IODP Expedition 350: Izu Bonin Mariana Rear Arc

Week 7 Report (12–18 May 2014)

Operations

Hole U1437E

During the previous week, coring in Hole U1437E advanced to 1194.0 mbsf, with 75% recovery. This week, RCB coring continued to 1582.7 mbsf.

On 13 May, after the first two days of coring (Cores U1437E-15R through -24R; 1194.0–1290.8 mbsf), the drill bit life cycle (~50 h of rotation with weight on bit) expired and a new bit needed to be installed. The bit was pulled from the bottom of the hole to 1077 mbsf with the top drive engaged. High torque, temporary loss of circulation, and up to 40 klb overpull required to raise the drill string indicated that the hole was packing off at 1281–1242 mbsf. After circulation was reestablished and torque and pull returned to normal levels, the top drive was removed and the drill string retrieved from 1077 mbsf, with the bit clearing the seafloor at 1025 h and the rig floor at 1400 h on 13 May.

After a few hours of rig maintenance, including installation of the upper guide horn, a new RCB bit was installed and lowered to the seafloor. The camera was lowered to the seafloor and Hole U1437E was reentered with the new RCB bit at 0010 h on 14 May. When the bit could not easily pass 1176 mbsf, it was raised to 1164 mbsf and the top drive was engaged. The hole was washed to 1206 mbsf, where another obstruction and high torque were encountered. After raising the bit back to 1174 mbsf, where normal torque was reestablished, the bit was washed down to 1290 mbsf and no fill was detected in the bottom of the hole. The hole was swept with 40 barrels of high viscosity mud and RCB coring resumed at 0915 h on 14 May.

Cores U1437E-25R through -31R penetrated from 1290.8 to 1359.0 mbsf and obtained 44.66 m of core (65% recovery). After Core 31R was recoverd, a wiper trip was conducted from 1291–1359 mbsf (0930–1630 h on 15 May) to clear the hole of drill cuttings. The procedure included two sweeps with 30 and 40 barrels of high viscosity mud, respectively.

Coring operations during the remainder of the week (15–18 May) retrieved Cores U1437E-32R through -54R (1359.0–1582.7 mbsf), yielding 94.81 m of core (42% recovery).

Science Results

Site U1437

We described ~233 m of core this week (Cores U1437E-8R through -46R; 1132.8–1495.8 mbsf), representing a recovery rate ~65%. Discussions are ongoing as to where to define the lithostratigraphic unit boundaries in Hole U1437E.

Tuffaceous mudstone and tuff dominate from Cores U1437E-6R through -27R (~1120 to 1320 mbsf) with the following lithofacies, listed in order of importance for the features used to demarcate stratigraphic unit boundaries: (1) pumice lapilli-tuff and pumice lapillistone; (2) reversely graded fiamme-rich lapilli-tuff with mudstone; (3) evolved tuff; and (4) tuffaceous mudstone. The tuffaceous mudstone lithofacies is silt sized, and moderately to highly bioturbated. When viewing the cores after they had dried, it became clear that many intervals originally described as tuffaceous mudstones are more likely to be bioturbated than equivalents of the reversely graded fiamme-rich lapilli-tuff with mudstone. The reversely graded fiamme-rich lapilli-tuff lithofacies is thin to medium-bedded, with very sharp basal contact immediately overlain by pale green to gray tuff that comprises abundant glass shards. This tuff grades upward into a matrix-supported, reversely coarse-tail graded fiamme-rich lapilli-tuff that contains bioclasts, typically foraminifers, and carbonate cement; it is weakly bioturbated. The evolved tuff lithofacies is typically silt to medium-sand sized and is similar to the evolved tuff lithofacies described in Unit III (see Weekly Report 4). This lithofacies is commonly normally graded with a sharp, crystal-rich base and a bioturbated top. The pumice lapilli-tuff and lapillistone lithofacies first appears as intervals ~5–10 cm thick in Section U1437E-16R-4 (1207.8 mbsf) and continues to Section 18R-6 (1230.0 mbsf); it is similar to the dominant lithofacies in Unit IV (see Week 5 Report).

Beginning with Core 28R (1320.0 mbsf), the thick to very thick bedded, clast-supported and matrix-supported polymictic pumice lapilli-tuff facies becomes dominant. Tuff (silt- to sand-sized) with occasional intercalated mudstone is a subordinate lithofacies, and tuffaceous mudstone is minor to absent. By Core 34R (1378.4 mbsf), igneous clasts in the lapilli-tuff are large enough (>2 cm) to be described independently. These clasts typically comprise altered green cryptocrystalline pumice, andesite lithic with variable amounts of feldspar, pyroxene and occasional amphibole, and minor scoria. One 121 cm thick moderately phyric hornblende-quartz-feldspar rhyolite-dacite, tentatively interpreted as an intrusive sheet with chilled margins and peperite, occurs within a continuous interval of clast-supported, polymictic pumice lapilli-tuff in Interval 35R-1, 76 cm to 35R-2, 55 cm (1388.9–1391.1 mbsf).

