

IODP Expedition 352: Izu-Bonin-Mariana Forearc

Week 5 Report (24–30 August 2014)

Operations

Week 5 of Expedition 352 (IBM Forearc) began while pulling the drill string out of Hole U1440B. The rotary core barrel (RCB) bit cleared the seafloor at 0100 h on 24 August 2014 and was back on the rig floor at 0945 h. After setting back the RCB bottom-hole assembly (BHA), a logging BHA was assembled and run into the hole. The subsea camera was sent to the seafloor at 1800 h, Hole U1440B was reentered at 2125 h for the third and last time, and the camera was retrieved. The end of the drill string was set inside the 10.75 inch casing at 96 mbsf. The triple combo tool string was rigged up with the Ultrasonic Borehole Imager (UBI) at the bottom and run into the hole at 0630 h on 25 August. By 1645 h, two passes had been logged down to ~253 mbsf, where the tool string encountered an obstruction. Data was obtained from ~150 m of open hole, but not the lowermost ~130 m of the hole. Next, the FMS-sonic tool string was rigged up and run into the hole at 1830 h. Logging data were collected down to 243 mbsf, where another obstruction was encountered. The logging pass with the FMS-sonic tool string ended at 0200 h and the tools reached the surface at 0330 h on 26 August. The drill string was pulled out of the hole, clearing the seafloor at 0405 h, and the seafloor positioning beacon was retrieved at 0612 h. Once the beacon was on board, the dynamic positioning system was engaged to move the vessel back to Site U1439, while continuing to pull the drill string to the surface. Thirty-six RCB cores were taken over a 281.3 m interval in Hole U1440B and recovered 34.7 m (12%). The total time spent on Hole U1440B was 364.75 h. The total time spent on Site U1440 was 414 h.

The end of the drill string reached the rig floor at 1210 h on 26 August, and the 8.2 nmi transit to Site U1439 was completed at 1430 h the same day. Preparations began for installing the reentry system at Hole U1439C. First, the previously assembled reentry cone was moved to the moonpool doors at 1400 h, and a 16-inch casing hanger was latched in it. Second, a 178 m long casing string was assembled that comprises a 10.75 inch casing hanger and 13 joints of 10.75 inch casing welded together to reinforce the connections. A casing running tool was used to latch the casing string into the reentry cone at 2000 h. Third, a drilling BHA was made up that comprises a bit, underreamer, and mud motor. The underreamer and mud motor were tested and a running tool was used to latch the BHA into the reentry cone by midnight on 26 August. The reentry system was lowered to the seafloor by 0600 h on 27 August, the subsea camera was deployed to monitor the reentry cone while drilling it into the seafloor, and Hole U1439C was spudded at 0745 h. Drilling continued for 10.75 h until the reentry cone landed on the seafloor and the casing shoe was at 178 mbsf. The running tool was unlatched from the reentry cone at 1830 h, and the drill string was back on the surface by 0415 on 28 August. The total time for the reentry installation including the pipe trip was 40 h.

An RCB BHA was assembled with a new bit, and the drill string was lowered to the seafloor. The subsea camera was sent to the seafloor at 1245 h, and Hole U1439C was reentered at 1415 h. A depth check of the seafloor was performed (3129.2 m below sea level) and then the camera was brought back to the surface. RCB coring began at 1700 h on 28 August. Coring continued through Core U1439C-14R to 289.8 mbsf. A 1.5 h wiper trip was conducted on 30 August to check hole conditions, which were found to be good. Coring continued until the end of the week. Cores 2R–16R penetrated from 182.0 to 309.3 mbsf and recovered 31.8 m (25%).

Science Results

Site U1440 (24–26 August)

Following petrological studies carried out during the previous week, further work was carried out on the structure and geochemistry, and ~700 samples were collected for postcruise research.

Petrographic studies on Hole U1440B thin sections reveal that within the igneous units, viscous-plastic fabrics, related to magmatic flow, are rare and limited to millimeter- to centimeter-wide domains. In general, the magmatic microstructures are equilibrated, isotropic, and without indication of magmatic flow. Glassy materials and fine-grained basalts generally exhibit circular vesicles, although in one exception vesicles are elongated. Dolerites usually display no shape-preferred orientation of plagioclase laths, apart from a few small elliptical domains. Both basalts and dolerites exhibit a typical radial microstructural arrangement of plagioclase laths attesting of rapid cooling. Macroscopic foliations occur between 145–146 mbsf, 281–291 mbsf, and 358–369 mbsf. Microscopic observations reveal that elongate clusters of chlorite define the macroscopic foliation. Chlorite grains display an irregular orientation within the clusters. Consequently, these foliations are interpreted as resulting from a metamorphic overprint. Between 358 and 359 mbsf, centimeter- to decimeter-wide domains are characterized by a macroscopic foliation, sub-parallel to inclined, 1 to 2 mm thick calcite veins. These domains are accompanied by alteration halos. The microstructural examination shows that these domains consist of millimeter-spaced sub-parallel microfractures resulting in microbrecciation, thus forming a cataclastic fabric. Although the isotropic magmatic fabric can still be discerned, the magmatic minerals, such as prismatic plagioclase and clinopyroxene, are fragmented by multiple sets of microfractures.

X-ray fluorescence (XRF) “chemostratigraphic” analyses using the portable XRF (pXRF) instrument were conducted on archive-half pieces of Hole U1440B cores. The results of these chemical analyses, in conjunction with hand-specimen and thin-section observations, contributed to a lithological subdivision of the Hole U1440B lavas into 15 units.

