IODP Expedition 350: Izu Bonin Mariana Rear Arc

Week 8 Report (19–25 May 2014)

Operations

Hole U1437E

This week we continued RCB coring in Hole U1437E. The expected safe bit life (50 h of rotation with weight on bit) had expired after cutting Core U1437E-54R (1573.0–1582.7 mbsf), which arrived on deck at 0005 h on 19 May. The day was spent round-tripping the drill string to replace the bit. The hole was swept with high-viscosity mud before the bit was raised with the top drive from 1583–1485 mbsf. The top drive was disengaged for the remainder of the trip and the bit cleared the seafloor at 0515 h on 19 May. The drilling line was slipped and cut on the rig floor as part of the general rig maintenance before the drill string was retrieved; the bit arrived back at the rig floor at 1100 h on 19 May. A new bit was installed and lowered to the seafloor. The camera was deployed and Hole U1437E was reentered at 1710 h on 19 May. The camera was retrieved and the bit lowered to 1489 mbsf, where resistance was encountered. The bit was pulled back to 1475 mbsf to engage the top drive, and washed to bottom (1582.7 mbsf) by 0215 h on 20 May. RCB coring resumed and continued until 0800 h on 24 May, except for 6 h on 22 May when rough seas forced us to suspend coring.

Cores U1437E-55R through -79R penetrated from 1582.7 to 1806.5 mbsf and recovered 107.55 m of core (48% recovery). At 0800 h on 24 May, the expected safe bit life (50 h) had expired again. The hole was swept with 30 barrels of high viscosity mud before the bit was raised to 1708.7 mbsf with the top drive. The top drive was disengaged for the remainder of the trip, with the bit clearing the seafloor at 1320 h and the rig floor at 1645 h on 24 May.

After installing the new bit, the drill string was lowered to the seafloor (1800–2200 h). At that time the camera transmission test, carried out routinely before the camera is lowered to the seafloor to guide reentry into the hole, failed to transmit a signal, indicating that the last of three fiber cables had broken. Measurements confirmed that the fiber was damaged at ~4000 m from the camera end of the cable—an interval that was never unspooled on Expedition 350. The other two fiber strands had been broken before our expedition and a replacement fiber optic cable is scheduled for installation next week in Yokohama. We lowered the camera to the seafloor to see if decompression from the spool might bring back the connectivity, without success. This prematurely ended our expedition's operations in Hole U1437E. Hole U1437E is currently in excellent condition for logging and/or further coring operations, preferably attempted soon, before the hole deteriorates.

Science Results

Site U1437

In addition to describing new core sections and thin sections obtained this week, the lithostratigraphy group continued to develop the Site U1437 report, with descriptions of lithostratigraphic Units IV, V, VI and VII taking shape, and first and second drafts of interpretative sections continuing revision.

Boundaries between Units IV and V (350-U1437E-6R-3, 122 cm; 1120.11 mbsf) and Units V and VI (350-U1437E-27R-CC, 15 cm; 1312.21 mbsf) were agreed upon this week. Based on macroscopic and microscopic observations and paleomagnetic data, it was agreed that the distinctive, moderately hornblende-quartz-feldspar phyric rhyolite-dacite interval described last week within Unit VI likely represents an intrusion and was designated as Igneous Unit 1. A separate description of this unit is in progress.

Cores 350-U1437E-47R through -79R (1504.90 to 1800.3 mbsf) were described, and assigned to Unit VII (1459.8–1806.5 mbsf; ending in bottom of Hole U1437E). The bulk (~90%) of Unit VII consists of extremely thick-bedded, non-graded, non-stratified, poorly sorted, coarse-grained, angular andesitic volcaniclastic intervals, with clasts ranging from lapilli to block size. Some clasts have quenched margins, jigsaw fit textures, intricate fluidal margins, or peperitic margins. These indicate hot emplacement of clasts, margins of lavas or intrusions, or both. Unit VII is interpreted to be a vent-proximal deposit.

Unit VII is divided into upper and lower parts (above and below 1643.7 mbsf). The upper part (183.9 m thick) of Unit VII is black, and is a homogeneous deposit of unaltered glassy lapilli tuff and lapillistone, with abundant large clinopyroxene glomerocrysts and plagioclase glomerocrysts. The lower part (156.6 m thick) of Unit VII differs by being green (more altered). It contains lithic clasts instead of glass clasts, and it is coarser, with more abundant blocks (>6 cm in size). The clasts have more variable plagioclase and pyroxene contents. Both parts are probably andesite (geochemistry pending).

