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Global observations of reflectors in the mid-mantle with implications for mantle structure and dynamics

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Abstract

Seismic tomography indicates that both up and downwelling flow is commonly deflected in the mid-mantle. However, without a candidate mineral phase change, causative mechanisms remain controversial. Deflection of flow has been linked to radial changes in viscosity and/or composition, but a lack of global observations precludes comprehensive tests by seismically detectable features. Using precursors to the mantle phases SS and PP, we perform a systematic global-scale interrogation of mid-mantle seismic reflectors with lateral size 500–2000 km and depths 800–1300 km. Reflectors are detected globally with variable depth, lateral extent and seismic polarity and identify three distinct seismic domains in the mid-mantle. Near-absence of reflectors in seismically fast regions may relate to dominantly subvertical heterogeneous slab material or small impedance contrasts. Seismically slow thermochemical piles beneath the Pacific generate numerous reflections. Large reflectors at multiple depths within neutral regions possibly signify a compositional or textural transition, potentially linked to long-term slab stagnation. This variety of reflector properties indicates widespread compositional heterogeneity at mid-mantle depths.

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