IODP Expedition 345: Hess Deep Plutonic Crust

Week 7 Report (20–26 January 2013)

This week of IODP Hess Deep Expedition consisted of (1) a jet-in test in Hole U1415L to 4 mbsf, (2) a failed attempt to establish reentry capability in Hole U1415M that penetrated to 25.9 mbsf, (3) a single bit RCB Hole U1415N that penetrated to 37.0 mbsf and recovered 1.56 m (4%) of olivine-phyric basalt and gabbro, (4) a failed attempt to establish reentry capability in Hole U1415O that penetrated to 17.0 mbsf, and (5) the initiation of Hole U1415P. Holes U1415L to U1415N were sited on flat-lying shoulder that is 160 m shallower than previous holes as it appeared to have the potential for better drilling conditions, but these ended due to bad drilling conditions in the upper formation.

Operations

At the start of this week, the RCB bottom-hole assembly (BHA) and coring bit from Hole U1415K had been retrieved to the rig floor. The seafloor positioning beacon deployed at the start of Hess Deep operations on 22 December was nearing the expected lifetime of its batteries, so it was released and recovered.

Hole U1415L

We assembled a 14.75 inch tri-cone bit and drilling BHA with three stands of drill collars and lowered it to the seafloor. While the BHA was being lowered, we also deployed the camera system with the same positioning beacon (with new batteries) and the 3.5 kHz pinger. The seafloor positioning beacon was commanded to release at the Hole U1415K coordinates, but it did not immediately fall to the seafloor. After 40 min of working the camera system up and down, the beacon eventually came loose. At 0515 h on 20 January, we started a visual and 3.5 kHz subbottom seafloor survey by moving the ship 95 m east of Hole U1415K. Unfortunately, the 3.5 kHz pinger ceased working before the survey commenced, but we continued with the visual inspection of the seafloor. After we arrived at the target location, we conducted a box survey extending out 10 m to ensure that no large boulders or rubble were in close proximity. We also tagged the seafloor with the bit that revealed an approximate seafloor slope of ~14° to the south. Hole U1415L consisted of a 1 h jet-in test that penetrated to 4 mbsf through sediment and soft rubble. Hole U1415L was spudded at 0845 h on 20 January and the bit was pulled clear of the seafloor at 0900 h.

Hole U1415M

After recovering the camera system, Hole U1415M was started at 1240 h on 20 January. The initial penetration from seafloor to 5 mbsf went relatively quickly indicating the formation was sediment/soft rubble. From ~5 to 9 mbsf the formation became hard with a significantly slower rate of penetration (0.5–1.0 m/h; ROP) and smooth torque typical of massive hard rock. The ROP increased again to approximately 4.0 m/h from 9.0 to 11.0 mbsf. A hard-rock reentry system (HRRS) style free fall funnel (FFF) with a 26 inch opening was assembled around the drill string in the moon pool. We did not attach a stinger or base plate. The funnel was deployed

at 2100 h on 20 January. We then deepened the hole to 19.6 mbsf when the hole began to pack off. We spent the next four hours washing and reaming the hole and circulating high viscosity mud. Eventually the hole was stabilized and we continued drilling down to 25.9 mbsf. At that depth, the bottom of the hole became problematic and the bit was unable to get deeper than 24 mbsf. So, we conducted a wiper trip by raising the bit up to 8 mbsf and then back down to the bottom of the hole. However, the bit still could not penetrate past 24 mbsf. Another high viscosity mud sweep was pumped. The camera system was lowered to observe the orientation of the FFF cone, but it was obscured by clouds of mud and cuttings coming from the hole. However, portions of the rim of the FFF cone were discernible at times buried in cuttings. We pulled the bit out of the hole at 1602 h on 21 January and then waited for 1 h to let cuttings settle for better visibility. The top of the FFF cone was clearly visible in the cuttings mound. The camera was retrieved, the drill string raised to 4660 mbrf, the top drive set back, and we performed a slip and cut of 115 ft of drill line. After the slip and cut, the drill string was recovered and the bit arrived back on the rig floor at 0330 h on 22 January. Our next step was to assemble 25 m of 10.75 inch casing and hang it off on the moon pool doors. Then we assembled a RCB BHA with a used C-7 core bit (2 h rotating time in Hole U1415K) and lowered it, and the camera system, to the seafloor. The top drive was installed and the drill string spaced out for reentry into Hole U1415M. An attempt was made to maneuver the vessel for reentry; however, because of the drill string space out, the bit was positioned nearly at the seafloor, and the driller was unable to raise the bit any higher. This resulted in the bit repeatedly tagging the cuttings mound and the FFF, creating clouds of debris in the water column and completely obscuring the FFF cone. We offset the ship to slightly deeper water to the south while a 30 ft knobby was laid out and a 20 ft knobby was picked up, giving an additional three meters of space in the derrick. We moved back over Hole U1415M and reentered the FFF cone at 1645 h on 22 January. The cone appeared to tip/shift as the bit made contact with the inner surface. Circulation along with slow rotation was used in an unsuccessful attempt to find the 14.75 inch hole. However, no progress was made and we retrieved the camera system so we could use more rotation. This also was not successful, so we redeployed the camera system and offset the ship in an attempt to drag the funnel out of the way. This also did not work and the FFF cone appeared to be solidly in place in the cuttings mound, wedged sideways into a large boulder that had been hidden beneath the seafloor sediment. We reentered the FFF cone for one last failed attempt to find the hole below the FFF cone. We then decided to abandon Hole U1415M at 0000 h on 23 January. A ghost core, Core U1415M-2G, was recovered at 0230 h on 23 January; this contained 5.87 m of surface gravel and mud from the multiple failed reentry attempts.

