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A new geophysical proxy for the characterisation of the layer 2A/2B boundary in the oceanic crust ground-truthed by ODP borehole 504B

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The seismic structure of oceanic crust is regularly used to define its geological structure. For example, the layer 2A/2B seismic boundary is often interpreted as either a lithological boundary or a geochemical alteration front, as well as being used to appraise changes in fracture and void volume. Velocity variations across a study area are commonly taken to indicate changes in composition, intrusion type, faulting or the degree of alteration.
We present the results of a comprehensive seismic study encompassing ODP borehole 504B in the SW Pacific, one of the deepest boreholes yet drilled into in-situ oceanic crust, and compare the seismically observed structure directly with measured rock physical properties and cored lithologies. Both P- and S wave 3D velocity models of a 625 km2 region have been developed by inverting >220,000 wide-angle travel time picks, together with seismic anisotropy and particle motion analyses. From these results we investigate the geological nature of the layer 2A/2B boundary and of lateral variations in velocity across the model space.
We develop a new proxy, based on the velocity-depth gradient, that places the layer 2A/2B boundary coincident with a measured in-situ significant decrease in porosity within the 504B borehole, as well as the lithological lava-dyke transition zone and a stepwise change in alteration. Variations in velocity and Poisson's ratio across the survey area are interpreted as changes in fracturing and porosity relative to the known characteristics of the rocks sampled by 504B. These indicate possible fossilised hydrothermal circulation cells, with faults inherited from initial crustal accretion providing conduits for mineralising fluid flow. We propose that our new proxy provides a means to help interpret similar data from locations with no borehole to provide a ground-truth.
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