IODP Expedition 385: Guaymas Basin Tectonics and Biosphere

Week 7 Report (27 October–2 November 2019)

The seventh week of International Ocean Discovery Program (IODP) Expedition 385, Guaymas Basin Tectonics and Biosphere, comprised (1) APC/HLAPC/XCB coring to 207 mbsf in Hole U1550A, (2) APC/HLAPC/XCB coring to 174 mbsf in Hole U1550B, (3) APC/HLAPC/XCB coring to 329 mbsf in Hole U1545C, (4) APC/HLAPC/XCB coring to 300 mbsf in Hole U1546D, and (5) APC coring to 54 mbsf in Hole U1551A. All times in this report are in ship local time (UTC − 7 h).

Operations

The week began while we were lowering the drill string to the seafloor to start coring in Hole U1550A with the advanced piston corer (APC) system. At 0315 h on 27 October 2019, we picked up the top drive and positioned the bit above the seafloor at a water depth of 1997.3 mbsl. We then spudded Hole U1550A at 0405 h. Mudline Core 1H recovered 5.8 m, which established a seafloor depth of 2001.0 mbsl. Cores 1H to 23X penetrated from the seafloor to 151.4 mbsf on 27 October. After encountering strong overpull force on Core 12H, we had to drill over the core barrel in order to retrieve it. We thus switched to the half-length APC (HLAPC) coring tool from 110.3 mbsf (Core 13F) onward. While deploying the HLAPC tool, we used the extended core barrel (XCB) coring system to core through infrequent hard layers that were penetrated on Cores 18X and 20X. Starting with Core 22X at 135.6 mbsf, we continuously deployed the XCB coring tool. We made formation temperature measurements with the advanced piston corer temperature tool (APCT-3) on Cores 4H, 6H, 8H, and 10H, as well as the Sediment Temperature 2 (SET2) tool following Core 15F. On 28 October, Cores 24X to 32X penetrated from 151.4 to 207.0 mbsf. After the XCB cutting shoe was destroyed on Core 32X, we terminated coring in Hole U1550A at 1200 h. Cores U1550A-1H to 32X penetrated from the seafloor to a final depth of 207.0 mbsf and recovered 190.9 m (92%). We pulled the drill string out of the hole and the bit cleared the seafloor at 1320 h, ending Hole U1550A.

The vessel then moved over to the Hole U1550B coordinates 55 m to the west of Hole U1550A. Upon cutting and reheading the core line, we loaded the sinker bars, deployed the APC core barrel, and positioned the bit above the seafloor at a water depth of 1997.3 mbsl. We spudded Hole U1550B at 1445 h on 28 October. Mudline Core 1H recovered 5.5 m, which determined a seafloor depth of 2001.4 mbsl. Cores 1H to 8H penetrated from the seafloor to 71.9 mbsf. On 29 October, Cores 9H to 23X penetrated from 71.9 to 174.2 mbsf. After encountering strong overpull force on Core 12H, we had to drill over the core barrel in order to retrieve it. We thus switched to the HLAPC coring tool at 109.9 mbsf (Core 13F). Upon encountering a partial stroke on Core 17F (131.7 mbsf), we deployed the XCB coring tool until refusal at 174.2 mbsf. Cores U1550B-1H to 32X penetrated from the seafloor to a final depth of 174.2 mbsf and recovered

160.8 m (92%). We pumped perfluorocarbon tracers (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. We terminated coring in Hole U1550B after recovering Core 32X and started pulling the drill string out of the hole. The bit cleared the seafloor at 1815 h. The decision was then made to return to Site U1545 to recover another complete set of microbiology and biogeochemistry samples from the northwestern part of Guaymas Basin. We secured the vessel for transit, and at 2233 h we switched from dynamic positioning (DP) to cruise mode, ending Hole U1550B and Site U1550. We started our ~31 nmi sea passage at 2300 h on 29 October.

