

## **IODP Expedition 352: Izu-Bonin-Mariana Forearc**

### **Week 8 Report (14–20 September 2014)**

#### **Operations**

Week 8 of Expedition 352 (IBM Forearc) began while cutting Core U1441A-21R at 198.7 mbsf. Coring continued through Core 22R to 205.7 mbsf when we terminated coring in Hole U1441A as a result of poor core recovery, the rubbly nature of the formation, and high risk of getting stuck. The seafloor positioning beacon was recovered at 0914 h on 14 September while the drill string was being pulled to surface.

The vessel began the slow move to Site U1442 in dynamic positioning mode while continuing to retrieve the drill string. A new C-4 bit was added to the bottom-hole assembly (BHA), and the drill string was lowered to 3138 m. The vessel arrived at Site U1442 (proposed Site BON-5A) and a seafloor positioning beacon was deployed at 1658 h on 14 September. After the beacon landed on the seafloor, the vessel offset 500 m from the beacon at an azimuth of 81°. Hole U1442A was spudded at 2320 h on 14 September. RCB coring continued with non-magnetic core barrels from the seafloor to 403.1 mbsf (Core U1442A-44R). Basement was encountered at ~82.0 mbsf in Core 10R. With 46.1 h on the bit, preparations were made to change the bit. A free-fall funnel (FFF) was assembled in the moonpool and dropped at 1510 h on 19 September. The camera was lowered to the seafloor to observe the FFF and the drill string pulling out of the hole. The drill string was recovered and a new C-7 bit with a mechanical bit release was added to the BHA. The bit was lowered to the seafloor and Hole U1442A was reentered at 1105 h on 20 September. After clearing obstructions at 82 and 279 mbsf, coring resumed at 1700 h from 403.1 mbsf. At the end of the week, we were coring Core 47R at 431.3 mbsf.

#### **Science Results**

##### *Hole U1441A (14 September 2014)*

In Hole U1441A, Cores U1441A-17R to 22R consist of light gray, aphanitic basalt, with rare microphenocrysts of plagioclase. One piece has a chilled margin and coating of unaltered glass, suggesting that this unit may be a pillow lava. Core 19R contains a similar light gray, aphanitic basalt with 3% clinopyroxene phenocrysts (1–2 mm). All of the basalts at this site are forearc basalts similar to those at Site U1440.

Seven igneous rocks from Cores U1441A-10R to 22R were analyzed by ICP-AES for major and trace elements and by CHNS for CO<sub>2</sub> and H<sub>2</sub>O contents. The igneous rocks recovered from Hole U1441A have LOI of 2–4.6 wt%. They have higher H<sub>2</sub>O contents in upper Unit 1 and relatively uniform H<sub>2</sub>O contents of 2.0–2.5 wt% in the lower units.

The igneous rocks recovered from Hole U1441A are all basalts, with SiO<sub>2</sub> concentrations of 49–51 wt% and total alkali contents of 2–4 wt%. Overall, the major element composition of Site U1441 basalts is relatively homogeneous with MgO of 6.4–8.4 wt%, CaO of 10.7–11.6 wt%, and Fe<sub>2</sub>O<sub>3</sub> of 10.8–12 wt%. Site U1441 basalts mainly plot in the compositional field of MORBs and are very similar in composition to the IBM forearc basalts previously recovered by drilling at Site U1440 and by diving. One sample has a higher Mg#, lower TiO<sub>2</sub>, higher Cr, and lower Zr and Y concentrations than other samples from Sites U1440 and U1441, but remains both geochemically and petrographically distinct from Site U1439 boninites.

In the volcanic units of Hole U1441A, viscous-plastic fabrics related to magmatic flow are rare and limited to millimeter- to centimeter-wide domains, defined primarily at the microscale. The magmatic foliation is mainly defined by the shape-preferred orientation of acicular feldspar crystals that are embedded within a glassy or microcrystalline matrix. Extensional fractures, without mineral fillings, are subvertical and were observed at 180.45 mbsf. Subvertical to inclined, whitish, crystalline, millimeter-thick veins are abundant between 190.2 and 190.6 mbsf. The veins form steeply inclined conjugate sets. The vein-filling material consists of Mg-calcite and/or zeolite and/or chlorite.

Physical properties measurements were made on Cores U1441A-19R to 22R. Whole-round (WR) core magnetic susceptibility values are 500 IU and gamma ray attenuation (GRA) density values are 2.4–2.7 g/cm<sup>3</sup>. Natural gamma ray (NGR) values are <5 cps. Bulk density values obtained from discrete samples are 2.6 g/cm<sup>3</sup> and porosities are <10%.

Paleomagnetic measurements were made on the sedimentary sections of Holes U1441A and U1442A. In both holes, magnetic inclinations define normal and reversed polarity zones. The inclinations are steep, typically >60°, which is probably an effect of sediment disturbance by RCB coring. However, there are significant gaps in core recovery that hinder interpretation. In addition, the reversal pattern shows a small number of polarity zones, whereas there should be several according to the biostratigraphic ages and the geomagnetic polarity time scale. Thus, we are unable to interpret the polarity record of the sediments in Holes U1441A and U1442A.