Hole U1415N

Because we had the RCB coring system in place, we decided to offset the ship to immediately spud a single bit unsupported hole. The vessel was moved 15 m to the west of Hole U1415M. We recovered the camera system, dropped a new core barrel, and started Hole U1415N at 0340 h on 23 January. Core U1415N-1R was cut from 0 to 14.9 mbsf and recovered 0.45 m of roller rocks. After retrieving Core U1415N-2R (14.9 to 18.9 mbsf; 0.15 m recovery), it took 4.75 hours to work the bit down to bottom before beginning to cut the next core at 2330 h on 23 January. Core U1415N-3R was a full 9 m advance (18.9 to 27.9 mbsf; 0.50 m recovered) and then the ROP for Core U1415N-4R (29.7 to 37.0 mbsf; 0.46 m recovered) was very high. After recovering Core U1415N-4R, the drillers were never able to work the bit back down to bottom. The hole continued to pack off (high pump pressures) and had high/erratic torque that we have seen during the expedition associated with the unstable/rapidly drilled intervals. We decided to

abandon Hole U1415N at 1700 h on 24 January. The bit cleared the seafloor at 1740 h and was back on the rig floor at 0145 h on 25 January. The core barrel that was in place during the final attempts to clean out the hole back to bottom (Core U1415N-5G) was recovered at 0125 h on 25 January. The four cores recovered from Hole U1415N extended from 0 to 37.0 mbsf and recovered 1.56 m (4%) of basement rocks.

Hole U1415O

We decided to discontinue operations on the "shoulder" and move back to the bench. The BHA was changed to a drilling assembly with a 14.75 inch tri-cone bit and lowered to the seafloor. While the BHA was being deployed, a new FFF cone was prepared for deployment. We deployed the camera system with the repaired 3.5 kHz pinger and conducted a seafloor survey around the target drilling location. We also observed the bit tag the seafloor at 4861.0 mbrf. The survey was completed at 1536 h on 25 January and the camera system was back on board at 1815 h. Drilling in Hole U1415O started at 1900 h. The bit was washed down 1.5 mbsf and then drilled in a massive and hard formation down to 5 mbsf. At 5 mbsf, the bit penetrated 10 m (to 15 mbsf) in only 15 min. The formation firmed up some from 15.0 to 17.0 mbsf. So we successfully conducted a wiper and started to prepare to deploy the FFF cone. At this time, the hole began to collapse and our attempts to drill and ream back down to bottom failed; we could only get back to ~8 mbsf. We decided to abandon Hole U1415N at 0700 h. The bit cleared the seafloor at 0710 h on 26 January, ending Hole U1415O.

Hole U1415P

We deployed the camera system at 0730 h on 26 January to conduct a seafloor survey for Hole U1415P. The camera reached the seafloor at 0928 h and the survey began with moving the ship 47 m to the west of current hole and 6 m to the south. We conducted a brief box survey around the location extending out to 10 m. Drill string tag depths at the corners of the box survey indicated a relatively flat seafloor (±2 m). We observed the bit tag the seafloor (4864.0 mbrf) and the started recovering the camera system before starting Hole U1415P.

Science Results

Igneous Petrology

The main work this week focused on the macroscopic description of cores Hole U1415K, U1415M, and U1415N, the microscopic descriptions of the corresponding samples, and preparation of the Hole U1415J report. The first four sections of Core U1415K-1G (ghost core) consist of a mix of mainly sand (grain size variation from fine to coarse) and minor pebbles, drill cuttings and brown mud/clay. The larger fragments include basalt, dolerite and gabbro. The first four sections of Core U1415M-1G (ghost core) consist of very fine to medium grained sand, with coarser grain size in section four which also includes basalt pebbles. Hole U1415N recovered olivine-bearing volcanic and hypabyssal rocks. Cores U1415N-1R to 4R contain basalts at the top (mostly olivine- moderately to highly phyric) and coarser grained hypabyssal rocks in the deeper part (olivine-phyric basalts, dolerites, olivine dolerites, microgabbros). One ghost core (Core U1415N-5G) recovered fine-grained olivine dolerite and highly olivine-phyric basalt.