We arrived at the coordinates of Site U1545 (proposed Site GUAYM-01B) at 0206 h on 30 October. Upon lowering the thrusters over the coordinates of Hole U1545C and switching from cruise to DP mode at 0228 h, we made up an APC/XCB bottom-hole assembly (BHA) and started lowering the drill string to the seafloor. At 0730 h, we picked up the top drive and positioned the bit at a water depth of 1589.0 mbsl. The sinker bars and core barrel were installed, and Hole U1545C was spudded at 0745 h on 30 October. Mudline Core 1H recovered 3.6 m, which determined a seafloor depth of 1594.9 mbsl. Cores 1H to 29F penetrated from the seafloor to 198.0 mbsf. After encountering a partial stroke on Core 16H, we switched to the HLAPC coring tool at 140.6 mbsf. The pace of coring was adjusted on some cores to accommodate the complex microbiology sampling program on the core receiving platform. On 31 October, Cores 30F to 63F penetrated from 198.0 to 329.0 mbsf. We deployed the XCB coring system whenever we had to core through hard carbonate layers, which happened on Cores 48X, 50X, 52X, 56X, and 60X. Cores U1545C-1H to 63F penetrated from the seafloor to a final depth of 329.0 mbsf and recovered 324.6 m (99%). We pumped PFTs for drilling fluid contamination monitoring on all cores. Upon accomplishing our microbiology sampling objectives at Hole U1545C, we started to pull the drill string out of the hole. The bit cleared the seafloor at 2025 h, ending Hole U1545C and Site U1545.

While cutting and reheading the core line, we moved the vessel in DP mode to the coordinates of Hole U1546D to recover an additional set of microbial and biogeochemical samples from Site U1546. We began to move at 2041 h and arrived at the Hole U1546D coordinates at 2214 h on 31 October. The sinker bars and APC core barrel were installed, and Hole U1546D was spudded at 2330 h. Mudline Core 1H recovered 3.9 m, which established a seafloor depth of 1585.9 mbsl. On 1 November, Cores 2H to 44F penetrated from 4.0 to 289.0 mbsf. On Cores 2H to 30H, we primarily deployed the APC coring system and switched to XCB coring whenever we had to drill through hard carbonate layers. This happened on Cores 13X, 26X, and 29X. After APC tool refusal, we predominantly used the HLAPC coring tool for Cores 32F to 44F. The XCB coring system needed to be deployed to break through hard layers on Cores 31X and 39X. On 2 November, Cores 45X to 47F penetrated from 289.0 to 300.1 mbsf. The XCB coring system was deployed on Core 45X to penetrate a hard carbonate layer. Upon accomplishing our microbiology sampling objectives, we terminated coring. Cores U1546D-1H to 47F penetrated from the seafloor to a final depth of 300.1 mbsf and recovered 314.7 m (105%). We pumped

PFTs for drilling fluid contamination monitoring on all cores. The drill string was pulled out of the hole and the bit cleared the rig floor at 0715 h on 2 November. We then secured the ship for transit to Site U1551, located ~29 km southeast of the northern axial graben of Guaymas Basin. At 0742 h on 2 November, we switched from DP to cruise mode, which ended operations in Hole U1546D and Site U1546.

Upon completing our ~34 nmi sea passage, we arrived at the Site U1551 (proposed Site GUAYM-15A) coordinates at 1213 h, lowered the thrusters, and switched to DP mode at 1219 h. We then made up an APC/XCB BHA and started lowering the drill string to the seafloor to start coring in Hole U1551A. At 1530 h, we picked up the top drive and positioned the bit above the seafloor at a water depth of 1836.8 mbsl. The orientation tool and APC core barrel were installed, and Hole U1551A was spudded at 1700 h on 2 November. Mudline Core 1H recovered 2.6 m, which determined a seafloor depth of 1844.1 mbsl. Cores U1551A-1H to 8H penetrated from the seafloor to 53.9 mbsf and recovered 55.2 m (103%).

