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Deep structures and melt-fluid migration in the Hole 1256D Superfast-Spread Crust

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ODP-IODP Hole 1256D drilled through the upper oceanic crust of the Cocos plate formed at the superfast spreading East Pacific Rise ~15 Ma ago (220 mm/yr). This hole penetrated, for a first time in the history of scientific ocean drilling, the upper gabbro layer of an intact oceanic section during IODP Expedition 312. IODP Expedition 335 deepened the hole by ~ 20 m and recovered cores and cobbles of basalts with granoblastic texture (granoblastic dikes) beneath two bodies of gabbroic rocks (Gabbro 1 and Gabbro 2). Recovered basaltic materials contain cross-cutting relationships between dioritic magmatic veins and hydrothermal veins, and between opx-bearing veins and hydrothermal veins. Here we present the structures in the sheeted dikes and gabbros, and deduce melt-fluid transport system in the deep part of the superfast-spread crust.

The Hole 1256D is located at the boundary between C5Br and C5Bn.2n (15.16 Ma) and inclines ~5 degree from vertical to the west. Results of GPIT logging imply that the upper part of the hole has reversed magnetic polarity, whereas granoblastic dikes and gabbros have normal polarity. Gabbro 1 yielded zircon U-Pb ages of 15.04 +- 0.18 Ma and 15.06 +- 0.30 Ma. U-Pb age for Gabbro 2 was 15.20 +- 0.17 Ma.

Structural orientations measured on the Exp. 312 cores with respect to the conventional IODP reference frame and AMS orientations were reoriented into a geographic reference frame using paleomagnetic data and assuming the magnetic structure obtained by GPIT tool. We also assumed that there was no significant tectonic tilting. Restored Sheeted dikes dip steeply to WSW toward the paleo-EPR axis. Kmax axes of AMS fabric parallel to the dike strike and mostly sub-vertical Kmin axes suggest that the magma transferred horizontally and underwent compaction during solidification. The recovered upper boundary between Gabbro 2 and the granoblastic dikes was irregular, and sub-parallel to the sheeted dike planes. However, textural banding and flow foliation in gabbros tend to dip gently to the east. Diorite veins in granoblastic dikes have irregular boundaries with various orientations and often accompany amphibolite alteration halo. X-ray CT images show inhomogeneous distribution of heavy mineral phases (Fe-oxides?) and light mineral phases (Qz?) in the melt channel implying flow differentiation occurring at hand specimen scale. Opx veins also exhibit irregular shape. Both dioritic and opx veins are cut by amphibole-bearing hydrothermal veins that accompany alteration halos of various width. Dips of amphibole veins exhibit a bimodal distribution: one shallower than ~30 degrees and other steeper than 60 degrees and dipping mostly to SW. S-poles to veins are plotted on a great circle on a stereographic projection about an axis (sigma 2 direction) plunging sub-horizontally to the NW. Brittle fractures also have the same tendency. Restored orientations of structures imply that, since the formation of the sheeted dike complex until formation of the brittle fractures, the crust dominantly underwent extension parallel to the spreading direction. Melt and fluid were likely to transfer subhorizontally through dike planes and through intersections of fracture planes, respectively.

Keywords: oceanic crust, structure, melt migration, paleomagnetism, dating, superfast spreading ridge