IODP Expedition 345: Hess Deep Plutonic Crust

Week 9 Report (3–12 February 2013)

The final week of science operations on IODP Hess Deep Expedition 345 consisted of (1) final RCB coring in Hole U1415P, (2) a failed attempt to log Hole U1415P, and (3) the transit from Hess Deep to Balboa, Panama. Cores U1415P-20R to -23R extended from 82.3 to 107.9 mbsf and recovered 7.3 m of gabbroic rocks from this 25.6 m interval (28%). Deteriorating hole conditions and the wish to attempt logging led to the conclusion of coring in Hole U1415P.

Operations

After we completed washing and reaming down to the bottom of Hole U1415P (82.3 mbsf), we recovered the core barrel used during this hole cleaning (Core U1415P-19G), which contained 0.6 m. We resumed RCB coring and Core U1415P-20R was cut from 82.3 to 89.4 mbsf. Before retrieving Core U1415P-20R, the hole had to be washed and cleaned enough to attempt making a connection. At the time, several bit nozzles were also plugged. At 0030 h on 3 February, we were able to remove a drilling knobby so Core 20R could be recovered with 2.42 m of nicely cored gabbro. A new core barrel was deployed and the drillers were able to partially unplug the bit nozzles. Before coring could resume, the hole had to be washed and reamed from 79.0 to 89.4 mbsf. At 0900 h on February 3, the core barrel deployed during this reaming was retrieved (Core U1415P-21G). We had to wash and ream back to the bottom of the hole again, but then continued coring. Cores U1415P-22R and 23R were recovered from 89.4 to 107.9 m and recovered 4.87 m (26%). After retrieving Core U1415P-23R, hole conditions began deteriorating with the hole packing off and the bit taking weight ~9 m above the bottom of the hole. As we had just added a joint of pipe and the bit was unable to pass below this depth, we had to offset the ship 100 m to reach a connection so the driller could pull up and lay out the same piece of pipe. At this point, we raised up to 76.0 mbsf, resumed hole cleaning, reamed back down to the bottom of the hole (107.9 mbsf), and recovered the core barrel (Core U1415P-24G) used during the reaming. Once again the hole packed off, circulation and rotation were lost while making the connection after laying out the barrel. So we offset the ship 100 m (2% of water depth) to reach a connection so we could remove more drill pipe. We raised the bit up to 79.0 mbsf and started to work the bit back down. However, after making another connection the bit could not be advanced further due to high torque, packing-off, and plugged nozzles. Ultimately we decided to stop trying to core and to conduct a wiper trip to prepare the hole for logging. RCB coring in Hole U1415P extended from 12.5 to 107.9 mbsf and recovered 30.57 m (32%) of gabbroic rocks. In addition, five cores were recovered from previously drilled portions of the hole during the hole cleaning operations.

To prepare for logging, we raised the bit up to 11.9 mbsf (inside the 10.75 inch casing) and then lowered it back down the hole. Problems were encountered at 41, 55–60, and 84–90 mbsf that had to be drilled through. We elected not to attempt to clean out the ~18 m of hard fill in the bottom of the hole. At 1215 h on 4 February, the bit was back up to 11.9 mbsf (inside the casing). We deployed the camera and pulled the bit clear of the hole at 1434 h on 4 February. At 1449 h, we observed the bit successfully release from the bottom-hole assembly. The end of pipe reentered Hole U1415P at 1550 h after only 15 min of maneuvering. We recovered the camera,

placed the end of pipe at 10 mbsf, and lowered the first logging string into the hole (caliper and dipole sonic imager [DSI]). We had decided to deploy a very short logging string due to the poor hole conditions and risk of the tools getting stuck. The logging tool string could not pass 24 mbsf (11.5 m below the 10.75 inch casing shoe). The logging tools were retrieved so the end of pipe could be lowered past the trouble area. The drill pipe could not be lowered past 20 mbsf (7.5 m below the casing shoe), so we terminated logging. We pulled the bit out of the hole at 0315 h on 5 February.

Since there was not sufficient time remaining to conduct any further drilling operations as we had dropped the bit for logging, we deployed the camera and 3.5 kHz pinger to conduct a final seafloor survey across Hole U1415P. The survey was completed at 0845 h on 5 February. Although the drill string was back on board at 1745 h on 5 February, the beacon retrieved at 1838 h, and the hydrophones raised by 1900 h, we delayed our departure until 2000 h so that ICP geochemical analyses that are sensitive to ship motion could be completed. After we raised the thrusters, we started our transit to Balboa, Panama at 2048 h on 5 February. This was about a half day ahead of the scheduled departure time. As of 0000 h on 10 February, we have completed 1045 nmi of the transit from Hess Deep to Balboa, Panama and have 422 nmi remaining. We are scheduled to be dockside in Balboa at ~1200 h on 12 February 2013.

