



## **Crack structure in oceanic crust: A seismic anisotropy study in the Costa Rica Rift**

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In 2015, an interdisciplinary cruise JC114 was carried out over the Costa Rica Rift (CRR) in the Panama Basin. A 5 x 5 grid of ocean-bottom seismographs (OBS) were deployed over the ridge axis, covering an area of 400 km<sup>2</sup>. Using tomography to invert ~69,000 Pn and Pg arrivals, we obtained a three-dimensional velocity-depth model of the upper crust beneath the CRR, discovering a variable velocity structure beneath the axis. By fitting the traveltimes residuals of our tomography result with a sinusoid curve composed of  $\cos(2\theta)$  and  $\cos(4\theta)$  terms, we investigated the crack-induced azimuthal anisotropy in the upper oceanic crust, focusing on the bathymetric dome in the west of our survey region and the small-offset overlapping spreading centre (OSC) to the east. Our results reveal that in the upper crust on/near the axis, the fast direction of P-wave propagation is roughly aligned with the strike of the ridge axis, implying the presence of vertically aligned cracks that are nearly in parallel to the axis in the upper crust. At the dome, beneath which the axial magma chamber has been imaged on coincident seismic reflection data, a high velocity and aspect ratio of  $A_{4\theta}/A_{2\theta}$  region within the dyke section indicates the presence of thinner cracks. We interpret that this interval may be partly filled by the minerals precipitated from active hydrothermal circulation and/or magmatic intrusions. Conversely, in the dyke section beneath the OSC, we observe an anomalously low velocity yet a high  $A_{4\theta}/A_{2\theta}$  with the fast direction oriented oblique counter-clockwise to the axis. These observations suggest the presence of thin and water-saturated cracks under tectonic stress that may provide important pathways for the downflow of seawater into the crust. However, near the bottom of the dyke section, a lower ratio of  $A_{4\theta}/A_{2\theta}$  and higher anisotropy amplitude is evidence for the presence of thicker cracks, which may implicate lower rate of mineral precipitation and/or the absence of crack filling by magmatic intrusions. This is consistent with our interpretation that the OSC is a less magmatically active region. The variability of crack characteristics on the axis of the CRR may help us to understand the relationship between along-axis hydrothermal circulation and crack structure in the upper oceanic crust.

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