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Convergence Depths of Tectonic Regions from an Ensemble of Global Tomographic Models

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We project the 3D aspherical variations in shear-wave (Vs) velocity from 21 published whole-mantle tomographic models onto global tectonic regionalizations. The radial Vs profiles of oceanic regions (divided according to crustal age) and continental regions (divided according to Phanerozoic tectonic stability) show strong variations in the uppermost mantle consistent with plate-tectonic expectations, and the profiles for most converge in the upper mantle, consistent with lower-mantle heterogeneity that is uncorrelated with surface tectonics. Using intra-regional variances determined from the models' angular correlation functions, we estimate lower bounds on a set of convergence depths; i.e. minimum depths where the regional averages become statistically indistinguishable from convecting mantle. We focus on Zo(t), the average convergence depths for oceanic profiles of crustal magmatic age t, and Zc, the average convergence depth for continents with tectonically stable crust. Vertical smearing of the aspherical anomalies by the tomographic inversion filters explains most of the variation in the apparent convergence depths across the model ensemble. We correct the regional profiles for vertical smearing bias using upper bounds on the vertical smoothing lengths derived from the models' radial correlation functions. The bias-corrected bounds on Zo(t) are generally consistent with high-resolution multi-mode studies of oceanic structure and half-space cooling models, but they indicate that is Zo(t) for $t > 25$ Ma likely to be more than twice as deep as the oceanic G discontinuity. With high confidence (95%), we can say that the stable-continent convergence depth, Zc, must exceed 350 km and is not likely to be much shallower the 410-km discontinuity. The structure of stable continents above this convergence depth shows very high radial correlation, indicating that Zc marks the base of the kinematically coherent tectosphere beneath stable continents. These results call into question the standard interpretation of the lithosphere-asthenosphere boundary as the base of the tectonic plates.