IODP Expedition 350: Izu Bonin Mariana Rear Arc

Week 2 Report (7–13 April 2014)

Operations

The transit from Keelung ended at 1142 h on 8 April, marking the beginning of operations at Site U1436 (proposed site IBM-4GT). The thrusters were lowered and an APC/XCB bottom-hole assembly (BHA) was built up and deployed to 1781 mbrf. The vibration-isolated television (VIT) camera system was lowered to bottom and a seafloor survey was conducted and verified no sub-sea communications cables could be observed in the drilling area. After observing the bit tag the seafloor, the camera system was retrieved. Coring in Hole U1436A commenced at 0705 h on 9 April. Cores U1436A-1H through -9H (0–59.7 m) yielded 59.4 m of core (99% recovery). The half-length APC (HLAPC) system was then used for Cores U1436A-10F through -12F (59.7–65.0 m) which retrieved a total of 5.22 m of core (98% recovery). The rate of penetration with the HLAPC decreased exponentially and we switched to the XCB system. Cores U1436A-13X through -21X (65.0–150.0 m) recovered only 7.1 m of core (8% recovery). The drill string was recovered and the bit cleared the rotary table at 1245 h, ending operations in Hole U1436A. Hole U1436A was completed with a total of 21 cores from 0 to 150 m and recovered 71.6 m (48%). The rig was secured for transit to Site U1437 (proposed site IBM-3C).

Site U1437

The 77 nmi transit from Site U1436 to Site U1437 was completed in 7.5 h. A beacon was dropped at 2304 h on 10 April, marking the beginning of operations at Hole U1437A. The thrusters were lowered and an APC/XCB BHA was made up and deployed to 2110 mbrf. The camera system was lowered to the seafloor and a survey confirmed that no subsea cables were observed at the site. The camera system was recovered after observing the bit tag the seafloor at 2127 mbrf. Hole U1437A was spudded at 0915 h on 11 April and a jet-in test was conducted to ~25 mbsf. Upon completion of the jet-in test, the ship was repositioned 10 m North of Hole U1436A to begin coring in Hole U1437B.

Coring in Hole U1437B commenced at 1035 h on 11 April. Cores U1437B-1H through 10H (0–89.2 m), cored with the full-length APC system, recovered 89.2 m of core (100% recovery). Pulling the core barrels from the formation became increasingly harder at the bottom of that interval and we therefore switched to the HLAPC system. Cores U1437B-11F through -24F (89.2–145.7 m) recovered 56.5 m of core (100% recovery). When the rate of penetration of the HLAPC decreased to a critical point we changed to the XCB system. Cores U1437B-25X through -55X (145.7–439.1 m) recovered 96.9 m of core for the 293.4 m interval drilled (33% recovery). The last core arrived on deck at exactly the end of this reporting period (2400 h on 13 April 2014).

Hole U1437B cored 439.1 m and recovered 242.6 m of sediment (55% recovery).

Science Results

The 66 m of intercalated mud and volcaniclastic sediment recovered from Hole U1436A were described as a single lithostratigraphic unit (Unit I). Unit I consists of mud with dispersed ash, and intercalated intervals of mafic ash and scoria lapilli ash (~80 intervals) and evolved ash and pumice lapilli ash (~70 intervals), for a total of ~40 m of mud and ~26 m of volcaniclastic sediment. The mafic intervals are thicker than the evolved beds, for a total mafic to evolved thickness ratio of about 1.5:1.

Mud intervals consistently contain abundant ash, mainly vitric with rare crystals, and foraminfera are common. Mud intervals average 25 cm in thickness and are up to 420 cm thick. They are massive and bioturbation is present. The mud is light gray to dark gray brown, commonly with a greenish hue. Rare glauconite (1–2 cm thick) occurs in the mud at the top contacts of evolved ash intervals.

The mafic ash and scoria lapilli-ash intervals average 14 cm in thickness, and are up to 230 cm thick (in Core U1436A-8H). The evolved ash and pumice lapilli-ash intervals average 9 cm in thickness, and are up to 60 cm thick. The maximum clast size of both pumice and scoria lapilli is ~3 cm (commonly less than 1 cm); in both compositions, smaller lapilli are angular and larger ones are subrounded. Most of the mafic lapilli-ash intervals have subordinate pumice and most of the evolved lapilli-ash intervals have subordinate scoria. Most mafic and evolved intervals are normally graded, with sharp bottom contacts and diffuse/gradational tops showing upward increase in mud content.

