IODP Expedition 345: Hess Deep Plutonic Crust

Week 8 Report (27 January–2 February 2013)

This week of IODP Hess Deep Expedition consisted of establishing reentry capability in Hole U1415P and RCB coring from 12.5 to 82.3 mbsf that recovered 23.28 m of medium to coarse-grained gabbroic rocks. At the end of the week, we had just reentered Hole U1415P with a new bit. Our plan, depending on hole conditions, is to core and then log until we depart for Panama at 1000 h on 6 February.

Operations

After conducting a visual survey and selecting the position for Hole U1415P, we recovered the camera system, installed the top drive, spaced out the drill string, and started Hole U1415P at 1255 h on 26 January. The 14.75 inch bit was washed without rotating to 2.0 mbsf (4866.0 mbrf) and then drilling proceeded to 11.0 mbsf (4875.0 mbrf). We then assembled a hard-rock reentry system (HRRS)-style free-fall funnel (FFF) cone. The 26 inch interior diameter of this cone was reduced to 16 inches by attaching portions of a CORK fishing tool funnel (OF3620). In contrast to our previous FFF cone deployments, this time we attached a base plate to the bottom of the FFF. After the FFF cone was deployed to the seafloor, we continued drilling the hole to 12.5 mbsf. The camera was deployed to observe the orientation of FFF cone and the bit pulling out of it. However, the funnel was very difficult to see through clouds of sediment. Eventually, we decided not to wait and we pulled the bit out of the hole and through the FFF cone at 1545 h on 27 January. The bit was back on the rig floor at 0105 h on 28 January. We assembled 12.5 m of 10.75 inch casing and hung it off on the moon pool doors. Next, we assembled an RCB bottom-hole assembly, lowered it through the casing in the moon pool, and lowered it to the seafloor. The camera system was also lowered to the seafloor. Before we prepared to locate and reenter Hole U1415P, we had to slip and cut the drill line for the fourth time this expedition. After installing the top drive and spacing out for reentry, it was immediately apparent that the FFF cone was not sitting upright. Some camera perspectives looked as if the FFF cone was leaning to one side, while in other perspectives it appeared to be lying fully on its side. At the base of the FFF cone was a dark spot that appeared to be the top of the hole. Discussions vacillated between whether we should attempt to reenter the cone or the hole. Eventually the pipe maneuvered close enough to take a stab at cone reentry and it became obvious that the cone was indeed lying on its side and this reentry attempt failed. We then moved the bit over the dark area at the base of the FFF cone and we successfully reentered Hole U1415P at 1450 h on 28 January. The total time expended after starting to search for the FFF cone was 2.6 h. The reentry of the bit into an open 14.75 inch hole with over 4800 m (3.0 miles) of drill string deployed was quite an impressive feat achieved by the dynamic position and drilling staff. The camera system was recovered and the hole had to be drilled from 8.0 to 12.5 mbsf and swept with high viscosity mud. The core barrel used during washing and reaming this interval (Core U1415P-2G) was recovered with 2.36 m of rubble. Our next step was to assemble a FFF cone to the 12.5 m of 10.75 inch casing hung off in the moon pool. We free-fall deployed the 10.75 inch casing with the attached FFF and dropped a core barrel to start coring ahead. The driller could not identify the normal pressure spike that occurs when the core barrel has landed at the bottom of the BHA. When the pump

pressure was increased to confirm the core barrel had landed properly, the rotary hose that supplies drilling fluid to the top drive burst. The hose failed on the top drive connection at 2400 psi (the hose is rated to 5000 psi working pressure). After we installed a new hose, we reached the bottom of the hole (12.5 mbsf) at 0500 h on 29 January. We started RCB coring and Core U1415P-3R (12.5 to 18.1 mbsf) arrived on deck at 1225 h. We had some difficulty getting the bit through the transition from the 14.75 to 9.875 inch portion of the hole, but we were able to drill out this area (Core U1415P-4G; 12.5 to 16.5 mbsf). RCB coring resumed and Cores U1415P-5R to -10R extended the hole from 18.1 to 45.6 mbsf and recovered 12.19 m (44%) of nicely cored pieces of gabbro. Core U1415P-11R was cut in only 45 minutes of rotating time. RCB coring continued to Core U1415P-18R that extended to 82.3 mbsf and was recovered on deck at 0920 h on 1 February. As the hole was deepened we experienced faster coring rates through a formation inferred to be more fractured leading to increasingly difficult hole cleaning. Eventually, we decided to pull out of the hole for a bit change due to increasing bit hours, decreasing recovery, and extended periods of washing/reaming back to bottom after recovering core barrels. We pulled the bit out of the hole and the bit was back on the rig floor at 1845 h on 1 February. After assembling a new C-7 RCB bit, we lowered the drill string, deployed the camera system, installed the top drive, and the drill string was spaced out for reentry by 0530 h on 2 February. We reentered Hole U1415P at 0553 h on 2 February. During this re-entry, we confirmed the top of the FFF cone was at 4862.5 mbrf. The height of the FFF from base plate to rim is 1.2 m placing the base of the FFF at 4863.7 mbrf. The seafloor tag depth was determined to be 4864.0 mbrf on 26 January at slack tide. The FFF depth was established on 2 February when the tide tables indicated a high tide of 0.2 m. Therefore the FFF appears to be installed right at the seafloor (4863.9 m vs. 4864.0 m). As of 1030 h on 2 February, we had washed and reamed down to 38 mbsf in Hole U1415P. This is being done slowly to clean out the hole in small increments as opposed to loading up the annulus with large amounts of fill/cuttings and then having to wash these out all at once.