Metamorphic Petrology

This week we have described rocks from Holes U1415K, U1415M, and U1415N, and preparation of the Hole U1415J report. It was not possible to describe the alteration in sediments recovered in Hole U1415K, except for some small rocks (2–5 cm in diameter) in Section U1415K-2G-5. Rocks from this interval are highly to completely altered fine-grained gabbros; olivine is completely replaced by serpentine, tremolite, magnetite, and pyrite. Clinopyroxene is completely replaced by green amphibole, and plagioclase is moderately altered to prehnite and chlorite. Multiple thin veins are present, and pyrite and magnetite are abundant. It was not possible to describe alteration in the mostly poorly sorted sediments recovered in Hole U1415M. The rocks recovered in Hole U1415N included primarily fine-grained olivine-phyric basalts that are minimally to highly altered. Olivine is typically 60–90% replaced by serpentine and pyrite ± talc ± chlorite. Plagioclase is typically 10–30% replaced by prehnite. In most of these rocks, phenocrysts within ~1 cm of piece rims are far more highly altered than phenocrysts from piece centers. Samples from Sections U1415N-4R-1 and U1415N-5G-1 are only slightly altered, typically <10%.

Structure

The week was spent finalizing the Hole U1514J report, as well as detailed macro- and microscopic observations of all cores and thin sections from Holes U1415K and U1415N.

Holes U1415K and U1415N: The few gabbro and quartz diorite pieces in Hole U1415K have isostropic magmatic fabrics, and show no deformation other than minor fracturing and smectite veining. The basalts, dolerites and microgabbros of Hole U1415N show weak plagioclase defined magmatic fabrics flowing around olivine/plagioclase xenoliths and antecrysts. They show no deformation other than minor fracturing and smectite veining.

Paleomagnetism

The paleomagnetic team finished measuring discrete samples from Hole U1415J, using low temperature and high temperature demagnetization techniques, and began analysis of the resulting data. Two sediment samples were taken from Hole U1415M and were AF demagnetized.

Geochemistry

Two basaltic samples were selected for geochemistry from Hole U1415N. The CO_2, H_2O and sulfur composition of the samples will be determined using gas chromatography (CHNS) and ICP-AES measurement will be performed as soon as a complete batch of samples is ready for analyses.

Physical Properties

The basalt/dolerite rubble from Hole U1415N was measured on the section half multisensor logger (SHMSL).

Education and Outreach

The E&O team completed 15 broadcasts this week. Nineteen broadcasts are schedule for next week to school groups in France, United Kingdom, USA, Italy, Serbia, China, Turkey, and Morocco). We continue to receive a lot of new requests for broadcasts and we anticipate three to four broadcasts each day.

Communication: The development of hands on activities, the publication of posts and enigmas on Facebook, Twitter, *JOIDES Resolution*, and French blogs are ongoing. These appear to be quite popular and with more than 400 followers for each daily post and weekly enigma.

Facebook: www.facebook.com/joidesresolution ; Twitter: TheJR; Blogs at www.joidesresolution.org and www.ac-nice.fr/svt/hdc

Drifter: We continue to follow the drifter launched for Christmas day from the *JOIDES Resolution* (a school program to study oceans currents). The buoy is still sailing to the East in the equatorial counter current and is ~500 km north of the ship.

Technical Support

Science mission support:

- Technical staff continued to provide core processing and analytical support for the Science Party.
- One successful and one less successful camera/sub-bottom surveys were made.

Other technical activities:

- 3.5 kHz pinger: We successfully repaired both the electronics and transducer that was suffering from numerous issues. The unit is now operating at full power and on a full charge that will operate over 24 hours. We still have an issue with a leak in the rubber cap on the transducer.
- IT Server and tape drive issues continued but are being managed.
- Underway Lab Instrument Hosts: No further progress on this issue was made due to higher priority work.
- SHMSL: Minor changes to software and hardware have partially mitigated the drift issue. More work is needed.
- New SHIL: Software development and hardware testing are in progress.
- Inventory: Physical counts were completed in Chemistry Lab.

HSE activities:

- The weekly fire and abandon ship drill was held as scheduled.
- Posting NFPA signs continued and hazardous inventories were updated.