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Seismic evidence for long-lived elevated temperatures beneath Earths mantle transition zone

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The Earths mantle comprises a series of discontinuities that result from mineralogical phase transitions as pressure and temperature increase with depth. Global discontinuities at 410-km and 660-km depth delimit the mantle transition zone (MTZ). In conjunction with seismic tomography models, properties of the MTZ help quantify regional thermochemical variations, to constrain mass and heat fluxes between the upper and lower mantle. While both discontinuities are detected in precursors to the mantle shear phase SS, the 660 is typically absent for the compressional equivalent, PP. Notably, the 660 transition selectively impedes up and downwelling flow. Here, we reveal from mineralogical modelling that a visible P660P corresponds to a dominant garnet transition at temperatures ¿1800 K; geodynamically, this promotes flow through the MTZ. We use comprehensive datasets of SS and PP precursors and a refined stacking approach based on Voronoi tessellations to generate global observations. We show that high temperatures, and hence efficient transportation through the MTZ, occur in only a small fraction (0.6%) of the globe. Broad regions of long-lived elevated temperature beneath the Pacific are consistent with impeded mantle upwellings, with implications for surface volcanism.