One very distinctive facies occurs in two intervals (U1436A-8H-2, 100 cm and 8H-3, 60 cm). It consists of a massive, nongraded, well-sorted black glassy ash. Both intervals have sharp upper and lower contacts. The lower ash is 15 cm thick, and the upper ash is >220 cm thick and finer-grained than the lower ash. Both contain visible (but minor) foraminifera. Under the microscope the glass is brown to greenish brown (polarized light), with few microlites. Glass particles are flat, blocky, curviplanar and/or plastically deformed, and contain vesicles.

The mud is interpreted to record hemipelagic background sedimentation, with substantial ash contribution from explosive eruptions and/or resedimentation products, presumably chiefly from the Izu-Bonin arc front. Mafic and evolved ash and lapilli-ash intervals may record distinct explosive events, also from the Izu-Bonin arc front, although evolved ashes may be from more distal sources. The mode of transport and deposition of the mafic and evolved ash and lapilli-ash intervals is not clear, but involve some combination of subaqueous fallout/vertical settling through the water column and/or sediment gravity flows. The distinctive black glassy ash facies

is unusually homogeneous in componentry and texture, suggesting an eruption-fed origin, and the shapes of the ash suggest subaqueous explosive eruption (limu o Pele and Pele's hair).

Hydrocarbon analyses from headspace samples (n = 13) yielded methane abundances <15 ppmv, with the highest values in the shallowest (1.50–1.55 mbsf) part of the cored sequence at site U1436A. Pore fluid samples (n = 10) from Hole U1436A were collected at one sample per recovered core interval. Pore fluid chemical compositions for Hole U1436A samples agree excellently with previous determinations from nearby ODP Site 792, albeit with double the sampling density over the cored interval. The combined data for Sites U1436 and 792 reveal moderate increases in Cl, Na, and Ca between 0 and 138 mbsf, which may reflect incipient alteration of volcanic glass and hydration of clay minerals. The Hole U1436A downhole profile, however, is too shallow to extend into the zone of extreme Mg depletion attributed to smectite formation that was encountered below the Miocene/Oligocene boundary (>450 mbsf) at Site 792.

Hole U1436A volcanic rock samples (n = 12) are currently being processed for ICP-analysis of major and trace elements to constrain the provenance of tephras.

The physical properties team began the week with calibration and verification of the shipboard instrumentation. Physical properties measurements were performed on the ~66 m of sedimentary record recovered in Hole U1436A to obtain the density, porosity, shear strength, thermal conductivity, magnetic susceptibility, natural gamma radiation, and *P*-wave velocity of the recovered material. Analysis and interpretation of the data are ongoing. In general, bulk density and porosity are variable throughout the stratigraphic record, and seem to reflect differences in lithologic composition and grain size rather than compaction related to burial. Mafic ash layers are commonly associated with high positive values of Magnetic susceptibility, whereas evolved ash layers are not well correlated with variations in the magnetic susceptibility. *P*-wave velocities varied between ~1450 and ~1620 m/s throughout Hole 1436A, probably reflecting changes in composition and grain size. The natural gamma ray radiation is also highly variable. In general, ash layers are associated with peaks, whereas bioturbated sediments in some cases produce lows. Thermal conductivity is uniform throughout Hole 1436A and displays a mean value of ~0.970 W/(m·K).

The paleomagnetism team completed archive-half demagnetization and remanence measurement at 10 mT steps up to 40 mT on all archive half sections from Hole U1436A. Intervals of continuous mud recovery yielded a good paleomagnetic record, with the drill-string overprint largely removed. Fortunately, the base of normal chron C1n (the Brunhes/Matuyama boundary) was recorded in one of the last continuous mud intervals, in Section U1436A-9H-4, at 25 cm. The reversal appears to have occurred in the time interval between two successive depositional events, and so it is sharp. This gives a datum for this depth of 781 ka.