In Cores 25R through 27R (1290.8–1320.0 mbsf), strata become inclined at angles up to 30°, and small-scale deformational structures are pervasive. These include sub-vertical normal and reverse faults, both planar and anastomosing, up to >30 cm length, with apparent offsets up to 6 cm, and intricate fracture networks at cm and mm scale. These structures occur in all sedimentary lithofacies.

Daily work continued on report writing and resolving minor inconsistencies within DESClogik and Strater, and defining unit boundaries. Descriptions and figures for Units I–III were submitted, returned with comments, revised, and then resubmitted. Interpretations of the rocks observed in Holes U1437B and U1437D have been submitted and others are in draft form. Descriptions of Units IV and below are in the preliminary stages.

The geochemistry group continued to analyze headspace gases as part of the hydrocarbon safety program. Headspace gases (n = 39) for Cores 9R through 48R (1150–1516 mbsf) peaked at 347 ppmv methane and 13 ppmv ethane. Methane and ethane have been steadily declining in the deeper parts of the hole where the abundances and thickness of tuff, lapilli tuff and tuff breccia intervals increased relative to those of mudstone. Mudstone samples for $CaCO_3$ and total carbon and nitrogen analysis (n = 25) are being collected for the same core interval at a rate of one sample per core when mudstone is present.

Samples of bulk tuff, single lapilli-sized or block-sized igneous clasts from lapilli-tuff, and a microcrystalline rhyolite-dacite sheet intrusion were collected for major and trace elemental analysis by ICP-AES (n = 16). Reconnaissance pXRF samples (n = 72) were analyzed for the same rock types, and in addition for selected mudstone intervals. After filtering out analyses that are affected by impurities from calcareous mud or alteration (leading to unusually high or low CaO for given Fe_2O_3, respectively), CaO in volcanic and volcaniclastic rocks averages 5.5 wt% (n = 43). Despite the filtering, effects of alteration may still remain because green secondary phases adhere to the margins of some analyzed clasts. Bracketing CaO abundances of ~5 and 7 wt% correspond to SiO_2 of ~67 and 60 wt%, respectively, for Neogene volcaniclastic turbidites from the Izu arc. By comparison, the volcaniclastic rocks in Hole U1437E are thus on average intermediate in composition. The exceptions are evolved green, gray, or white fine-grained tuffs with CaO ranging between ~2 and 4 wt%. These evolved tuffs are more prevalent in sections shallower than Core 28R (~1320 mbsf), below which polymictic pumice lapilli tuffs are primarily intermediate in composition, with three clasts appearing more mafic (CaO > 9 wt%). Another exception is the conspicuous quartz and hornblende-bearing rhyolite-dacite at 1388.9–1391.1 mbsf, which has extremely low CaO (0.55 wt%). This value is the lowest analyzed for any rock collected at Site U1437.

The deeper sections of Hole U1437E, beginning with Core 28R (~1320 mbsf) also show on average lower Zr (58 ppm; n = 16) compared to shallower sections (average Zr = 100 ppm; n = 27), whereas the degree of differentiation estimated from CaO abundances remains largely constant (average CaO of 5.3 wt% for Cores 5R through 27R, and 5.8 wt% for Cores U1437E-28R and below). This trend is mirrored by generally decreasing Zr in mudstone with depth throughout Hole U1437E. A tentative conclusion is a waning influence of volcaniclastic materials with geochemical affinities to the rear-arc seamount chains. Preparations for ICP-AES analyses, which will permit further testing of this hypothesis, are ongoing.

Physical properties measurements continued on Cores U1437E-12R through -48R (1172–1524 mbsf). The basic physical parameters of density, porosity, thermal conductivity, magnetic susceptibility, natural gamma ray radiation (NGR), *P*-wave velocity and color reflectance were obtained.

Some thermal conductivity experiments returned no data due to samples having a rough surface, making it difficult to make a good contact between the sample surface and the puck probe. To solve this problem, an extra stage was implemented in the methodology, involving sample polishing prior to vacuum saturation.

A new function was added to the *P*-wave measurement system at the end of last week whereby the amplitude spectrum of the waveform generated by each core sample can be recorded. Testing identified some deficiencies with the software, so the previous program version was used for obtaining discrete *P*-wave velocity measurements. The readings of densities and velocities of some consecutive cube samples are very similar, and the difference in velocity measured in three directions has become very small, indicating that the rocks are becoming more homogeneous. The rhyolite-dacite in Core 35R generated relatively higher *P*-wave velocities than the average value of the core.

