IODP Expedition 352: Izu-Bonin-Mariana Forearc

Week 4 Report (17–23 August 2014)

Operations

Week 4 of Expedition 352 (IBM Forearc) began while coring Core U1440B-16R with the rotary core barrel (RCB) from 202.5 mbsf. Coring continued through Core 17R before it had to be suspended for a short wiper trip to condition the hole. After the 2.75 h wiper trip, coring continued through Core 23R to 251.1 mbsf. Coring was suspended to change the RCB bit after rotating time on the bit had reached 39.2 h. The drill string was tripped to surface, with the bit clearing the seafloor at 1120 h and the rig floor at 2100 h on 18 August 2014. A new RCB C-4 coring bit was picked up and the drill string was tripped down to just above the seafloor at 0745 h on 19 August. The subsea camera was run to bottom at 1200 h, the ship manoeuvred for reentry, and the drill string reentered Hole U1440B at 1305 h. After the subsea camera was retrieved, the bit was lowered until it encountered an obstruction at 160.2 mbsf. After the problematic section was cleaned, the bit was run down to 251.1 mbsf and coring resumed. Coring continued with Cores 24R–32R to 338.7 mbsf (1345 h, 21 August). A wiper trip back to the casing shoe was performed, but while tripping back into the hole, another obstruction was encountered at 232.2 mbsf and the problematic section had to be cleaned. Coring resumed at 1800 h with Core 33R and continued through Core 36R to 377.6 mbsf.

While trying to retrieve the last core barrel, we experienced high torque and loss of circulation. The drill string was pulled up to 218.2 mbsf without circulation, at which point the torque returned to normal and we were able to run in with the wireline to retrieve Core 36R at 1850 h on 22 August. Circulation was then re-established, and the bottom-hole assembly (BHA) was checked to make sure that it was clean and free of cuttings. The bit was tripped back toward bottom, encountered an obstruction that had to be cleared at 235.0 mbsf, and eventually reached the bottom of the hole (377.6 mbsf) at 0045 h on 23 August. A core barrel was dropped and the hole was advanced 5 m to 382.6 mbsf. Core 37R was retrieved at 0930 h and was found to be empty. Since the bit might be obstructed, we deployed a core barrel with a bit deplugger to unblock core guides within the bit. When the core barrel with the bit deplugger was brought back to the surface, the sinker bar got stuck in the blocks. An inspection revealed slight damage to the wireline blowout preventer (BOP) and several hours were spent retrieving the sinker bar and replacing the damaged BOP part. We resumed coring, but after advancing the bit only 1 m in ~4 h, Core 38R was pulled and also came up empty. The core catcher sub showed signs of mechanical damage, which could only happen if the bit was damaged, and the decision was made to terminate coring and prepare for logging. Cores 16R–38R penetrated from 202.5 to 383.6 mbsf and recovered 18.2 m (10%).

Science Results

The whole rock chemical composition of 38 sediment and 19 igneous rock samples from Holes U1439A, U1440A, and U1440B was determined via ICP-AES, and the carbon and nitrogen compositions of 26 sediment samples were also analyzed. Analyses of volatile species for Hole U1440B basaltic samples via CHNS were hampered by concentrations that were below those of the detection limit of the instrument (<2 wt% total). Eleven ICP-AES measurements were repeated on carbonate-rich sediment samples from Hole U1439A to resolve inconsistencies between carbonate content estimates based on ICP-AES Ca and HCO_3 analyses. Ultimately the results from ICP-AES, portable XRF (pXRF), LOI, and inorganic carbon demonstrated that these samples suffered from incomplete decarbonation during ignition, leading to anomalously low results for Ca and other elements.

Extensive analytical work was conducted with the pXRF (1105 measurements) to (1) define a downhole chemostratigraphy at Hole U1440B and (2) assess the reproducibility and accuracy of pXRF measurements. Three different kinds of materials were measured to discern downhole variations not evident from hand specimen examination or thin section petrography: (1) powders for direct comparison with ICP results, (2) thin section billets cut adjacent to ICP samples (to compare rock and powder results for similar materials), and (3) archive-half pieces. To ensure that pXRF results were consistent to a first order with accepted values for international reference samples, an expanded correlation test was conducted including peridotite and boninite reference materials, and an automated Microsoft Excel correction sheet was constructed to facilitate data correction and comparison.

Hole U1439A sediments show a broad range of compositions, mainly marking the downhole changes in lithology, from the carbonate-rich calcareous ooze (CaO > 50 wt%, Sr up to 2000 ppm, total C up to 11 wt%, and Zr ~30–40 ppm) to the clay-rich and volcaniclastic-rich silty muds (CaO <2 wt%, Sr down to ~200 ppm, Zr up to 150 ppm, and no measured C). The downhole transition to igneous basement is marked by a thin, muddy, manganese-rich layer.

Site U1440 sediments are dominantly silty muds, with a more restricted range of compositions compared to the sediments from Hole U1439A. They have on average low CaO contents (<2 wt%), high SiO_2 contents (>55 wt%), and Cu of 120–240 ppm. A few samples display slightly higher carbonate contents with total C contents > 0.9 wt%, CaO of 5–22 wt%, and lower Cu contents (70–90 ppm).

The two igneous rocks sampled at Hole U1439A were confirmed by ICP-AES analysis to have major and trace element compositions characterizing them as low-Ca boninites. In contrast, the igneous rocks sampled at Site U1440 display a range of basaltic compositions.