Science Results

Igneous Petrology

This week we finished macroscopic and microscopic description of Cores U1415P-17R to -25G. The recovered rock consists mainly of troctolites. From Core U1415P-15R (piece #6) downward, the lithology is monotonous, medium to coarse grained, granular troctolite. The troctolites generally consist of olivine (35%), plagioclase (65%), with trace amounts of clinopyroxene (<1%) and oxide (<1%, Cr-spinel). Olivine is euhedral to subhedral with a subequant habit. While the olivine above this interval shows harrisitic features, the olivines in the deeper part of the section are in general prismatic. Plagioclase is suhedral to anhedral with a tabular habit. Clinopyroxene is anhedral with an interstitial habit. The interstitial clinopyroxene in many cases are optically continuous, forming what appears to be large grains (<20 mm). Two igneous contacts between troctolite and olivine gabbro are interpreted as intrusion of finer grained, folitated olivine gabbro into troctolite.

Metamorphic Petrology

The rocks from the lowermost sections of Hole U1415P are troctolites with moderate alteration. Olivine is moderately altered to serpentine, talc, clay, magnetite and sulfide. Plagioclase is variably pseudomorphically altered to prehnite and chlorite. A number of prominent serpentine veins were observed for the first time this expedition. These are characterized by broad vein haloes with intense alteration. Secondary sulfide assemblages include Ni-Fe sulfides typically associated with serpentinization.

Structure

In Hole U1415P, we observed planar layering/banding on a decimeter scale, including plagioclase-rich bands; these are common in the upper part of the section and rare in the lower part. In contrast, magmatic foliation defined by shape-preferred orientation of plagioclase, olivine, and rarely pyroxene is more common in the lower part of the section. The dips of the both the banding and the foliation is relatively steep (mean 63°). Cataclasis is minimal in rocks recovered from Hole U1415P, which contrasts with those from Hole U1415J.

Paleomagnetism

The paleomagnetic team continued to thermally demagnetize discrete samples from Hole U1415P, and synthesize final paleomagnetic datasets.

Geochemistry

During Expedition 345, we completed chemical analyses of 50 gabbroic and three basaltic rocks. The three basalts are variously altered with composition similar to the primitive MOR basalts previously sampled in the Hess Deep and are at the more primitive end of the East Pacific Rise basalts recovered along the northern escarpment of the Hess Deep Rift. The 50 gabbroic rocks comprise a range of lithologies including gabbronorite, clinopyroxene-oikocryst bearing troctolites and gabbros, orthopyroxene-bearing olivine gabbros and olivine-bearing gabbronorites, troctolites, olivine gabbros and gabbros.

Except for one gabbronorite in the rubble zone at the top of Hole U1415E, all samples are characterized by their primitive composition compared to gabbroic rocks previously collected along the northern escarpment of the Hess Deep Rift and overlap in composition with the most primitive gabbros and troctolites sampled along the East Pacific Rise.

Physical Properties

The remainder of core sections from Hole U1415P was run through the Whole Round Multisensor Logger and the Section Half Multisensor Logger, with no significant changes in the recorded values of natural gamma radiation (very low, below background level) and magnetic susceptibility (low, ~1300 x 10^{-5} SI on average). We completed measurements on all discrete samples of olivine gabbro and troctolite from Hole U1415P. Grain density ranges from 2.74 to 2.99 g/cm^3, and porosity ranges from 0.4 to 1.8%. *P*-wave velocity ranges from 5.98 to 6.45 km/s. The average thermal conductivity of olivine gabbros and troctolites are 2.31 and 2.87 W/m·K, respectively.

Education and Outreach

Broadcasts: We had 19 broadcasts this week. With our last broadcast on Monday, we will have conducted a total of 93 interactive educational videoconferences to students in sixteen countries during the expedition. The shipboard education officers plan on continuing their interactions with a number of these schools following the expedition.

The education team has continued with development of hands on activities, informational posters, enigmas, and blogs. The social media sites are updated daily, the number of followers continues to increase. Facebook: www.facebook.com/joidesresolution ; Twitter: TheJR; Blogs at www.joidesresolution.org and www.ac-nice.fr/svt/hdc

Drifter: We continued to follow the drifter launched for Christmas day from the *JOIDES Resolution* (a school program to study oceans currents) until partly through the week when it stopped transmitting after travelling more than 600 km from the ship.

Technical Support

Science mission support:

- Technical staff continued to provide support for core processing and analytical support for the science party, sampling of hard rock cores, and end-of-expedition activities.

Other technical activities:

- Preparing off-going shipments and paperwork.
- Completing Technical Reports.

HSE activities:

- The weekly fire and abandon ship drill was held as scheduled.
- A copy of IODP hazardous material inventory was prepared and given to Siem Offshore.