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Ambient lower mantle structure and composition inferred from seismic tomography, convection models, and geochemistry.

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The lower mantle can be grouped into high, low, and average (i.e., ambient) seismic velocity domains at each depth, based on the amplitude and polarity of wavespeed perturbations (% δlnVs, % δlnVp). Many studies focus on elucidating the thermo-chemical and structural origins of fast and slow domains, in particular. Subducted slabs are associated with fast seismic anomalies throughout the mantle, and reconstructed palaeo-positions of Cenozoic to Mesozoic subduction zones agrees with seismically imaged deep slabs. Conversely, slow wavespeed domains account for the two antipodal LLSVPs in the lowermost mantle, which are potentially long-lived features, as well as rising hot mantle above the LLSVPs and discrete mantle plumes. However, low-amplitude wavespeeds (close to the reference velocity models) are often overlooked By comparing multiple P- and S-wave tomographic models individually, and through “vote maps”, we reveal the depth-dependent characteristics and the geometry of ambient structures, and compare them to numerical convection models. The ambient velocity domains may contain early refractory and bridgmantic mantle with elevated Si/(Mg+Fe) and Mg/Fe ratios (BEAMS; bridgmanite-enriched mantle structures). They could have formed by early basal magma ocean (BMO) fractionation during a period of core-BMO exchange of SiO_2 (from core to BMO) and FeO (from BMO to core), or represent cumulates of BMO crystallization with bridgmanite as the liquidus phase. The high viscosity of bridgmanitic material may promote its convective aggregation and stabilise the large-scale, degree-2 convection pattern. Despite its high viscosity, bridgmanitic material, representing a primitive and refractory reservoir for primordial-like He and Ne components, might be entrained in vigorous, deep-rooted plumes. The restriction of a weak seismic signal, ascribed to iron spin-pairing in ferropericlase, to the fast and slow domains, supports the notion that the ambient lower mantle domains are bridgmanitic.