

December 26, 2005

**IODP EXPEDITION 312:
SUPERFAST SPREADING RATE CRUST 3
WEEK 8 REPORT**

OPERATIONS

Reentry No. 14: Following a wiper trip that focused on the newly cored section of the hole, the hole was flushed with 210 bbl of 8.9 ppg sepiolite mud. A bottom-hole assembly (BHA) with a logging bit was made up and reentered Hole 1256D at 2318 hr on 19 December. The logging bit was set at ~280 mbsf and a total of six tool strings were deployed.

Logging: The first deployment consisted of the triple combo tool string, which contained the Hostile Environment Gamma Ray Sonde (HNGS), Accelerator Porosity Sonde (APS), Hostile Environment Litho-Density Sonde (HLDS), Dual Laterolog (DLL), and Lamont Doherty Earth Observatory (LDEO) Temperature-Pressure-Acceleration (TAP) tools. After the tool string was lowered ~2500 meters below rig floor (mbrf) into the pipe, the wireline winch started to stall. After 2 hr adjusting the chain drive, the winch was back in operation. Later, communication with the DLL tool was lost and after several failed several attempts to re-establish connection the logging run was terminated. At a depth of 1440 mbsf, the cable head tension decreased, indicating that the tools had reached a bridge ~67 m above the total cored depth of 1507 mbsf. The first logging run was conducted from this depth to 343 mbsf and a repeat pass logged from 1438 to 1080 mbsf. The tool was on deck at 1639 hr and the rig down completed at 1730 hr on 20 December.

The second tool string consisted of the check shot survey. The Versatile Seismic Imager Tool (VSI) was lowered into the open hole at 0541 hr on 21 December to ensure compliance with the Marine Mammal Protocol. The tool was lowered to 1433 mbsf by 0733 hr and the survey started with a 30 min ramp up of the air gun, beginning at 500 psi and gradually increasing to 2000 psi. No mammals were sighted during the survey. Because of a weak first arrival at the first clamping (1433 mbsf), the second was placed 50 m above at 1383 mbsf. The remaining clampings were made ~22 m apart at 58 stations through the entire basement section. At each station, 11–15 shots were taken. Two of the deepest Leg 206 clampings were reoccupied to provide data overlap and comparison. The tool was recovered at 1930 hr on 21 December.

The third tool-string deployment was the FMS/Sonic consisting of the Dipole Shear Imager (DSI), the Scintillation Gamma Ray Tool (SGT), the General Purpose Inclinator Tool (GPIT), and the Formation MicroScanner (FMS). The tool string was run into the hole after testing the FMS caliper arms. The main pass started at 1100 hr from 1431 mbsf. After 15 min, the main voltage dropped and the main current increased to 1600 mA. The data channels of the FMS, both calipers, and the GPIT tool also showed random values, so the only working tool was the DSI. The logging run was aborted at 1309 mbsf and the tool string was rigged down by 0318 hr, 22 December.

The fourth tool string consisted of the Ultrasonic Borehole Imager (UBI), GPIT, and SGT tools plus the DSI. The tool string was run into the hole at 0414 hr and the first pass was logged from 1430 to 1099 mbsf. A repeat pass was made between 1432 and 1322 mbsf, and a second main pass was run from 1433 to 1089 mbsf. The tool was recovered and rigged down by 1527 hr.

The repaired FMS tool was combined with the Scintillation Gamma Ray tool and lowered into the hole making two main passes from 1437–1098 and 1436–1089 mbsf. The last tool string made up of the TAP, repaired DLL, and SGT tools then logged the hole from 325 to 1431 mbsf.

Once the logging equipment was rigged down, the drill string was pulled out of the hole, clearing the seafloor by 1345 hr on 23 December. The drill string was retrieved and the BHA broken down and secured for transit. The vessel departed Hole 1256D for Balboa at 2200 hr on 23 December. The total time on site during Expedition 312 was 926.5 hours (38.6 days).

