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Tectonic History of Australia Preserved by Mantle Anisotropic Boundaries

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Australia is an old stable continent with a rich geological history. Limitations in sub-surface imaging below the Moho, however, mean that it is unclear to what extent, and to what depth, this rich geological history is expressed in the mantle. Scattering of surface waves at ~150km depth by lateral gradients or boundaries in seismic anisotropy, termed Quasi-Love waves, offer potential new insights. The first such analysis for Australia and Zealandia is performed with over 300 new scatterers detected that display striking geographical patterns. Around two-thirds of the scatterers are coincident with either the continental margins, or major crustal boundaries within Australia, suggesting deep mantle roots to such features. Within the continental interior such lateral anisotropic gradients imply pervasive fossilized lithospheric anisotropy, on a scale that mirrors the crustal geology at the surface, and a strong lithosphere that preserves this signal over billions of years. Along the continental margins, lateral anisotropic gradients may indicate either the edge of the thick continental lithosphere, or small-scale dynamic processes in the asthenosphere, such as edge-drive convection, tied to the transition from oceanic to continental crust/lithosphere.