At least 15 broad chemostratigraphic units are present in the basement cores of Hole U1440B. Calibrated pXRF measurements were integrated with the petrologic (macroscopic) and petrographic (thin section) data to define preliminary stratigraphic units. Igneous rocks in Cores

U1440B-16R to 31R are dominantly aphyric to sparsely phyric basalts with a groundmass of plagioclase, pyroxene, and oxides. Thin veins of quartz or calcite are present on fractures. These basalts exhibit some alteration, but otherwise are remarkably fresh. Glass forms selvages on some of the larger fragments and small glass-rich fragments are common. Some units consist largely of glass (variably devitrified) and were probably derived from hyaloclastite deposits. Other samples have glass selvages (variably devitrified) on crystalline basalt, and may represent pillow lava. Pillow structures are also evident in radial fractures emanating from a massive central area, with finer grained margins on the outer, curved contacts. Some samples appear to be coarser grained and may contain igneous fabrics consistent with dike intrusion. Igneous rocks in Cores U1440B-32R to 36R are fine- to medium-grained mafic rocks with doleritic to seriate textures. No chilled margins were confirmed, but these rocks appear to represent hypabyssal intrusive sheets. The first appearance of chlorite in Core 16R indicates higher temperature types of alteration.

Deeper in Hole U1440B, occurrences of chlorite increase in parallel with a decrease in clay mineral abundances. The general degree of alteration is variable, and the background alteration stays weak to moderate. This alteration is characterized by total replacement of the groundmass by clays and zeolite, and pseudomorphic alteration of plagioclase and clinopyroxene into chlorite, green amphibole, zeolite, and clays. Rarely, minute crystallization of calcite at the expense of the groundmass is observed in thin section. Veins were absent (or not recovered) down to Core 11R. Below Core 11R, the density of veins is variable. Below Core 16R, veins are omnipresent. Between Cores 16R and 27R, two types of veins are observed with variable orientation: (1) veins mainly filled by brownish clays, and (2) veins made of a cataclastic assemblage of calcite and zeolite. Rare sulfide and native copper were found in this interval. Chloritic veins, partially invaded by late carbonates, appear below Core 27R.

We measured 124 structures related to brittle deformation in Cores U1440B-16R to 36R. These structures mainly comprise veins and fractures without any observable displacement along the fracture planes. The vein-filling material of the studied structures consists of (Mg^{-}) calcite and/or zeolite and/or chlorite, as well as variable amounts of clays plus other minerals. Most fractures are surrounded by millimeter-thick alteration seams (halos). Veins with a thickness of up to 5 mm become very abundant in Cores 17R and 18R, mainly between 212 and 225 mbsf. Host-rock fragments are commonly embedded with precipitated vein material. The wider veins appear to have formed in incremental steps of extension. Below 225 mbsf, veins become less pronounced and decrease in abundance and thickness (between 1 and 2 mm). These veins locally form crisscrossed networks with two dominant orientations at a high angle from each other. Viscous flow fabrics related to magmatic flow were rarely observed and are limited to centimeter-wide domains. Microfabrics described in thin sections are mainly isotropic and do not reveal anisotropic fabrics related to magmatic flow.

Whole-round bulk density, magnetic susceptibility, and natural gamma ray measurements were completed for Cores U1440B-15R to 36R. Discrete sample moisture and density measurements

were completed for Cores 7R–26R, *P*-wave measurements were completed for Cores 7R–34R, and thermal conductivity measurements were completed for Cores 9R–34R. Cores 16R to 36R were split, imaged, and section halves were measured for magnetic susceptibility and color reflectance. Some cores had whole-round images taken prior to splitting. Magnetic susceptibility increases distinctively from ~1000 to >3000 IU at 265 mbsf. Natural gamma radiation is constantly <10 cps and decreases to <3 cps below 250 mbsf. *P*-wave velocities measured on discrete samples are in the range from 4500 to 5500 m/s. Porosity is consistently <10%, density is ~2.8 g/cm^3, and thermal conductivity is ~1.8 W/[m·K].

The remanent magnetization of igneous units was measured on 46 oriented pieces from archive-half sections of Cores U1440B-16R to 36R with the pass-through cryogenic magnetometer. In addition, 12 discrete samples were measured from the working-half sections through Core 26R, most with alternating-field demagnetization and a few with thermal demagnetization. To understand the magnetic grain properties, partial ARM acquisition curves were measured for five samples. The magnetic characteristics of the cores are highly variable, with coercivities ranging from low to high. In addition, some intervals display stable, well-behaved magnetizations and others display unstable magnetizations. The basement in Hole U1440B has predominantly normal polarity with a reversed polarity zone at ~175–225 mbsf.

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) blogs on http://joidesresolution.org/ and scientists' sites, (3) video conferences with Japanese and American schools and the University of South Florida, (4) research for future blogs, (5) interviews for technician video, (6) photo contest for shipboard participants, and (7) streamlining of education officer crossovers.

Technical Support and HSE Activities

Technical staff supported science operations at Site U1440.

Laboratories:

- The Section Half Imaging Logger had 64-bit LabView installed, after which point the 0 kb TIFF files and memory errors stopped. RGB and VCD capabilities have been restored.
- Working with ASC Scientific to resolve an amplifier issue with the discrete sample DTech AF demagnetizer. Scientists are able to work around the problem.
- Replaced the lift cylinder on the Section Half Multisensor Logger (SHMSL) *y*-axis.

- SHMSL color reflectance data were collected using Ultralene film to test the material for use on Expedition 353.
- Tested latest version of new generation of RGB and LSIMG Reports.

HSE activities:

- Eye wash stations and safety showers were tested in the laboratories.
- An abandon ship and fire drill took place on 17 August.