The black, upper part of Unit VII consists of lapilli-tuff and lapillistone that are non-stratified, well-sorted, non-graded, ranging from matrix- to clast-supported. The matrix consists of glassy fragments, crystals and lesser lithic fragments, with ~95% of the smaller clasts (<2 cm) made of angular, dense glass with phenocrysts of plagioclase and pyroxene. The glass is isotropic, and appears to be only slightly altered. In addition to the vitric clasts, less than a few percent of red-oxidized and less phyric volcanic lithic clasts occur throughout. Some of the lithic clasts >2 cm were described individually and are clinopyroxene-plagioclase phyric andesite, with variable phenocryst contents, set in a microcrystalline matrix; they reach a maximum of 42 cm in size, and some have quenched margins. The black upper part of Unit VII lacks stratification entirely, except for one thin (~25 cm thick) interval of crudely stratified ash; the rest is massive glassy lapilli tuff and lapillistone.

The green, lower part of Unit VII consists of lapilli tuff, tuff breccia and breccia, with clasts up to 53 cm in size. About two-thirds (n = 261) of the total clasts described individually in Unit VII are in Cores 350-U1437E-62R through 79R (1651–1806.5 mbsf). The majority of these clasts are moderately to highly clinopyroxene-plagioclase phyric andesite that ranges from non-vesicular to moderately vesicular, with vesicles mostly filled with secondary minerals. Some of the clasts have intricate fluidal margins, others jigsaw-fit brecciated margins, and in at least one case a clast appears to be surrounded by sediment with a baked margin. The group debated whether these "clasts" are in fact clasts, or instead represent the margins of lava/intrusive bodies. Fluidal, quenched, baked and jigsaw fit margins all indicate that the "clasts" were deposited hot and cooled in situ, but this does not resolve whether they were deposited as individual clasts, or represent the complexly embayed margins of igneous bodies. Further support of hot emplacement is provided by paleomagnetic inclinations from two of the "clasts" (discussed further below). Clasts with broken chilled margins are absent; these would be expected if the clasts had been transported and deposited after they cooled. The green, lower part of Unit VII has minor intervals of tuff, averaging about 20 cm thick, with variable color (brown, dark gray, red-brown and green). These thin tuff intervals are stratified or massive, non-graded or normally graded (with rare reverse grading), and commonly contain minor lapilli.

Headspace gases (n = 31) were analyzed for Cores U1437E-49R through -79R (1516–1800 mbsf) as part of the hydrocarbon safety program. Hydrocarbon abundances are consistently low with methane concentrations between 2.6 and 33 ppmv and ethane below the detection limit, barring Sample U1437E-55R-2, 114–116 cm (1584.7 mbsf) where it was detected in low abundance (1.7 ppmv). Only a few mudstone samples were collected for $CaCO_3$ and total carbon and nitrogen analysis due to the high abundance of recovered volcaniclastic rocks without intercalated mudstone. Measurements for $CaCO_3$ and total carbon and nitrogen contents are being completed for the remaining samples.

Chemical analysis of igneous rocks and igneous components in tuffs has continued using pXRF and ICP-AES techniques. A calibration for pXRF analysis of yttrium (Y) in igneous samples has been developed. Because the factory-set quantification of the pXRF instrument omits Y, computations were performed offline using raw spectral data. Characteristic peak intensities were background corrected and normalized to the intensity of the Ag K_α Compton peak to account for variable X-ray yields due to differences in the average density of the powdered rock samples. A minor correction on Y K_α is made by subtracting the Rb K_β interference using a constant ratio of Rb K_β/Rb $K_\alpha = 0.11$, which was determined from analyzing standards with known Rb/Y. Analyses of international reference rocks agree with certified Y values at the level of precision and accuracy for other trace elements reported by the instrument software. Deviations from the certified Y abundances are –4 % (relative) for JB-2 (basalts) and –16% for JR-2 (rhyolite). The stronger deviations for rhyolites are likely due to uncertainties in the Rb interference correction when Rb is >250 ppm.

Samples collected for analysis by pXRF (n = 29) consist primarily of clasts as opposed to bulk tephra samples, because large lapilli and blocks are much more common in the lower intervals of Site U1437, relative to the shallower intervals. Samples are dominantly intermediate, with Zr/Y between ~2 and ~4.

