IODP Expedition 350: Izu Bonin Mariana Rear Arc

Week 4 Report (21–27 April 2014)

Operations

Hole U1437D

RCB coring in Hole U1437D continued until 21 April with Cores U1437D-56R through -59R (941.6–980.4 m) recovering 33.6 m (87%). At this time, the bit had been rotating for 51.5 h and required changing, so we decided to stop coring and collect wireline log data. A free-fall funnel (FFF) was deployed and the drill string was pulled out of the hole.

The drill bit was dropped on the seafloor and we attempted to reenter Hole U1437D. The top connection of the mechanical bit release (MBR) was unable to slide into the FFF and the reentry was aborted. The drill string was pulled to surface with the end of pipe (EOP) clearing the rotary table at 0430 h on 22 April. The MBR top connection was removed and a logging bit was made up to the bottom-hole assembly (BHA). The drill string was then lowered and Hole U1437D was reentered at 1207 h on 22 April. The logging bit was set at 92.4 mbsf.

Three logging strings were deployed in Hole U1437D. The first tool string deployed consisted of the triple combo with the Magnetic Susceptibility Sonde (MSS). The triple combo-MSS string reached ~960 m, indicating about 20 m of fill had accumulated at the bottom of the hole. The data recorded from this first run show that the hole was in excellent condition, with a diameter barely exceeding the bit size for most of the hole. The second tool string deployed (FMS-sonic) was able to record high quality velocity data and electrical images to a maximum depth of 950 m. The final logging run was a vertical seismic profile (VSP) that obtained data at 14 depths spaced every 50 m from the maximum depth of 875 m. All logging operations were completed within 24 h and the equipment rigged down by 1330 h on 23 April.

The subsea camera system was lowered to observe the drill string exiting the FFF; however, a fishing line was observed tangled on the drill pipe approximately 300 m below the ship so the camera system was brought back up. The drill string was then pulled out of the hole, the drill string recovered, and the logging bit cleared the rig floor at 2235 h on 23 April.

A new RCB bit was made up to the BHA and Hole U1437D was reentered at 0630 h on 24 April. The drill string was lowered without circulation or rotation to a depth of 950 mbsf. The hole was then washed to the bottom of the hole (980.4 m) and coring resumed. Hole U1437D was deepened to 1104.6 m by the morning of 26 April. Cores U1437D-60R through -73R (980.4–1104.6 m) recovered 69.3 m (56%). At that time hole cleaning time was exceeding coring time due to crushed rock generated in the borehole that was difficult to remove, requiring a large number of mud sweeps. Also, packing of mud around the bottom of the core barrel indicated a malfunction. The drill string was recovered and the bit cleared the rig floor at 2040 h on

26 April, ending Hole U1437D. The total cored interval in Hole U1437D is 677.4 m, with 503.8 m recovered (74%).

At this point, we decided to abandon Hole U1437D in favor of drilling and casing a new hole to the total depth of Hole U1437D, then coring and logging it as deep as time permits. This decision was prompted by (1) the increasing risk with penetration depth of not being able to clean a hole, particularly a deep non-cased hole; and (2) the fact that the ship is carrying ~1100 m of 11.75 inch casing, just enough to cover the interval cored to date, which makes this the optimal time to install the casing.

Hole U1437E

The ship moved ~20 m northeast to begin installation of casing in Hole U1437E. The reentry cone, equipped with 20.7 m of 20 inch casing, was run to the seafloor. The subsea camera system was deployed to observe the jetting in of the casing and landing of the reentry cone on the seafloor. Deployment was complete at 1905 h, the drill bit cleared the reentry cone, and camera system and drill string were retrieved.

Science Results

Site U1437

Approximately 240 m of core was described this week, representing the ~83% recovery from the interval penetrated by Cores U1437D-40R through -73R (796 to 1105 mbsf). Thin sections from Cores U1437D-29R through -62R have been described, while additional samples over the described core interval are being prepared. More extensive use of the microscopic observations template in DESClogik this week resulted in further development of the volcaniclastic sediment logging procedures, and modifications in the way extrusive rock clasts were described.

Combined macroscopic and microscopic observations show that tuffaceous mudstone is the most abundant facies (133 m) with subordinate evolved tuff (90 m) and lapilli-tuff (19 m). Intervals of tuffaceous mudstone dominate in the upper parts of the sequence described this week, but gradually give way to evolved tuff with depth. The intervals of lapilli-tuff occur mostly below Core U1437D-57R, and gradually become the dominant facies down to Core U1437D-73R.

All cores described this week are strongly altered to chlorite and other minerals, and are silicified. All cores are dark to light green when freshly cut, but turn into shades of gray within hours after exposure to air. Occasional pumice clasts are flattened to form fiamme, and burrows appear vertically compacted by ~50%, which is probably comparable to the bulk compaction.

