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Global correlation of lower mantle structure and past subduction

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Advances in global seismic tomography have increasingly motivated identification of subducted lithosphere in Earth's deep mantle, creating novel opportunities to link plate tectonics and mantle evolution. Chief among those is the quest for a robust subduction reference frame, wherein the mantle assemblage of subducted lithosphere is used to reconstruct past surface tectonics in an absolute framework anchored in the deep Earth. However, the associations heretofore drawn between lower mantle structure and past subduction have been qualitative and conflicting, so the very assumption of a correlation has yet to be quantitatively corroborated. Here we show that a significant, time-depth progressive correlation can be drawn between reconstructed subduction zones of the last 130 Myr and positive S-wave velocity anomalies at 600-2300 km depth, but that further correlation between greater times and depths cannot presently be demonstrated. The approximately linear time-depth correlation reveals that subducted slabs sink through the lower mantle on average at 1.2-1.9 cm/yr. This range of slab sinking rates falls between existing empirical and modelled estimates that are presently discrepant and provides an important observational constraint for the determination of lower mantle viscosity—a critical but poorly characterized variable in geodynamics.