IODP Expedition 352: Izu-Bonin-Mariana Forearc

Week 3 Report (10–16 August 2014)

Operations

Week 3 of Expedition 352 (IBM Forearc) began while coring with the advanced piston corer (APC) at Hole U1440A from a depth of 49.0 m below seafloor (mbsf). The FlexIt core orientation tool was removed from the bottom-hole assembly (BHA) after Core U1440A-6H due to the high heave conditions. Formation temperature measurements (APCT-3) were taken on Cores 8H and 11H. Core 12H was a partial stroke of the APC piston when a hard formation was encountered, most likely around 101 mbsf. The coring system was switched to the extended core barrel (XCB) system and Core 13X was cut from 103.5 to 104.6 mbsf. Core 14X was the last core for Hole U1440A and extended to 106.1 mbsf. At the conclusion of coring, the drill string was pulled from the hole, clearing the rotary table at 0730 h (all times presented are ship local time, which is UTC + 9) on 11 August 2014, and ending Hole U1440A. A total of 12 piston cores were taken over a 103.5 m interval with a recovery of 96.4 m. Two XCB cores were taken over a 2.6 m interval with a recovery of 0.2 m. Overall core recovery for Hole U1440A was 91%. The total time spent on Hole U1440A was 49.25 h.

The ship was offset 20 m north to start operations at Hole U1440B. The APC/XCB BHA was laid out, and the crew prepared for installing casing. The casing running tool was made up to a stand of drill collars and racked back in the derrick. A reentry cone was moved on top of the moonpool doors. Based on the depth to basement at Hole U1440A, a 99-m-long casing string was assembled out of seven joints of 10.75 inch casing with a casing shoe welded onto the first joint, a 16 inch × 10.75 inch crossover, followed by a 16 inch casing hanger assembly. The casing string was then latched into the reentry cone on the moonpool doors, and the casing running tool was unlatched and pulled back up to the rig floor. Next came the assembly of a BHA composed of a 9.875 inch diameter drill bit, followed by a 9.5 inch underreamer (set to a 12.75 inch diameter), and a mud motor. After testing the mud motor and underreamer, the rest of the BHA was assembled, lowered through the reentry cone and casing in the moonpool, and finally latched into the reentry cone. The entire reentry system was deployed through the moonpool at 2130 h on 11 August and then lowered to just above the seafloor. Then the subsea camera was deployed to monitor the reentry system as it was drilled into the seafloor. Hole U1440B was spudded at 1100 h on 12 August 2014. At 1535 h, the reentry cone landed on the seafloor and the casing running tool (and drill string) was released from the reentry system at 1540 h. The subsea camera and drill string were pulled back to the surface, and the underreamer, mud motor, and casing running tool were laid out. From start to finish, the reentry system took 2.6 d to assemble and install.

A new RCB C-4 bit was attached to the BHA, the drill string was lowered to just above the seafloor, and the subsea camera was run to bottom. The ship started maneuvering for reentry at

0015 h on 14 August 2014 and Hole U1440B was reentered at 0021 h. After the subsea camera was retrieved, an RCB core barrel was dropped and coring began from 102.3 mbsf. The first two cores contained soft sediment and the basement was encountered at ~124.7 mbsf in Core U1440B-4R. RCB coring continued through Core 13R to 183.0 mbsf. Core 9G (102.3–144.1 mbsf) recovered 5.7 m of material while drilling back to the bottom of the hole following the repair of a leaking connection in the drill string. After Core 13R, a wiper trip was performed from the casing shoe to just above the bottom of the hole to improve drilling conditions. By the end of the week we had recovered Core 15R that extended to 202.5 mbsf.

Science Results

Hole U1439A

Remanent magnetization measurements were completed for 16 discrete samples from Core U1439A-17X. Some samples are affected by a strong, drilling-induced overprint. Nevertheless, portions of the hole can be correlated to the geomagnetic polarity timescale, and these correlations are consistent with the nannofossil ages.

Whole rock analyses of major and trace element concentrations by ICP-AES were performed on 22 sediment and two igneous rock samples representative of the different lithologies recovered in Hole U1439A. Data quality assessment of these results is ongoing. Sediment carbon and nitrogen compositions were also analyzed. As expected, carbonate contents follow the lithologic units and are highest in the nannofossil-rich carbonaceous ooze. Interstitial water (IW) samples were analyzed for salinity, alkalinity, pH, and Cl^-, Br^-, SO_4^{2-}, Na^+, K^+, Ca^{2+}, Mg^{2+}, and PO_4^{2-}. The major result of the IW analyses is a broad correlation with the lithologic units, with the exception of Mg^{2+} and Ca^{2+}. The distribution of these elements in the sedimentary column of Hole U1439A is invariant of lithology and shows a downhole increase in Ca^{2+} and a decrease in Mg^{2+} concentrations. These variations can be attributed to either (1) incipient dolomitization reactions or (2) hydrothermal alteration via fluids released from the basaltic basement.