Remanent magnetization measurements were made on 14 and 16 igneous rock samples from Holes U1441A and U1442A, respectively. The Hole U1441A samples show both normal and reversed polarity, with normal polarity at the top and bottom of the section bracketing a reversed polarity zone. The magnetic inclinations are close to that of the current field, implying that these rocks may have been remagnetized in the near geologic past. Most of the Hole U1441A samples are from igneous Unit 1, which is thought to consist of talus, so the coherent inclinations are surprising. Remagnetization could explain the coherency of the jumbled pile of rocks.

#### *Hole U1442A (14–20 September 2014)*

Primary sedimentary structures in Hole U1442A were strongly disturbed by rotary drilling. The sediment in Cores U1442A-1R to 5R is mostly pale beige to pale brown, silty to sandy

nannofossil mud and nannofossil ooze. The sediment becomes slightly darker and more muddy toward the base of this interval, and the calcareous nannofossils decrease in the lowermost part of Core 6R. Dark gray patches are interpreted as the remains of admixed thin ash layers dispersed by bioturbation, reworking, and/or drilling disturbance. Core 7R reflects a change in sedimentation and consists of alternating layers of consolidated clay, varying from dark brownish to brownish black (manganese banding) to pinkish gray. After Core 7R, the sedimentation returns to olive- and pale-colored, structureless nannofossil ooze with conspicuous bioturbation and different amounts of silt and sand. The sediment becomes lithified toward the base of the hole in Cores 9R and 10R. Sediment bedding is subhorizontal down to Section U1442A-9R-2 and becomes inclined at the bottom of the sedimentary section. The top of the igneous basement in Core 10R includes five main clasts of altered extrusive igneous rocks that are subrounded and coated with manganese oxide. The clasts are supported within a matrix of pinkish colored, non-calcareous silty clay.

Sediments containing calcareous nannofossils were recovered from core catcher Samples U1442A-1R-CC to 9R-CC. An additional sample was taken from Section 10R-2, 22–23 cm, just above the layer containing igneous rocks. A fairly continuous, condensed section was recovered with sediments from the Eocene/Oligocene boundary up to the Late Pleistocene.

In Hole U1442A, igneous basement was encountered in Section U1442A-10R-3 and igneous units were described in Cores 10R–44R. The upper 165 m of this interval is dominated by hyaloclastite breccia, containing rounded lava globules from ~1 cm up to several centimeters across, in a matrix of green, altered glass ash, together with more angular fragments. Glass fragments are common, most of them completely unaltered. Intercalations of massive lava (13–20 m thick) occur at two levels. This base of this uppermost unit is bounded by a major fault zone at the top of Section U1442A-29R-2. Cores U1442A-30R to 44R below the fault are massive lavas, with some possible pillows. Boninites with abundant phenocrysts and aphyric or sparsely phytic basalts are found throughout this lower interval. There are no obvious breaks in chemistry or petrography. Some pieces appear to represent dikes intruded into the volcanic section. These samples are compositionally distinct from the rocks around them, with no vesicles or phenocrysts, and they have aphanitic cryptocrystalline textures that are common in shallow dikes. Chemostratigraphic pXRF measurements carried out on archive-half core pieces were used to identify Hole U1442A units.

Igneous basement Cores U1442A-10R to 24R contain few structural features in comparison with previous holes. The key structures include thin, subvertical tension fractures filled with zeolite and calcite. One piece in Core 24R contains a prominent planar fabric provisionally interpreted as flow banding in basaltic lava or rheomorphic flow in a tuff. Cores 27R to 30R contain 28 structures. The main features include carbonate and zeolite veins that tend to form conjugate sets with a steep to nearly vertical bisecting plane. A few microbreccias were observed at 238 and 247 mbsf. A 40 cm-thick shear zone with moderate dip is present at 248 mbsf in Section U1442A-29R-2. Below this shear zone, a damage zone characterized by a fracture network was

recovered within Cores 30R–33R. Below Core 33R tectonic deformation structures become progressively less abundant.

Physical properties measurements were made on sediment Cores U1442A-1R to 10R and igneous basement Cores U1442A-10R to 40R. WR magnetic susceptibility values are 50–400 IU in the sediments and 100–1500 IU in the basement. GRA values are 1.3–1.7 g/cm<sup>3</sup> in the sediments and 1.7–2.4 g/cm<sup>3</sup> in the basement. NGR values are 5–25 cps in the sediments and 5–15 cps in the basement. *P*-wave values are 1500–1600 m/s in sediment WR cores and 3000–5500 m/s in igneous rock discrete samples.

### **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 University of Edinburgh (UK), University of Haifa (Israel) with the Israel Minister of Science in attendance, University of South Florida (FL), College of Charleston (SC), Modesto Junior College (CA), Austin Community College (TX), Eastern Mennonite School (VA; two broadcasts), H.H. Dow High School (MI; seven broadcasts covering 17 classes and ~450 students), and St. Anne School (CA); (4) National Geographic blog; and (5) postings on AGU's blogosphere.

### **Technical Support and HSE Activities**

Technical staff supported science operations at Sites U1441 and U1442.

#### **Laboratories:**

- Completed sampling of Hole U1439C and U1441A for postcruise research.
- Fixed SampleMaster issue that, on rare occasions, caused the cores from a previous hole to be reassigned to a new hole. This update has not been deployed pending testing.
- Testing of new ThermconFileConverter utility is in progress.
- Developing proposal for needed enhancements to ICP Analyzer application.

#### **HSE activities:**

- Eye wash stations and safety showers were tested in the laboratories.
- An abandon ship and fire drill took place on 14 September.