Transit to Balboa, Panama: As of 1800 hr on 26 December, the vessel had sailed 725 nmi at an average speed of 10.8 kt. We expect to conclude the 115 nmi transit to the Pacific Anchorage off Balboa, Panama by 0600 hr on 27 December. We will drop anchor for ~24 hr. We are scheduled to start the Canal transit to Cristobal at ~0700 hr on 28 December. The USIO and Transocean crew change is planned for 29 December.

SCIENCE UPDATE

Hole 1256D now penetrates through a 345 m sheeted dike complex, with the lower 50 m of the dikes containing local granoblastic textures. Below 1406.6 mbsf is the Plutonic Complex, consisting of two gabbroic units Gabbro 1 (1406.6–1458.9 mbsf) and Gabbro 2 (1483.1 mbsf to the bottom of the hole at 1507.1 mbsf), separated by a dike screen.

A range of gabbroic rocks and variably altered basaltic dike material was recovered from 1458.9 and 1502.8 mbsf. After having passed from Gabbro 1 into a dike screen, we continued to recover fine-grained basaltic rocks with an original intergranular texture. This texture has been strongly overprinted with the development of granular clinopyroxene and plagioclase and the appearance of orthopyroxene. The dike screen is intruded by Gabbro 2 at 1483.1 mbsf. The uppermost part of this complex body contains many xenolithic fragments of the overlying basalt, which contain abundant granular orthopyroxene, and the host rock is a gabbro. In the following 10 m of orthopyroxene-bearing gabbro, no macroscopic xenolith fragments are observed, but thin section inspection shows that orthopyroxene oikocrysts commonly enclose granular clinopyroxene. Fine-grained xenolith fragments reappear at 1493.95 mbsf and all recovery is fine grained from 1494.95 mbsf onwards. The proportion of orthopyroxene in this material drops from ~20% at 1494.95 mbsf to <1% by 1497.63 mbsf, and over this interval the texture is very similar to samples from the dike screen. At 1502.59 mbsf, Gabbro 2 is cut by an aphyric cryptocrystalline basaltic dike that has well preserved igneous texture and appears to have undergone less high temperature alteration than the immediately overlying rocks.

Final shipboard ICP-AES analyses on 46 basalts, dikes, gabbros, and leucocratic rocks indicate the dikes within the sheeted dike complex are fractionated, MOR-type basalts. Gabbros 1 and 2, separated by basaltic dikes, are more evolved at the top of each sequence ($Mg\# = 40-55$) and become less fractionated at greater depths ($Mg\#s = 61-69$). Some gabbros are low in FeO, relative to MgO, and this may suggest that they are cumulate rocks, as they fall below the fractional crystallization trend composed of other gabbros and dikes, as well as by the basalts from higher up in the hole. High-MgO gabbros are promising for understanding melt removal and crystal accumulation in the magma lens beneath a fast-spreading MOR.

The gabbros and associated rocks from the Plutonic Complex are moderately to completely altered, with the intensity of alteration strongly influenced by grain size and proximity to intrusive margins. Clinopyroxene is highly to completely replaced by actinolitic hornblende and plagioclase is replaced by secondary plagioclase, actinolitic hornblende, epidote, prehnite, and chlorite. Coarser-grained zones within the gabbros tend to be more highly altered. The most intense alteration occurs at the margins between dikes and gabbros and along the margins of thin magmatic leucocratic dikelets, which tend to be highly to completely replaced by epidote, quartz, chlorite, titanite, and actinolitic hornblende. These contacts have 5–20 mm green chlorite-rich halos. The gabbros have fewer veins than the overlying sheeted dikes. The earliest generation of veins are difficult to discern and occur as diffuse 1–2 mm wide actinolitic hornblende halos with no discrete vein filling. These veins are crosscut by discrete 0.5–1 mm actinolite veins, also with alteration halos. In zones of intense hydrothermal alteration, the actinolite veins are cut by epidote + quartz + prehnite veins with chloritic margins. These relatively early vein sets are crosscut by 0.5 mm chlorite and later ~1 mm quartz + chlorite veins. The basalts in the dike screen intruded by the gabbros are partially recrystallized to granoblastic assemblages, which are in turn hydrothermally altered and cut by veins.