Two meetings were held to review the scientific results from the sediments and igneous basement at Hole U1439A.

Hole U1440A

Three lithologic units are recognized above igneous basement in Hole U1440A. Unit I is further subdivided into three subunits and Unit II into two subunits. The top of Unit I (Core U1440A-1H, 0 cm, to Section 5H-1, 78 cm) comprises a soupy, nannofossil-rich mud, locally rich in siliceous microfossils. The remainder of Unit I contains mostly mud interbedded with thin, normally graded ash layers. Core disturbance is commonly extensive, likely accentuated by the high ship heave during coring. Unit II (Sections 5H-1, 78 cm, to 9H-3, 63 cm) is characterized by silty mud with a component of mud-matrix conglomerate-breccia. Unit III (Sections 9H-3, 63

cm, to 12H-CC) is mainly a matrix-supported, granule- to pebble-grade, breccia-conglomerate with abundant altered volcanogenic material. A thin layer of manganese oxide separates the sediments from the igneous basement beneath.

Samples U1440A-1H-CC to 5H-CC contain nannofossils sufficient for age diagnostics, although assemblages and abundances are greatly reduced in Cores 4H and 5H. Samples 6H-CC to 10H-CC are barren of calcareous nannofossils. Samples 11X-CC to 13X-CC again contain nannofossils sufficient for age diagnostics, although with heavy overgrowth features. Samples 5H-CC to 10H-CC are approximately Late Miocene to Recent in age while Samples 11X-CC to 13X-CC are Oligocene.

Igneous rocks were recovered in Cores U1440A-13X and 14X, which form a single igneous basement unit. Unit 1 begins in Section 13X-1, 5 cm (103.55 mbsf), and continues through Section 14X-1, 12 cm (104.72 mbsf). Recovery is very poor (7.1%), making characterization difficult. However, it appears that Unit 1 consists largely of hyaloclastite breccia with minor pillow or lava fragments. The recovered material consists almost entirely of basalt fragments that range from ~1 to 9 cm in length. The basalts in this section are all dark gray, aphyric basalt which differs significantly from the boninites of Hole U1439A.

Twenty-five sedimentary structures were measured down to 56.9 mbsf, below which severe drilling-induced deformation prevented further measurement of sedimentary or tectonic structures in the sediments.

All whole-round cores from Hole U1440A were measured for bulk density, magnetic susceptibility, *P*-wave velocity, natural gamma radiation, and thermal conductivity. *P*-wave velocity has values of ~1500 m/s from the top to 50 mbsf and increases gradually with variable values to the bottom of the hole. Magnetic susceptibility increases slightly from the top to ~70 mbsf, with a spike at ~53 mbsf. Bulk density is ~1.4 to 1.5 g/cm^3 with some slight shifts up to 1.8 g/cm^3 between ~36 and ~40 mbsf and between ~92 and ~100 mbsf. Natural gamma radiation shows some variation between the top and ~15 mbsf, stays constant between 15 and 20 cps to ~80 mbsf, and has variable values to the bottom of the core.

Remanent magnetization measurements were completed for 54 discrete samples and all of the archive-half sections from Hole U1440A. The upper ~50 m of Hole U1440A (APC cores) is placed within magnetic Chrons 1n–3n, but below that the record is difficult to interpret.

Six gas samples from Cores U1440A-7H to 12X and three samples from Cores U1440B-2R to 4R were analyzed for hydrocarbon safety monitoring. Six interstitial water (IW) samples (one per core) were analyzed from Hole U1440A. All IW samples were analyzed for salinity, alkalinity, pH, and Cl^-, Br^-, SO_4^{2-}, Na^+, K^+, Ca^{2+}, Mg^{2+}, and PO_4^{2-}.

Tests conducted on the performance of the portable X-ray fluorescence spectrometer indicate consistent relationships between signal intensity and concentration for basalt and andesite

reference materials. Signal intensities for fine-grained rock samples are comparable to those obtained from powdered samples. The results have been promising enough that we have begun conducting pXRF measurements on cut cores and thin section billets for preliminary identification of igneous rock types. Further testing of instrument performance, including the examination of a wider range of reference materials and previously analyzed boninites, is ongoing.