A third batch of ICP-AES samples consisting primarily of reruns of Unit I samples was completed. Unfortunately, ash layers from Unit I persistently yielded low analytical totals and will not be analyzed again. We suspect that ignition temperatures of 750°C were too low to drive off all volatiles, but higher temperatures resulted in fused beads sticking to the crucible. Successful ICP-AES analyses include five mud samples from Unit I and three bulk tephra samples from Unit V (U1437E-6R-3, 106–109 cm, 1120.0 mbsf; 7R-7, 71–74 cm, 1130.9 mbsf; and 17R-2, 114–117 cm, 1215.9 mbsf). Unit V tephras are uniformly andesitic (average SiO_2 = 54 ± 1 wt%) with trace element compositions similar to Unit IV rocks. Because of end-of-cruise preparations, further sampling for ICP-AES has been discontinued and the final batch of samples is being processed.

Physical properties measurements continued to be taken from Cores U1437E-49R to -79R (1524.4–1806.5 mbsf). Physical parameters of density, porosity, thermal conductivity, magnetic susceptibility (MS), natural gamma ray radiation (NGR), *P*-wave velocity and color reflectance were obtained. Several cores contained many fractured, loose pieces, so extra care had to be taken when handling cores. Four new physical properties (PP) units were defined. The upper boundary of PP unit 9 (1140–1315 mbsf) is below the lithostratigraphic Unit IV/Unit V boundary and is marked by a decreased scatter in density, porosity, *P*-wave velocity, and NGR measurements, as well as a decrease in the thermal conductivity values from ~1.9 to ~1.2 W/[m·K]. The upper boundary of PP unit 10 (1320–1460 mbsf) coincides with the lithostratigraphic Unit V/Unit VI boundary and is characterized by an abrupt decrease in the NGR values relative to PP unit 9 and a slight increase in the thermal conductivity (~1.2 to ~1.5 W/[m·K]). Measurements taken from Igneous Unit 1, within PP unit 10, yielded *P*-wave velocities of >5000 m/s. The top of PP unit 11 (1460–1575 mbsf) corresponds to the lithostratigraphic Unit VI/Unit VII boundary and is characterized by an abrupt decrease in the MS and a decreased scatter in density, porosity, and *P*-wave velocity values. The comparatively low MS readings could relate to the reported lack of opaque minerals. NGR values from the upper PP unit 11 are higher than in PP unit 10, before decreasing again in the lower part. PP unit 12 (1575–1807 mbsf) is defined by an abrupt increase in MS and increased scatter of *P*-wave velocities, relative to PP unit 11.

The paleomagnetic team focused on interpretation of magnetostratigraphy from discrete samples, as superconducting rock magnetometer (SRM) demagnetization and measurement of the archive section halves had become ineffective at removing the drilling overprint. Liquid nitrogen cooling of the samples, which serves to demagnetize the problematic overprints carried by multidomain magnetite, allowed us to recognize a magnetostratigraphy in Hole U1437E down to Core U1437E-26R, and to confirm the polarity record near the base of Hole U1437D. The newly

recognized datums are: C3An.1n base, 6.252 Ma, 1026.11 mbsf; C3An.2n top, 6.436 Ma, 1056.65 mbsf; C4n.1n top, 7.528 Ma, 1122.07 mbsf; C4n.1n base, 7.642 Ma, 1136.63 mbsf; C4n.2n top, 7.695 Ma, 1152.8 mbsf; C4n.2n base, 8.108 Ma, 1195.84 mbsf; C4r.1n top, 8.254 Ma, 1221.63 mbsf; C4r.1n base, 8.3 Ma, 1238.24 mbsf; C4An top, 8.771 Ma, 1302.83 mbsf.

The base of C3An.2n was not recognized: Hole U1437D ended in normal polarity, but the first core in Hole U1437E was reversed. Noting this, and the apparent break in the sedimentation rate across the change in holes, we suggest that a normal fault at or near the base of Hole U1437D has caused a loss of section between the two holes, although a hiatus may be indicated instead. Continuing the magnetostratigraphy into Hole U1437E leads to a last datum at 8.771 Ma near the base of lithostratigraphic Unit V. Extrapolating this rate to the core catcher of Core U1437E-36R (1402 mbsf) substantially underestimates the nannofossil-based age of 10.97–11.85 Ma at this depth. The most likely explanation is a hiatus at the boundary between Lithological Units V and VI. Magnetostratigraphy in Units VI and VII is proving impossible to recognize, with the exception of reversed polarity seen in Sample U1437E-35R-1, 125–127 cm, from Igneous Unit 1, indicating that coring had proceeded below the base of normal Chron C5n.2n (9.984 to 11.056 Ma), which spans the upper part of the lowest nannofossil datum.