Sixty oriented pieces were recovered below 1464 mbsf, with 129 measured structures, including veins, fractures, igneous contacts, and a magmatic foliation. The magmatic foliation is observed in two gabbro intervals below 1483 mbsf and is primarily defined by the preferred orientation of plagioclase laths with dips of $19^{\circ}-31^{\circ}$. The foliation is generally parallel to the boundaries of xenolithic gabbro lenses. Leucocratic patches are present below 1464 mbsf, but they have a different structure and abundance than patches near the top of the plutonic complex. Veins throughout the upper gabbro and dike screen are subvertical but are more shallowly dipping in the lower gabbro.

Bulk density and grain density measured on minicubes, bulk density from gamma ray attenuation, and thermal conductivity all increase through the two gabbro units and the dike screen. Porosity decreases over the same interval. Both gabbro units have short intervals with relatively high NGR counts. The highest magnetic susceptibility values in Hole 1256D (~20,000 SI units) were measured in the uppermost section of the Gabbro 2 unit. Compressional velocity increases from 5.5 km/s in the upper gabbro to 6.3 km/s in the dike screen and then decreases in the Gabbro 2 unit. These data suggest that the

mineral and alteration changes associated with gabbro emplacement affect the physical properties of middle ocean crust.

Paleomagnetic results from 1435 to 1503 mbsf extend the previously recognized pattern that gabbro magnetization is similar to dike magnetization. Drilling overprint continues to dominate the NRM direction but is largely removed by high-demagnetization fields. NRM intensities of the gabbro samples at 2–40 A/m overlap with the intensities of the dike samples at 7–56 A/m, but lower intensities of 2–7 A/m make up about half of the gabbro population. Even if drilling overprint increases NRM intensity by a factor of 5, these units may well be a significant fraction of the source of marine magnetic anomalies. Thermal demagnetization results show a gradual drop in intensity with temperature, with the final 5%–10% removed at 570°C or 580°C temperature steps, indicating nearly pure magnetite as the primary carrier.

Thirty-three oriented pieces from Cores 231-234R were scanned with the DMT core scanner. Lengths of scanned pieces vary from 70 to 975 mm, averaging 208 mm. Distinctive veins and fractures on surfaces of the pieces, particularly in Core 231R are promising and may allow reorientation using FMS and UBI logs.

The triple combo logging run provided excellent data, indicating monotonous NGR radiation below 4 gAPI for most of the sheeted dike complex. Only at the sheeted dike/granoblastic dike boundary is the NGR radiation increased. Density varies only slightly but increased also at this boundary, whereas porosity decreased. The resistivity reached values well above 1000 Wm and the decoupling of the shallow and deep resistivity, observed at the top of the sheeted dikes, became more prominent. Compressional velocities below 1350 mbsf increase to values around ~7 km/s followed by a drop to 4 km/s in the gabbros. Travel times acquired during the check shot survey complement the sonic velocities. Temperature measurements indicate an increase by 3.6°C from 64.2°C to 67.9°C at a TD of 1440 mbsf within 5 hr. The last temperature measurement with the TAP-DLL tool recorded a maximum of 86.5°C after 73 hr. The first tentative evaluation of the FMS and UBI borehole images indicate that formations are dominated by discontinuous fractures above the gabbro/sheeted dike boundary, whereas below this boundary, fractures breakouts occur more often.

TECHNICAL SUPPORT ACTIVITIES

Coring was finished this week and the logging program began. A 10 hr VSP experiment was successfully completed. The split cores were laid out for the scientists to make their on shore sample selections and the samples were cut. Inventorying and packing the samples is in progress. The DMT was crated for return to owner. Lab cleanup is in progress. PM is being done to the thin section machines for storage. Gym equipment is being prepared for shipment from Cristobal. Space in the gym and hold will be cleared to stage the priority equipment coming off the ship in Galveston.

HSE: The weekly boat drill was a fire in the paint locker, and all hands not associated with the drill reported to their life boats. The METs team was ready in support.