One discrete paleomagnetic cube was sampled per section in undisturbed mud and silt intervals. We demagnetized these at 5 mT steps up to 20 mT. Less intense and magnetically softer overprinting of these discrete samples meant that the demagnetized inclination at 20 mT tightly

clustered around the expected geocentric axial dipole (GAD) inclination of ±51°. For this reason, we halted demagnetization and measurement of most discrete samples at this level, continuing to 25 mT only in samples near and below the base of chron C1n, in order to improve the isolation of the reverse polarity remanence. Discrete samples in the discontinuous record below a hiatus allowed us to recognize two additional datums: the Top of normal chron C1r.1n (0.988 Ma) between Samples U1436A-9H-4, 66–68 cm (which is reversed) and 10F-2, 64–66 cm (which is normal); and the base of normal chron C1r.1n (1.072 Ma) between Samples U1436A-10F-2, 64–66 cm and 16X-2, 53–55 cm (which is reversed).

Discrete samples, and a patchy record in the archive half SRM measurements, indicate that Core U1436A-17X is all reversed polarity, so this core probably still lies in the Matuyama interval (i.e., above normal chron C2n, so <1.778 Ma).

The main focus of the paleontology group's efforts this week was on Hole U1346A where a 150 m interval was cored. The biostratigraphy of the succession was defined by examining the planktonic foraminifera and calcareous nannofossil content of all the 19 core catchers recovered. The standard bio-events for planktonic foraminifera and nannofossils were recognized and their ages assigned mainly with reference to Gradstein et al. (2012). Despite the very poor recovery below Core U1436A-12F (>0.9 Ma), both calcareous nannofossils and planktonic foraminifera biostratigraphy indicate that the sedimentary succession reaches into the Late Pliocene and covers the last 2.7 Ma. Foraminifera and nannofossil bioevents agree well with each other and with the paleomagnetic stratigraphy.

Planktonic foraminifera were generally abundant, although their concentration was diluted by ashes and/or scoria in some volcaniclastic-rich intervals, and well preserved with the exception of Sample U1346A-5H-CC. The boundary between Pt1a/b (0.61 Ma) was placed in Core U1346A-6H based on the last appearance of *Globorotalia tosaensis*. We placed the Pleistocene/Pliocene boundary (2.588 Ma) somewhere within Cores U1346A-18X, -19X or -20X based on the presence of *Globorotalia pseudomioceanica* (LAD 2.39 Ma) in 18X-CC and *Globoturborotalita decoraperta* (LAD 2.75 Ma) in 20X-CC. Our planktonic foraminifera biostratigraphy was consistent with an established progressive benthic foraminifera bio-event (i.e. the gradual extinction of the Stilostomelidae between 1 Ma to 0.7 Ma). The recognition of the Brunhes/Matuyama reversal in Core U1346A-9H-3 provided a major stratigraphic control point at a time when bio-events were rarer.

Nannofossils are generally abundant and well preserved, with minimum signal of reworking. Based on calcareous nannofossil bioevents, the succession cored at Hole U1346A spans from the Pleistocene (from Samples U1346A-1H-CC to 16X-CC) to late Pliocene (from U1346A-16X-CC to 20X-CC). In the Pleistocene the succession is continuous until the Brunhes/Matuyama boundary and all the standard bioevents are recognizable: X (cross over) *Gephyrocapsa caribbeanica–Emiliania huxleyi* (Sample U1346A-2H-CC), base of *E. huxleyi* (4H-CC), and top of *Pseudoemiliania lacunosa* (5H-CC). Below the Brunhes/Matuyama boundary a big hiatus

occurs in the succession and the first identifiable event is top of *Calcidiscus macintyrei* (15X-CC). The late Pliocene succession is identified by the top of *Discoaster brouweri* (17X-CC) and the top of *Discoaster pentaradiatus* (19X-CC).

After departing from Site U1436, the science party and technical staff prepared for, and carried out a sampling party. All working half sections of the cores recovered from Hole U1437A were laid out throughout the core lab and a total of 428 samples were taken for postcruise research.