The tuffaceous mudstone in the cores described this week is similar to the tuffaceous mudstone in higher intervals in the stratigraphy (i.e., above 796 mbsf). It is composed of clay minerals, silica, igneous crystals, and glass shards in varying proportions. Bioturbation is intense. The

evolved tuff is also similar to evolved tuff intervals higher in the stratigraphy. Evolved tuff intervals are normally graded, composed of crystals and glass shards, commonly with a crystal-rich layer at the base of each interval. A new and distinctive type of evolved tuff is first encountered around Core U1437D-40R. This new facies is very fine-grained (silt-sized), non-graded, white to light green when freshly cut, and often tens of centimeters thick. It is commonly finely stratified, containing light and dark bands that highlight soft sediment deformation. The clast-supported, polymictic, evolved, pumice lapilli-tuff intervals become increasingly more common downward and form much thicker intervals than the other facies (typically >50 cm) below Core U1437D-64R. They are normally graded, and composed of subrounded pumice, scoria, fiamme and crystal fragments; fines are virtually absent. Below Core U1437D-70R these intervals become coarser (mostly 2–12 mm; maximum 60 mm) and contain numerous types of fragments, including olivine-bearing mafic scoria clasts, porphyritic andesite clasts, evolved pumice and fiamme, red scoria clasts, and rare mollusk shells. In Core U1437D-64R and below, mollusk shells are present and coarse, often oxidized, scoria clasts are abundant in the lapilli tuffs, suggesting increasing sediment supply by erosion from the oxic zone or from land, perhaps a nearby island. The ~6.5 Ma Manji seamount is the most likely source, given the location of Site U1437 at the base of its southeastern flank. The deepest two cores of the section described this week, and the last cores of Hole U1437D, Cores U1437D-72R and -73R, are intensely fractured and have limited recovery, presumably because of problems with the coring/drilling process and are not thought to reflect the real formation characteristics.

Concentrations of methane in Cores U1437D-42R through -73R (824–1096 mbsf) vary between 15 and 638 ppmv, with the highest value measured in Core U1437D-53R. Other hydrocarbons were below detection limits. Pore water samples collected in Cores U1437B-2H through U1437D-29R (8– 693 mbsf) were analyzed. In addition to these new samples, major element concentrations of pore water samples from our last site (Site U1436) were re-analyzed by inductively coupled plasma–atomic emission spectroscopy (ICP-AES) to resolve inconsistencies between ion chromatography (IC) and ICP-AES results. Data from ICP-AES were consistently higher than those from IC analyses. After dismissing instrumental parameters such as drift and fitting of the calibration data, an error in the dilution of the IASPO seawater standard stock solution was identified. To preserve limited shipboard argon gas for ICP-AES analyses of solids, re-measurement of pore waters was delayed until later in the cruise. The analysis of ammonium concentrations in pore waters was hampered by calibration instabilities, and tests with a back-up UV-VIS spectrophotometer are underway.

$CaCO_3$ and inorganic carbon abundances were measured in 63 mud samples from Site 1437 collected between 217 and 913 mbsf. Carbonate abundances range from below detection to 57 wt% ($CaCO_3$ equivalent) translating into maximum inorganic carbon abundances of 7 wt%. Three samples from >900 mbsf yielded consistently elevated $CaCO_3$ abundances between 41 and 53 wt% (inorganic carbon between 5 wt% and 7 wt%). These values exceed those for samples collected between 217–900 mbsf.

Selected major and trace elements of 27 solid samples from Sites U1436 and U1437 were analyzed by ICP-AES. Eight USGS and GSJ rock standards were used for calibration covering the concentration range of unknown igneous samples. Site U1437 ash samples range in composition from basaltic andesite to rhyolite, and fall into both low-K and medium-K categories. Several samples of mud or tephra mixed with mud exceeded the maximum calibration point for CaO (BHVO-2 11.4 wt%) and need to be further scrutinized. In addition, 89 solid samples from Sites U1436 and U1437 were analyzed by reconnaissance pXRF, using a handheld scanner mounted for safe analysis of powders. Key elements (K, Ca) were found to be consistent between ICP-AES and pXRF analyses, and confirm the presence of low- and medium-K volcanic rocks, presumably of arc front and rear arc provenance, respectively.

Physical properties measurements were taken from Cores U1437D-42R to U1437D-73R (the bottom of Hole U1437D). These include measurements of density, porosity, thermal conductivity, magnetic susceptibility, natural gamma radiation, and *P*-wave velocity. Thermal conductivity was measured using a puck probe on working halves that were not too fractured and fragile. Moisture and density (MAD) measurements were performed mostly on samples shared with the palaeomagnetics group. *P*-wave velocities measurements were taken from both cubes and section halves. In addition, anisotropy measurements were attempted on the cubes.

Analysis and interpretation of the physical property data from Hole U1437D are ongoing. We were able to divide the cored interval into several intervals based on characteristic signals of magnetic susceptibility, natural gamma radiation, thermal conductive and *P*-wave velocity. Some of the changes correlate with lithostratigraphic unit boundaries, while others provide further subdivisions. Magnetic susceptibility values are extremely high at the bottom of the hole, and correspond to very low velocity values.