Science Results

Igneous Petrology

Our work this week focused on the macroscopic description of gabbroic rocks from Hole U1415P up to Core U1415P-17R. The first two sections of Core U1415P-2G consist of a mix of mainly sand (grain size variation from fine to coarse) and minor rubble of gabbros and sparsely phyric basalt. Core U1415P-3R and -4G recovered mainly medium to coarse-grained olivine gabbro, with granular to poikilitic texture, in part foliated and orthopyroxene-bearing. Section U1415P-4G-1 contains a remarkable pegmatitic patch with a ~7 cm wide grain of clinopyroxene. Cores U1415P-5R to -15R recovered a coherent series of locally orthopyroxene-bearing coarse-grained olivine gabbro with spectacular textural features like curved banding or diffuse interfingering of modal and texturally different lithologies. From Cores U1415P-15R to -17R the lithological character of the gabbroic series changes from multi-textured olivine gabbro to more homogeneous, medium to coarse grained, granular troctolite.

Metamorphic Petrology

This week we described rocks from Hole U1415P, which include a range of minimally altered gabbroic rocks of varying lithologies. Most of the samples have been moderately altered 10–

60%. Plagioclase is moderately altered to secondary plagioclase, prehnite along microfractures, and chlorite rims adjacent to olivine and orthopyroxene. Olivine is moderately to highly altered to serpentine+talc+clay+pyrite. Clinopyroxene and orthopyroxene are variably altered to amphibole. Chlorite and prehnite veins are the dominant vein types, although these rocks have not developed pervasive vein networks. A low abundance of secondary sulfides has been observed in olivine replacement and disseminated in chlorite and prehnite after plagioclase.

Structure

The week was spent completing detailed macro- and microscopic observations of core from Holes U1415K and U1415N, and making initial observations on Cores U1415P-2G to -18R (8 to 82.3 mbsf).

Cores from Hole U1415P recovered a sequence of orthopyroxene-bearing olivine gabbro and olivine to troctolitic gabbro between 12.5 to 63.8 mbsf (Cores U1415P-4G to -15R). These cores show a spectacular (and persistent) subvertical, wavy olivine and plagioclase banding. Troctolites from below Cores U1415P-15R (>68 mbsf), show more variable and shallower dips (~35°) in observed banding.

Hole U1415P cores show little deformation other than minor fracturing, and one zone of minor cataclasis in the bottom of Core U1415P-15R (64.1 mbsf). Thin (<0.1 cm) alteration veins are ubiquitous, but low density throughout the hole. Rare dark amphibole veins are overprinted by two sets of later low-temperature chlorite, prehnite, zeolite and clay veins, with both shallow (dominant) and steep dips.

Paleomagnetism

The paleomagnetic team began measuring archive half cores from Hole U1415P on the cryogenic magnetometer and associated discrete samples on the spinner magnetometer and Kappabridge. They also presented data from Hole U1415J to the science party.

Geochemistry

Ten samples have been collected from Hole U1415P for geochemical analyses: five olivine gabbros, four orthopyroxene gabbros and one troctolitic olivine gabbro. The CO_2, H_2O and sulfur composition of two basaltic samples from Hole U1415N were measured in addition to some duplicates from Hole U1415J, and the data are now being processed. The 10 new samples will be measured by CHNS and ICP-AES within the following week.

Physical Properties

Core sections from Hole U1415P were measured in the Whole Round Multisensor Logger and the Section Half Multisensor Logger. Natural gamma ray radiation remains very low (<2.5 count/s), below background level. Magnetic susceptibility remains generally low (below ~8000 x 10^{-5} SI, average ~900 x 10^{-5} SI). We completed measurements on the first few discrete samples of olivine gabbro from Hole U1415P. Grain density ranges from 2.82 to 2.96 g/cm^3, and porosity ranges from 0.4 to 1.1%. *P*-wave velocity ranges from 6.1 to 6.4 km/s. Thermal conductivity ranges from 2.15 to 2.33 W/m·K in 3 olivine gabbro pieces (Cores U1415P-4G to -5R).

Education and Outreach

This week the E&O team has completed 20 broadcasts to students in nine countries; feedback from the evaluation forms continues to be extremely positive. Next week, fourteen broadcasts are scheduled.

The team has made good progress with the "Tales of the Resolution" comic book and information posters. 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 continue to follow the drifter launched for Christmas day from the *JOIDES Resolution* (a school program to study oceans currents). This week "Drifty" has travelled 100 km in a southeast direction this week; it is now 600 km from the ship.

Technical Support

Science mission support:

- Technical staff continued to provide core processing and analytical support for the Science Party.
- We began preparing hard rock cores for sampling party and end-of-expedition activities.

Other technical activities:

- Underway Lab Instrument Hosts: We were unable to host the SB_Logger application on the virtual Windows XP operating system. We configured the PC to Windows 7 (32-bit) and successfully installed Bathy 2010 and Winfrog applications. Live testing started.
- Software development and hardware testing for the SHIL were in progress.
- Physical inventory counts were completed in Chemistry Lab.

HSE activities:

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