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3D P- and S-wave Velocity Structure and Anisotropy of 5.9 Ma Oceanic Crust at ODP Borehole 504B

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Faults and fracture networks within the oceanic crust influence the pattern of hydrothermal circulation. This circulation changes the primary composition and structure of the crust as it evolves, particularly the upper crust (layer 2), through the secondary alteration of minerals and the infilling and 'sealing' of cracks. Processes influencing the extent and depth within the crust of these changes are not currently well known. Alteration can be investigated by observing changes in the seismic velocity structure of the crust, while analysis of seismic anisotropy within the upper crust reveals the nature of aligned faults and fractures acting as fluid pathways.

Here we show 3D Vp and Vs models for 5.9 Ma crust at ODP borehole 504B, situated ∼200 km south of the Costa Rica Rift, derived from an active-source wide-angle seismic survey in the Panama Basin conducted in 2015. The P-wave seismic structure reveals relatively homogeneous, ∼5 km thick oceanic crust with upper crustal velocity boundaries occurring coincident with alteration fronts observed in 504B. A correlation between basement highs and faster upper crustal velocity suggests a shallowing of the layer 2b/2c transition in these locations, potentially linked to more intense hydrothermal alteration of the upper crust. Upper crustal P-wave azimuthal anisotropy is also present with a strong cos(2[U+03F4]) pattern, indicating aligned open fractures with a ridge-parallel fast direction.
The calculation of Vp/Vs and Poisson's ratios details variations in fracturing and alteration and, combined with anisotropy analysis, distinct relationships can be drawn between hydrothermal alteration, basement topography, fracturing, and the velocity structure of layer 2 as a whole.

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