooting DNS services resolved matter entirely.
- Assisted Ship's Doctor with accessing participant physical forms sent from HQ Human Resources. Problem was isolated to wrong-application-to-file association.
- Encountered a Windows 10 workstation that lost its activation. We connected it to the internet but were still not able to activate it. Further investigating revealed the wrong product key had been entered.
- Assisted scientist with recovering ~500 GB of personal files from their external drive.

Application Support Activities

- Continued work on the Catwalk sampling application project.
- Assisted Organic Geochemistry team with generating correctly integrated natural gas analyzer (NGA) gas chromatograph data, completing re-upload to LIMS, and removal of previous results.
- Working on a change to MUT to better fit current expedition NGA gas chromatograph workflow.
- Made a minor change to SampleMaster requested by the drillers.
- Worked on an improvement to VirtualPhotoTable involving regeneration of composite images.
- Assisted Marine Instrumentation Specialists with Excel formula/graph creation.

HSE Activities

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