Science Results

Scientists described and analyzed cores recovered from Holes U1550A, U1550B, U1545C, U1546D, and U1551A. The laboratory groups presented their Site U1547 and U1548 results at two science meetings on October 29 and 30, and submitted their combined Site U1547 and U1548 report, as well as their Site U1549 report.

Core Description

The core description team (sedimentologists, petrologists, and structural geologists) continued describing and analyzing cores from Sites U1549, U1550, and U1545. The sediments recovered at Site U1549 are mostly biogenic (mainly diatom ooze) with a significant (~10%) proportion of sandy to silty laminae and beds compared to the previous Sites U1545 through U1548. There was no evidence of significant lithologic and/or diagenetic changes in the relatively shallow sediments recovered at Site U1549, so only one lithostratigraphic unit has been defined. Unit I contains four distinct terrigenous deposits that were penetrated at different intervals downhole. These deposits are distinguished by their gray to black hues, and range from thin laminae to beds that can be several meters thick. Thicker beds are associated with basal sand to silt horizons that grade into clay-rich lithologies in overall fining-upward successions. The thickest terrigenous beds (>2 m) exhibit decreasing natural gamma radiation (NGR) and magnetic susceptibility (MS) and increasing b* color reflectance.

At Site U1550, the sediments consist of alternations between diatom clay and graded silt and silty sand beds. The lithological succession is complex with the occurrence of folded, tilted beds and laminae, as well as the presence of sand injection in diatomaceous sediment and disruption of sedimentary beds. Carbonate occurs as disseminated micrite or distinct concretionary beds in a

few cores in Hole U1550A. There is also an unusual bed containing gravel-sized scoria fragments.

No igneous rock was recovered at Site U1549. In contrast, we recovered igneous rocks in both Holes U1550A and U1550B. In Hole U1550A, igneous rocks are solely composed of dolerite with 60 vol% plagioclase in the groundmass, and show subophitic texture. Few sections are vesicular. Vesicles are rounded, filled with chlorite and carbonate, and are slightly altered. In Hole U1550B, nonvesicular basalt and dolerite were recovered. Dolerite shows subophitic texture, whereas the basalts are plagioclase-phyric and moderately altered. Occasional dolerite xenoliths are found in the basalt. Multiple calcite veinlets are present in both basalt and dolerite.

The sediments recovered in Hole U1545C are similar to those recovered in Holes U1545A and U1545B. They are mostly biogenic (mainly diatoms) in composition. Siliciclastic components mainly comprise 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 at depths similar to those identified in Holes U1545A and U1545B.

Biostratigraphy

The biostratigraphy team finished the assessment of Hole U1550A samples for nannofossil and marine diatom taxa description. The occurrence of calcareous nannofossils *Emiliania huxleyi* and the absence of diatom age marker *Fragilariopsis doliolus* at the bottom of Hole U1550A indicate a deposition age of Holocene to Middle Pleistocene (<0.29 Ma) for the entire sediment column. Examination of samples from Hole U1551A has not yielded any age-diagnostic species yet.

Paleomagnetism

The paleomagnetism team completed the analysis of archive-half sections from Site U1550 (Cores U1550A-1H to 32X and Sections U1550B-22X-1 and 23X-1) by using the superconducting rock magnetometer (SRM). The bottom cores of Hole U1550A (i.e., U1550A-30X to 32X) and Hole U1550B (U1550B-21X to 23X) contain igneous rocks of which only the natural remanent magnetization was measured. The remaining sections contain sediments. Only sections from Hole U1550A were demagnetized up to 20 mT using the SRM (Cores U1550A-1H to 29X). Detailed alternating field demagnetization (up to 60 mT) on 32 discrete samples taken from the sediments support the data obtained from the archive halves. Similar to previous sites, 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 SRM and discrete sample results, the analyzed cores were assigned to the normal Brunhes Chron C1n (<0.78 Ma), in agreement with the biostratigraphy datums.