The paleomagnetic team completed AF demagnetization of archive section halves from Cores U1437E-14R through -45R. The strong magnetic overprint (already mentioned in the previous weekly report), characterized by a very steep inclination value (>70°), has so far prevented determination of the magnetostratigraphy from the study of the archive halves below Core 26R (1310 mbsf). AF demagnetization up to 15 mT on discrete samples (one every two sections) appears insufficient to remove the overprint. These samples were then given to the Physical Properties group. Subsequent higher AF demagnetization steps up to 50 mT, and thermal demagnetization up to 450°C, on these samples indicate a second overprint generated by the MAD measurements. Difficulty in removing the overprints, and the ease with which the rocks get remagnetized, suggest that the occurrence of low coercive multidomain grains make it difficult to recover the primary magnetization.

In order to remove the contribution of multidomain grains on the remanence, some discrete samples were cooled in liquid nitrogen in a shielded enclosure for several hours, until the nitrogen evaporated. This technique aims to cool the samples through the Verwey transition of magnetite (at 120 K), i.e., equivalent to a demagnetization at low temperature. The remanence measured after this low temperature treatment is significantly lower (more than 50% in some cases), indicating that the amount of multidomain grains is significant. The subsequent demagnetization steps allow the recovery of the primary magnetization on the majority of the samples, and eventually, recovery of the magnetostratigraphy. This series of measurements and the interpretation are ongoing.

The paleontology group examined all core catchers as well as additional samples from suitable mud intervals from Cores U1437E-4R through -46R (1107–1487 mbsf). The identification of

bio-events has proved challenging in Hole U1437E due to poor preservation (foraminifers and calcareous nannofossils are highly dissolved, recrystallized, or overgrown) and low abundance in both fossil groups.

Although standard calcareous nannofossil marker species were not present or not identifiable, it was possible to broadly constrain the age of the samples using a few preserved specimens. For example, it was possible to infer that Sample U1437E-25R-CC (1296.4 mbsf) is younger than 11.85 Ma (late Miocene) by the absence of *Cyclicargolithus floridanus* (T 11.85 Ma), and the presence of *Calcidiscus macintyrei* (B 13.36 Ma) and *Reticulofenestra pseudoumbilicus* > 7 µm (B 12.83 Ma). No planktonic foraminifer bioevents were recognized. The presence of *Globorotalia praemenardii* in Sample 15R-CC (1203.6 mbsf) places this sample at younger than 14.38 Ma (middle Miocene). Samples below Core 20R (1246.7 mbsf) are mostly barren of planktonic foraminifers, except Sample 27R-CC (1312.4 mbsf), which contains internal molds of *Orbulina suturalis*. These datums agree with a magnetostratigraphic datum of 8.771 Ma in Core 24R (1283.6 mbsf).

The foraminifer paleontologists have also been working on the electron microscope to illustrate their report, and taking light microscope pictures to document the coarse fraction samples across the various units recognized so far.

Education and Outreach

Video sessions were held with groups around the world, including Japan, USA, and Scotland. A video session for special needs students at a school in Scotland was a great success; the feedback proves that with careful thought and planning, all levels of groups can access the *JOIDES Resolution* and learn from it.

This week we had to cancel a significant zoom session that would have reached 10 schools from Montana with about 200 students in attendance. Their school district uses a hardware system to connect between schools and was incompatible with Zoom on the ship. Several solutions were tried to try and link the two systems that were unsuccessful, mainly due to the limited bandwidth needed to download applications. The Information Technology staff will install this software once we reach shore so future connections to systems (such as polycom) can happen.

The numbers of people accessing the blogs and Facebook continue to rise, with more links to new organizational and personal accounts. Updates, photos, and blog posts were disseminated to our various social outlets, including Facebook, Instagram, Twitter, and the *JOIDES Resolution* blog. Video projects are underway. We have received positive feedback of our outreach efforts, and evaluations are being solicited from all our onshore participants.

Technical Support and HSE Activities

Technical staff supported coring and science operations at Site U1437 while conducting "repository-style" sampling for the scientists' personal research. In addition, preparations for end-of-expedition activities and port call logistics have begun.

Laboratory

- IODP staff is working with ship's officers on implementing Siem Offshore's trash can color code system.
- The vendor software upgrades for the Bathy 2010 system still has not arrived.
- The vertical seismic profile (VSP) equipment was dismantled and stored.
- Work on future safety upgrades for the laser engraver is ongoing.

Development

- Investigations continue into what causes DESCLogik to insert 500 blank rows into the spreadsheet under certain circumstances.
- Developer met with Tool Pusher and Operations Superintendent regarding requirement for new driller Core Entry interface.
- Work continues documenting the requirements for hole data management tool. A new "Hole Management Utility" project website was created.
- Developer met with Curator and Assistant Laboratory Officer to finalize requirements for Sample Entry tool.
- MUT version 8.0, including upload of data from the upgraded Alkalinity software, was deployed.
- Alkalinity validation testing continues as time allows.

Information Technology

- The CommVault Oracle agent was installed on the server for Oracle backups. Testing for capability issues with our systems still needs to happen during port call or the next expedition.
- A log rotation scheme was implemented to minimize issues with excessive log file size for the Novell OES Servers.

Safety

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