Site U1437

The section recovered in Hole U1437B consists predominantly of mud and mud with ash, intercalated with mafic and evolved ash (with mud) layers. Over the entire section recovered in Hole U1437B, the mud and minor clay layers amount to a total thickness of 212 m, and the ash (with mud) and minor lapilli-ash layers amount to 29 m, a ratio of ~7:1. The ~343 identified ash layers range from 0.01 to 1.5 m in thickness (average 0.08 m, standard deviation 0.11 m). Approximately 70% of the volcaniclastic sediments are evolved (felsic) ash, and the remainder are mafic ash, with the distinction between ash types based mostly on color. Many ash shards are vesicular, curved, and may reflect submarine eruptions. Crystals are subordinate.

Geochemical sample collection and analyses are ongoing for Hole U1437B. One sample each per core was collected for the analysis of pore fluids and hydrocarbon gasses. Hole U1437B headspace samples have methane <5 ppmv. Because clay and carbonate is more abundant in Hole U1437B sediments compared to Site U1436, additional sampling was undertaken for determining inorganic and organic carbon content.

At Hole U1437B, demagnetization of archive halves very efficiently removed the drill-string overprint, which was mostly eliminated by 20 mT. Similarly, very low level AF demagnetization was required to clean the drilling overprint from discrete samples, with tight dipole grouping apparent from the 10 mT step. As of Core U1437B-10H-2 the base of C1n (the Brunhes normal) had not yet been reached.

Paleontological work on Hole U1437B appears promising. We have already been able to establish the existence of an expanded carbonate-rich Pleistocene section inter-bedded with thin ash beds. This section likely has the potential to provide a fine-scale Quaternary biostratigraphic and paleoclimatic framework for the volcanic events recorded in the Izu-Bonin rear-arc area.

Education and Outreach

Few schools in the USA had signed up for videoconferences (compared to European schools and organizations), so publicity was increased from the shore office. We now have 63 scheduled broadcasts to schools, colleges and Universities across the US, Europe, plus a couple from Japan. We estimate this should reach ~3500 students and teachers.

We conducted one Zoom videoconfernce event with a French Earth Science Teachers Conference; this was hosted by Education Officers who had previously sailed on the *JOIDES Resolution* in 2013. We also had a Skype event with a French School. Zoom is working much better than Skype.

We scheduled Skype interviews (plus test) for two science party members with Kiel University. The shore office sent a list of crew members to be interviewed for online profiles. Daily blogs, tweets and Facebook entries were posted. An interactive map was completed showing ship positions to date. New education resources are in production to support elementary school ship tours. A teacher's resource based on navigation is in preparation.

The limited Internet speed makes uploading photos and videos directly to the *JOIDES Resolution* website difficult. Compressed pictures can be sent to shore to be uploaded.

Technical Support and HSE Activities

Technical staff supported all aspects of coring and science operations at Sites U1436 and U1437.

We are still waiting for information from SyQuest regarding the failure of the current (recently repaired) Bathy 2010 boards from last expedition and are therefore only operating the system for site approaches and drilling depths. Magnetometer surveys have been suspended for the duration of the expedition per our drilling permits.

The science party is attempting to obtain meaningful results with the hand-held XRF scanner. Issues with DESClogic data downloads formats are being investigated. Issues with the Image Capture program saving a scale bar that is twice the size of the bar actually used are being addressed.

The BIOS on the SHMSL PC station was updated to see if this will clear the issue with dropping USB ports. National Instrument drivers were reinstalled for the Spectrophotometer to clear up communication issues with program. A vacuum leak in the freeze dryer was repaired.

Development and Information Technology

The developers deployed IMS 8 upgrades; are addressing issues reappearing with the SHIL and MUT programs colliding over memory resources; fixed bugs and made enhancements to the Thin-Section Report Writer; finished changes to and deployed the Image QAQC Report for testing; deployed a new version of LIMS Reports to correct problems with the Core Summary report; and updated documentation of various developer processes.

IT Systems support completed Cumulus import from shore into ship environment; verified Acronis backups are working on all instrument PCs; power cycled equipment after VSAT outage

on Wednesday and Sunday, cleared problem and opened an issue with RIGNET; and updated ship website with shore content.

Miscellaneous

The rowing machine clutch in the gym failed; parts will be needed for repair. Electrical issues with the large treadmill were repaired and maintenance was completed on the small treadmill.

Safety

A weekly fire and boat drill was completed as scheduled.