Thirty-three igneous samples from Site U1440 were measured via ICP-AES. Most have basaltic compositions with SiO₂ ranging from 49–52 wt% and total alkali (Na₂O + K₂O) contents of 2.1

to 3.2 wt%. One highly differentiated sample had SiO₂ concentrations of 57%. They are variably depleted in incompatible trace elements, and have highly variable Cr concentrations (15–380 ppm), indicating different degrees of differentiation. At ~260 mbsf, downhole major element oxide profiles show an increase in SiO₂ concentrations. This depth corresponds to a unit boundary, which was tentatively interpreted to be between entirely volcanic units above and, lavas cut by dikes below.

The remanent magnetization was measured on 29 discrete samples from Hole U1440B igneous rocks. Both thermal and alternating field (AF) demagnetization techniques were used. Because recovery was low, the magnetization of 72 oriented archive-half core pieces was also measured, using AF demagnetization. The cored section was divided into three polarity zones: two normal zones at the top and bottom of the hole and a reversed section in the middle.

Two downhole logging tool strings were deployed in Hole U1440B. The first tool string was the triple combo with the ultrasonic borehole imager (UBI). This tool string reached ~253 mbsf (~150 m of open hole below casing) where an obstruction in the hole prevented logging of the lowermost ~130 m of the hole. The caliper data from this run indicate that the borehole was in reasonable condition, with a diameter of ~11–18 inches. The second tool string deployed was the FMS-sonic. This tool string was able to record acoustic velocity and electrical image data to ~243 mbsf. With the exception of the UBI images, the collected data are of good quality and are consistent with the data collected from the cores.

Site U1439 (26–30 August)

Cores U1439C-2R to 4R are dominated by hyaloclastites consisting of orthopyroxene- and olivine-phyric boninite. The breccia matrix consists of small lithic granules, crystals, and glass shards. Cores U1439C-4R to 6R are dominantly boninite lava, typically fractured and veined, with olivine ± orthopyroxene phenocrysts. These may represent a pillow lava flow within the breccia, and some interpillow sediment. This is underlain by more heterolithologic breccia with lava interbeds (Cores 7R–8R). Cores U1439C-9R to 13R are dominated by boninite lava, typically fractured and veined, with olivine ± orthopyroxene phenocrysts. Curved chilled margins on several of the larger pieces indicate that these are pillow lava flows, with some interpillow breccia. Fractures and veining are common in some sections, with most veins filled by calcite ± zeolite. Pipe vesicle trains in Sections U1439C-8R-2 and 9R-1 are inclined ~40° from vertical, indicating that the formation has been tilted by ~50°. Alternatively, this could be a younger, crosscutting dike. The entire sequence likely was the result of submarine hydromagmatic eruptions, interspersed with more quiescent lava flows.

Alteration in Hole U1439C is extremely variable, very fresh cores alternating with totally altered ones. The top of Hole U1439C is dominated by zeolite and clay minerals. Olivine and orthopyroxene are strongly altered into smectite and glass into clays and zeolite. A mixture of zeolites and clays fills the vesicles. Starting with Core U1439C-8R, chlorite and carbonates additionally become omnipresent. Ultramafic phenocrysts are constantly altered into smectite

down to Core U1439C-11R. Veins are abundant from the top of the hole. They are mainly filled by zeolite down to Core U1439C-5R and the proportion of carbonates progressively increases downhole. In Cores U1439C-10R and 11R, carbonate-rich veins form a dense network. Vesicles located in the vicinities of this network are completely filled with carbonates and zeolite.

In Cores U1439C-2R to 12R, 134 structures related to brittle deformation were measured. These structures mainly comprise fractures without observable displacement along the fracture planes, and veins. The vein-filling material consists of (Mg-) calcite and/or zeolite as well as clay. Veins have thicknesses of <1 mm up to 7 mm. Host-rock fragments are commonly embedded within precipitated vein material. The wider veins appear to have formed in incremental steps of extension. The veins locally form crisscrossed networks with two dominant orientations at a high angle from each other.

Physical properties were measured for whole-round and archive-half Cores U1439C-2R to 15R. Magnetic susceptibility values are high (>600 IU) at 185 mbsf, decrease to <200 IU at 220 mbsf, and increase again to >600 IU at 245–270 mbsf. Bulk density values are stable at $\sim 2.4 \text{ g/cm}^3$ from 180 to 290 mbsf. Natural gamma ray values are mostly <6 cps, with two peaks of >10 cps at 190 and 250 mbsf. *P*-wave values measured on discrete samples are $\sim 6000 \text{ m/s}$ at 185 mbsf and decrease to $\sim 4000 \text{ m/s}$ at 195 mbsf. Thermal conductivity is 1.2–1.9 W/[m·K].

Remanent magnetization measurements have begun on Hole U1439C igneous rocks, with archive-half core pieces having been measured through Core 352-U1439C-13R. Measurements are in progress on discrete samples from Cores U1439C-2R to 8R.

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 Meihu Junior High School (Japan), Unity Point School (Illinois), and the University of South Florida, (4) two videos uploaded to YouTube, (5) finalized interviews for inclusion in the technician video, and (6) a photo contest for shipboard participants.

Technical Support and HSE Activities

Technical staff supported science operations at Sites U1439 and U1440.

Laboratories:

- Serial port communication testing in progress to resolve issue with DTech demagnetizer.
- Completed cleaning and maintenance of Fantail geophysical equipment.

- Replaced batteries of Fo'c'sle deck –80 freezer.
- Worked on Thermal Conductivity file converter utility.

HSE activities:

- Eye wash stations and safety showers were tested in the laboratories.
- An abandon ship and fire drill took place on 24 August.