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Petrophysical characterization of the hydrothermal root zone in the sheeted dike complex from IODP Hole 1256D.

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IODP (Integrated Ocean Drilling Program.) Site 1256 is located on the Cocos Plate in the Eastern Equatorial Pacific Ocean. It samples 15 Ma-old oceanic lithosphere that was formed at the EPR during a period of superfast spreading rate (> 200mm/yr). Drilling operations at Site 1256 were conducted during three ODP and IODP expeditions, and reached for the first time gabbros below the sheeted dike complex in Hole 1256D. This offers a unique opportunity to study in situ the fossil root zone of the sheeted dike complex in present-day oceanic crust. This zone is a boundary layer between the magmatic system of the melt lens (around 1100 °C), and the overlying high temperature hydrothermal system ($\leq$ 450 °C). This boundary layer during crustal accretion is critical to our understanding of crustal processes along mid-ocean ridges.

This work focuses on the petrophysical characterization of the root zone. Physical properties were determined from downhole geophysical profiles and images, and from laboratory petrophysical measurements from 21 minicores. Dikes, granoblastic dikes and gabbros testify to an important hydrothermal circulation in the vicinity of the magmatic lens. Porosity is primarily controlled by sample initial texture, hydrothermal alteration, and recrystallization processes. Green schist facies alteration of basalts is associated to relatively higher porosity values ($\approx$ 2%) and a very variable organization of the pore space, as revealed by electrical properties. The electrical formation factor in diabase is high and variable (920 to 6087). Granoblastic dikes are characterized by locally recrystallized texture with Cpx and Opx (granulite facies) and little alteration at low temperature. The recrystallization induces abrupt decrease in porosity (< 1%) probably due to neoblast blocking of pre-existing porous space. From the coherent results in porosity estimates obtained with different techniques, it is proposed that the recrystallization progresses with depth in the granoblastic interval. Gabbros show very heterogeneous textures, but have a fairly constant porosity, which likely consist mostly in microcracks. Crack density increases linearly with depth from 0.02 in diabase to 0.08 in gabbros. It is consistent with a fissural porosity (crack aspect ratio ranges from 0.02 to 0.1 in diabase, and from 0.02 to 0.04 in gabbros). Electrical (FMS) borehole wall images show three several meters thick fault zones (N160°, 60°NE), which are the likely main hydrothermal circulation channels through the base of the sheeted dike complex. A series of smaller subhorizontal fractures and veins, dipping 20° to the west (i.e., to the ridge axis), perpendicular to the main faults and to dike boundaries, may represent the closure of the hydrothermal system at depth.