IODP Expedition 335: Superfast Spreading Rate Crust 4

Week 1 Report (14-17 April, 2011)

Operations

All Expedition 335 scientists transferred from their hotel in San Jose to Puntarenas and moved onto the vessel on 14 April, except for one scientist who was delayed by three days. On the morning of 15 April, the co-chief scientists participated in a press conference at the Marine Biology Station of the Universidad National Costa Rica, located near the vessel. Regional visitors toured the ship in the afternoon. The final science party member arrived on board on 16 April.

The last line was released on 17 April at 04:20, and the vessel began transit to Site 1256 (6°44.2 N, 91°56.1 W) at 04:30. The estimated time of arrival on site is 02:00 on 19 April.

Science Results

The science party received presentations about the expedition project and general workflows, which concluded the settling-in phase of the cruise. The science party then proceeded to start defining the detailed methods for the scientific activities of the cruise, including all analytical measurements that will be made on discrete samples, and the specification of macroscopic and microscopic descriptions of cores (igneous petrology, alteration petrology, and structural geology).

Expedition 335 introduction and objectives

IODP Expedition 335 will be the fourth scientific ocean drilling cruise of the Superfast campaign to drill a deep hole into intact oceanic basement, and will return to ODP Hole 1256D to deepen this scientific reference penetration a significant distance into cumulate gabbros. The cores and data recovered on the Superfast 4 Expedition will provide hitherto unavailable observations that will test models of the accretion and evolution of the oceanic crust. Site 1256 lies in 3635 m of water in the Guatemala Basin on Cocos Plate crust formed ~15 m.y. ago on the eastern flank of the East Pacific Rise.

Site 1256 was specifically located on oceanic crust that formed at a superfast spreading rate (>200 mm/yr) to exploit the observed relationship between spreading rate and depth to axial low velocity zones, thought to be magma chambers, seismically imaged at active mid-ocean ridges. This was a deliberate strategy to reduce the drilling distance to gabbroic rocks because thick sequences of lavas and dikes have proved difficult to penetrate in the past. ODP Leg 206 (2002) initiated operations at Site 1256 including the installation in Hole 1256D of a re-entry cone with 16-in casing inserted through the 250 m-thick sedimentary cover and cemented into basement to facilitate deep drilling. The hole was then cored ~500 m into basement. IODP Expeditions 309 and 312 (2005) successfully completed the first sampling of an intact section of upper oceanic crust from lavas, through the sheeted dikes, and into the upper gabbros. Hole 1256D now penetrates >1500 mbsf and >1250 m sub-basement and currently resides in the dike-gabbro transition zone. The first gabbroic rocks were encountered at 1407 mbsf. Below this lies a

~100 m complex zone of fractionated gabbros intruded into contact metamorphosed dikes.

Although the previous cruises to Site 1256 achieved the benchmark objective of reaching gabbro in intact ocean crust, critical scientific questions remain. Specific scientific questions that will be addressed by deepening Hole 1256D a significant depth into gabbros include the following:

(1) What is the major mechanism of magmatic accretion in crust formed at fast spreading rates?
(2) Does the lower crust form by the recrystallization and subsidence of a high level magma chamber (gabbro glacier) or crustal accretion by intrusion of sills throughout the lower crust, or some other mechanism?
(3) How is heat extracted from the lower oceanic crust? Is the plutonic crust cooled by conduction or by deep circulation of hydrothermal fluids?
(4) What is the geological significance of the seismic layer 2/3 boundary at Site 1256?
(5) What is the magnetic contribution of the gabbro layer to marine magnetic anomalies?
(6) Can the magnetic polarity structure of the lower crust be used to constrain cooling rates?

Technical support and HSE activities
The science party received introductory safety and life on board information upon arrival on the vessel as well as science laboratory tours. The first weekly fire and boat drill was held on 17 April at 13:00.