Inorganic Geochemistry

The inorganic geochemistry team started the week by finishing the shipboard interstitial water (IW) analyses for Site U1549 (alkalinity, salinity, cations, anions, and nutrients). We then collected 42 IW samples and one mudline water sample from Site U1550, 13 IW samples from Hole U1545C, and 15 IW samples from Hole U1546D. The IW analyses for Site U1550 were finished and the analyses for Holes U1545C and U1546D are in progress. The results from Site U1549 show that (1) the sulfate/methane transition zone (SMTZ) is estimated around 25–30 mbsf; (2) the maximum concentrations of alkalinity and Mg^{2+} are 84 and 65 mM, respectively, and are located just below the SMTZ; and (3) the concentrations of Li^{+}, B, Sr^{2+}, and $H_4Si(OH)_4$ generally increase with depth below the SMTZ. Site U1550 displays a shallower SMTZ (10 mbsf). In addition, Li^{+}, B, Sr^{2+}, and $H_4Si(OH)_4$ concentrations show excursions around the sill. In general, IW profiles at Sites U1549 and U1550 display nonsteady state behaviors and are likely influenced by turbiditic events and/or slumps.

Organic Geochemistry

The organic geochemists performed safety gas monitoring in Holes U1550A, U1550B, U1545C, and U1546D. Anomalous headspace gas C_1/C_2 values were observed at Site U1550, but hydrocarbon concentrations remained low. In Hole U1550B, an extensive suite of sediment and gas samples were taken for both shipboard and shore-based analyses. In Holes U1545C and U1546D, headspace samples were taken for shore-based stable isotope analysis in addition to the safety headspace samples to facilitate biogeochemical correlation with Holes U1545B and U1546B. At Site U1550, igneous rock samples 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 U1550, 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 cores were collected on the core receiving platform in Hole U1550B. Syringe samples for cell counts (deposited in fixative), RNA analysis (flash frozen in liquid nitrogen and stored at −80°C), and contamination tracer were taken directly on the catwalk. The WR core samples were immediately frozen or flushed with nitrogen and stored in mylar bags at 4°C until further processing. Cultivation and radiotracer and stable isotope incubation experiments were started. Preliminary cell counts were done for Holes U1549B and U1550B via epifluorescence microscopy. Mudline water samples from each hole were filtered or frozen as a contamination control.

The discovery of considerable oxygen contamination in the shipboard nitrogen line that affected samples taken from Site U1545 earlier in the expedition (based on gas chromatography analysis

of headspace of arbitrarily chosen mylar bags) and the potential loss of anaerobic microorganisms led to the decision to revisit Sites U1545 and U1546. Holes U1545C and U1546D were cored down to ~300 mbsf (70°C) for additional microbiological sampling. Sampling and storage procedures for WR cores in Hole U1545C and U1546D were carried out as described for Site U1550. All samples from previous Sites U1545 to U1550, which were stored in Schott bottles with significant amount of headspace or mylar bags, were reflushed with nitrogen or argon.

Physical Properties

The petrophysics team finished the moisture and density (MAD) measurements on hard rock cubes from Sites U1547–U1549. Coring operations at Site U1550 recovered 32 cores in Hole U1550A to a depth of ~207 mbsf. They were measured on the Whole-Round Multisensor Logger (WRMSL) and Natural Gamma Radiation Logger (NGR). Thermal conductivity (TCON), MAD, *P*-wave velocity, and strength were measured on sediment working-half sections. A similar procedure was applied to the 23 cores that were recovered down to ~174.2 mbsf in Hole U1550B. The cubes collected from igneous rocks recovered in Holes U1550A and U1550B were processed for discrete *P*-wave velocity and MAD measurements. Upon return to Sites U1545 and U1546, 63 cores were recovered in Hole U1545C down to ~329 mbsf and 47 cores in Hole U1546D down to ~300 mbsf. The WR cores from both sites were measured on the WRMSL and NGRL. For the split sections, TCON and strength measurements are still being performed. Using the thermal conductivity results, we calculated the geothermal gradient in every hole cored during the week.