Hole U1440B

Cores U1440B-2R and 3R consist of a mud-matrix breccia-conglomerate interbedded with minor nannofossil ooze. In Section U1440B-4R-1, these sediments are directly underlain by fragments of basalt, several of which are coated by a several millimeter-thick coating of manganese oxide.

Samples U1440B-2R-CC and 4R-1 contain nannofossils that are most likely Oligocene in age.

Cores U1440B-4R through 15R recovered igneous basement, which consists primarily of basalt lava flows. All of the rocks were described macroscopically, imaged on the Section Half Imaging Logger (SHIL), and measured on the Section Half Multisensor Logger (SHMSL). A few cores contained long, oriented pieces appropriate for whole-round imaging. All cores were sampled for shipboard analyses, and 12 thin sections have been described.

The basement begins beneath a Mn-rich layer This layer also forms the base of the sediment in Section U1440B-4R-1, 27 cm. Its upper part is made up of 62 cm of fragments with mixed basalt lithologies which are interpreted to represent clasts in a talus accumulation. Below the presumed talus unit, aphyric basalts form units that vary slightly in appearance but retain essentially the same mineralogy and textures. Core 12R recovered basalts cut by a network of hydrothermal veins comprising quartz, calcite, epidote, and other phases. Core U1440B-9G, which contains cuttings of material that fell into the hole and was re-drilled when getting the bit back to the bottom of the hole, contains two horizons rich in basaltic glass. This glass probably represent pillow or sheet flow margins from the overlying lava flows, or hyaloclastite that was not recovered by coring. Glass from these horizons was hand-picked and will be used for shore-based analyses.

All of the recovered lavas are aphyric to very sparsely phyric (phenocrysts <1%) basalts with an intergranular to intersertal groundmass of plagioclase, clinopyroxene, and oxides. These basalts are typically sparsely vesicular and unaltered to weakly altered. Two recovered pieces have glassy rims that are the rims of pillow lavas or sheet flows. Unit boundaries are difficult to define but tentatively are placed where different textures are visible in hand specimen. More formal unit assignments will require geochemical data to define.

Fifty-six tectonic structures were measured in Cores 4R–12R. From 144.8 to 164.2 mbsf, the dominant tectonic structures consist of systematically sub-vertical extensional fractures, with ≤1 mm-thick filling, surrounded by millimeter-thick alteration seams (halos). From 164.2 to

165.90 mbsf, the dominant tectonic structures consist of sub-vertical to inclined whitish crystalline veins (up to 7 mm thick). These veins locally form crisscrossed networks with two dominant orientations at a high angle from each other. The wider veins appear to have formed in three successive steps of tensional opening. The material filling the veins consists mainly of calcite, with variable amounts of clays and quartz with other minerals tentatively identified in hand specimen to be chlorite, epidote, limonite, and boxwork secondary minerals after sulfide. Magmatic flow structures, defined by the alignment of platy or elongate minerals, are observed in Cores 8R and 10R, between 137.5 and 145.7 mbsf.

Whole-round bulk density, magnetic susceptibility, and natural gamma ray measurements were completed through Core U1440B-14R. Thermal conductivity measurements were completed on discrete samples through Core 8R. Moisture and density and *P*-wave measurements were completed on discrete samples through Core 6R.

Remanent magnetization measurements were made on four discrete samples from the working-half sections of sediment cores and six discrete samples from basalt cores (up to Core U1440B-11R). Because recovery is low, measurements using the cryogenic magnetometer were also made on 32 pieces taken non-destructively from the archive half.

Education and Outreach

The following activities took place: (1) Facebook (https://www.facebook.com/joidesresolution) and Twitter (https://twitter.com/TheJR) posts with photo albums and short science summaries, (2) daily blogs on http://joidesresolution.org/, (3) start of video conferences, (4) gathering of imagery and sounds for future projects, (5) shrinking of styrofoam cups for schools, (6) photo contest for shipboard participants, and (7) development of school curriculum.

Technical Support and HSE Activities

Technical staff supported science operations at Site U1440.

Laboratories:

- Modifications were made to core description software (DESClogik) templates and the Thin Section report format.
- The Section Half Imaging Logger continues to have issues with 0 kb TIFF files, missing files, and memory errors.
- Working with ASC to resolve DTech amplifier issue.
- Work on the proto-type M-Drive controller boards has begun.

HSE activities:

- Safety showers were tested in the laboratories.
- An abandon ship and fire drill took place on 10 August.