Paleomagnetic measurements this week included AF demagnetization on all archive section halves from Hole U1437D. Steeply positive drilling overprints continue to affect measurements of remanence; we found that isolation of the depositional remanence was best achieved after 30 mT demagnetization. Sufficient cube samples were demagnetized to recognize magnetic polarity from all cores down to and including Core U1437D-43R. As before, we took advantage of the lower intensity and less resistant nature of the drilling overprint in discrete samples. In most discrete samples, AF demagnetization of 15 to 25 mT was sufficient to reveal the magnetic polarity. We suspect that the overprint may be largely carried by the magnetic iron sulfide greigite, which is known to be both susceptible to the drilling overprint and resistant to AF demagnetization. Greigite, however, is easily removed during thermal demagnetization, due to its oxidation at temperatures of 300–350°C. For this reason, we commenced thermal demagnetization of a subset of the discrete samples.

Continuing the magnetostratigraphy recognized in the previous week, we were able to identify all successive magnetochrons down to the base of Sidufjall normal polarity interval (Chron C3n.3n base), and more tentatively, pending discrete sample control, to the end of the Gilbert

reversed polarity interval (Chron C3An.1n) in the Messinian. These identifications are in close accord with, but more closely defined than, nannofossil and foraminifer datums over the same interval.

The calcareous nannofossil paleontologists examined smear slides from all recovered core catchers from Cores U1437D-37R through -68R. The foraminifer paleontologists examined core catcher samples only down to Core U1437D-58R because of the additional processing time required to disaggregate samples. Additional samples from suitable mud intervals were taken, as core catchers frequently did not yield either fossil group.

Establishing a biochronology for this part of the succession has proved challenging due to the degree of lithification, poor preservation, and the low numbers of fossils recovered (many "barren" intervals). A "kerosene soak" step was added to the sample preparation process for foraminifers, which is helping to break up the samples and recover more microfossils. Also thin sections of selected mudstone samples were also examined for foraminifera: this aids the identification of at least the genus, and in some cases the species. However, most foraminifer specimens in the deeper parts of the core are highly deformed due to compaction. The nannofossil workers have also faced problems surrounding preservation, particularly because several Pliocene and Miocene datum markers are from the genus *Discoaster,* which is easily dissolved or overgrown.

Based on nannofossil bioevents, the succession between Samples U1437D-19-3, 32 cm and 61R-CC can be placed somewhere between 3.70 and 7.42 Ma (Early Pliocene/Late Miocene). This agrees with the paleomagnetic stratigraphy, which found two reversal datums at 4.493 Ma and 6.033 Ma in Cores U1437D-36R-4 and 58-7R, respectively. In terms of planktonic foraminifer bioevents, the presence of *Globorotalia margaritae* in Sample U1437D-39R-CC indicates an age <6.08 Ma, which is consistent with the nannofossil and paleomagnetic stratigraphy. In deeper cores, the deformed assemblages show long ranging species from the late Middle to Late Miocene, with some evidence of reworking.

Education and Outreach

Eleven successful videoconferences were completed this week, and follow up evaluations have been sent. Test videoconferences sessions have been completed with the Denver Museum of Nature & Science, Truro College, and Union Academy, in preparation for future events. The videoconference schedule for April and May continues to be updated.

Daily blogs on the *JOIDES Resolution* website (http://joidesresolution.org) have covered a mixture of science, drilling technology and daily life on board. Additional blog posts have been posted on other science education sites and personal blogs (http://www.SAGANet.org, http://www.imonaboat.org). Daily posts, photos, and updates to our social media outlets

(Facebook, Twitter, and Instagram) are ongoing and each network is gaining followers from active engagement with the public.

On 23 April the *JOIDES Resolution* and her crew participated in a social media event instigated by NASA Climate Change, on behalf of Earth Day. A group photo was taken on the bow of the ship with the event sign and the "Blue Marble" Earth flag. Using the hash tag #globalSelfie the image was posted to all of our social media networks with resounding accolade, and viewership of over 4,500 individuals.

Technical Support and HSE Activities

Laboratory

A major effort has been the sampling of cores for postcruise studies. Cores are laid out for ~2 days at a time, so scientists can make detailed sample lists by viewing the cores and marking their exact sample locations on the working section halves. Technical staff, with the help of scientists, collect, label, and bag the samples.

The Underway Lab supported a successful VSP operation.

Ship's crew is welding pad eyes under the Pallet Store's deck in preparation for moving equipment out of the chiller room.

Electronics Technicians are working on a board design for the future deployment of the new stepper motors.

Development and Information Technology

Work continues on a replacement for the Alkalinity data acquisition program. The Image Batch download utility is now working again. DESCLogik bug fixes are still in progress.

Staff continued work with the Cumulus vendor to resolve import issues with shore vault documents during the beginning of the cruise process; worked with drillers experiencing video issues with existing equipment and loaned a replacement monitor for their evaluation; resolved remaining host instrument PCs not being backed up via Acronis software, so that all host stations are now actively being backed up; continued to work with the vendor for our new firewall concerning an application control item.

Safety

The weekly fire and boat drill was completed as scheduled. Hazardous and flammables store areas were cleaned up.