Outreach

During the seventh week of Expedition 385, we released nine posts on Facebook (https://www.facebook.com/joidesresolution), which produced 1,645 engagements and 17 new followers. On Twitter (https://twitter.com/TheJR), 35 tweets generated 16 new followers and 529 engagements. The Instagram account (http://instagram.com/joides_resolution) released 35 posts that produced 858 engagements and 56 new followers. Twenty-seven stories had 10,287 views. Our weekly takeover of the AGU Instagram account on 31 October to 1 November included seven posts that gained 617 engagements and 592 likes. We published three blog posts with 277 views combined. The expedition's website (https://joidesresolution.org/expedition/385/) had 219 new views. The Tumble Science Podcast for Kids (~60,000 subscribers) published an episode about the *JOIDES Resolution* and Expedition 385: http://www.sciencepodcastforkids.com/single-post/2019/11/01/The-Expedition-of-the-Science-Ship.

We conducted seven ship-to-shore live events, connecting with Brazil, Japan, Mexico, and the United States. One broadcast connected with a Japanese high school. Two more events were conducted during the Kochi Core Center Open Day. In Mexico, we connected with the Mexican

Geophysical Union and Centro de Investigación Científica y de Educación Superior de Ensenada (CICESE). In the US, we connected with James Madison University. In addition, we connected with the Universidade Federal do Paraná (UFPR) in Curitiba, Brazil. The total number of people in attendance was 550, with an additional 1,300 virtual viewers.

Technical Support and HSE Activities

The IODP JRSO technical staff supported the science operations at Sites U1545, U1546, U1550, and U1551.

Laboratory Activities

- Curation of igneous rock WR pieces that were returned to sections after special shipboard analyses were completed.
- Extensive sampling of cores from Holes U1545C and U1546D on the core receiving platform for microbiology and geochemistry, and extensive processing of samples in the Microbiology and Geochemistry Laboratories.
- Analysis of the nitrogen gas coming from the ship's nitrogen generator revealed extremely high contamination of oxygen. The nitrogen generator was inspected and it was found that an O-ring in one of the valves had failed. After the valve was repaired, the generator was restarted and quality improved dramatically. There is no indication of the exact time the failure occurred. Ultra-high purity nitrogen and argon bottles were used to reflush all sample storage bags and are in use for all remaining sample flushing to ensure minimal oxygen contamination.
- The QE Pro spectrometer on the Section Half Multisensor Logger gave anomalous values and calibration revealed that there may be a problem with it. The QE Pro was replaced, which seemed to fix the problem temporarily. Troubleshooting revealed switching USB communication cables will fix the problem but the anomalous values will return and the cables need to be switched again. Users are monitoring each scan for quality and troubleshooting continues.

IT Support Activities

- Found all shipboard Windows 7 installations and compiled listing for shore.
- Performed successful test of installing Rigwatch software on DHML PC53267 with Windows 10 64-bit and without dongle. Software works without dongle.
- Siem Offshore encountered email issues sending a standard Office Word document to OPS, triggering a rejection by shore bulk-relay server as spyware. Further investigation revealed format corruption within the Word document causing rejection. Creating a new document resolved the matter.

- Worked with Assistant Laboratory Officers on preparation of VSAT equipment for packing.
- Reinstalled Adobe Illustrator on PC53266 due to software corruption.
- Implemented change from daylight saving time to standard time.

Application Support Activities

- Continued work on the Launcher application, as test deployment approaches.
- Continued work on the Catwalk sampling application that has been deployed for testing.
- Resolved an issue with SampleMaster where all section top/bottom depths for a hole were off by exactly 1 cm.
- Assisted geochemists with removing duplicate NGA and CHNS results from LIMS.

HSE Activities

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