Selected clasts in Unit VII, Cores U1437E-66R (n = 5), -70R (n = 3) and -72R (n = 3) were demagnetized in order to determine if they were emplaced cold or hot. The results showed that the dominant magnetic mineralogy is multidomain, making it difficult to recover the primary magnetization because of the strong overprint (particularly strong for clasts from Core U1437E-72R). However, Samples U1437E-66R-5, 106–108 cm, and U1437E-66R-6, 16–18 cm, display characteristic reverse polarity that might support an interpretation of hot emplacement, also made on the basis of textures described in core (above).

Rock magnetic analysis proceeded downhole to Core U1437E-40R, in lithostratigraphic Unit VI. $S_{-0.3T}$ in Hole U1437E stays tightly grouped at the high values reached at the bottom of Hole U1437D, indicating near-complete conversion of magnetic sulfides to pyrite. Despite the broadly similar lithological characteristics of Units III and V, the background log-linear downhole decrease in SIRM/k that persists throughout Units I through IV is absent from Units V and VI. Instead, SIRM/k values appear to be randomly scattered over a wide range. Coercivity spectra from partial anhysteretic remanence (pARM) analysis also show a wide range, from very magnetically soft (peak coercivity <20 mT) to harder (broad coercivity peak from 20–30 mT) without any systematic downhole trends. Increased alteration in the footwall of the possible normal fault near the base of Hole U1437D may be responsible for both the changes in rock magnetic characteristics, and for the degradation of the magnetic polarity signal that limits the recognizable magnetostratigraphy to above Unit VI.

The paleontology group examined the samples from Hole U1437E for their calcareous nannofossil content, examining smear slides from all core catchers from Cores U1437E-47R

through -73R. Additional samples from suitable mud intervals within cores were taken. All samples were barren of nannofossils and for this reason no samples were examined for planktonic foraminifers below Core U1437E-36R (1408 mbsf), examined last week.

Education and Outreach

The video session scheduling is virtually complete except for daily sessions with a UK science center this coming week, and the final session will be held on Wednesday May 28. Sessions involved multiple countries, including 42 in the UK, 57 in the USA, nine in Japan, four in the EU, one in Australia, and one in Iraq. Four were with universities, and most of the others were with 11–18 year olds. The total number of people reached was around 5270, mainly children/students but some adults. A live broadcast to SAGANet.org (Astrobiology social network) was successful.

Education resources are in the final formatting and editing stages to send to shore for uploading to the Deep Earth Academy and/or *JOIDES Resolution* websites as downloadable activities for children. All blogs to date were made available on the ship network for scientists to review.

Technical Support and HSE Activities

The technical staff has been fully engaged in supporting coring and science operations at Site U1437 while conducting "repository-style" sampling for the scientists' postcruise research. In addition, preparations for end-of-expedition activities and port call logistics have begun.

Laboratory

- The Bathy 2010 vendor software upgrade was finally received. The new software was installed without incident. The latest revision has brought the system back to full functionality and our set of new spares work.
- The integration sphere on the Section Half Multisensor Logger (SHMSL) was realigned as part of regular maintenance.

Development

- The issue that causes DESCLogik to insert 500 blank rows into the spreadsheet was resolved.
- The issue that caused LIMSpeak not to display some images properly was resolved.
- Meetings with tool pusher and operations superintendent regarding requirements for the new Driller Core Entry interface continued.
- The MUT uploader was modified to include alkalinity data; the LIMS Reports application was modified to display the correct "pH" symbol.

- A meeting was held to discuss acceptance/closure of the thin section report application.

Information Technology

- Working with the vendor, the issue with CommVault incorrectly identifying new tapes as bad was cleared after resetting the system's configuration. IT staff continue to monitor the situation.
- The shipboard AMS software upgrade was completed without incident.
- A shutdown in the HVAC for the server room was cleared while the auxiliary cooling system kept the room at operational temperatures.

Safety

- The weekly fire and boat drill was completed as scheduled.