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Towards absolute plate motions constrained by lower-mantle slab remnants

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Since the first reconstruction of the supercontinent Pangaea, key advances in plate tectonic reconstructions have been made. Although the movement of tectonic plates since the start of the mid-Cretaceous period (100 (Myr) ago) is relatively well understood, the longitudinal position of plates before this period is not constrained at all. Here, we use a global mantle tomography model to estimate the longitude of past oceanic subduction zones. We identify 28 remnants of oceanic plates that were subducted into the lower mantle and link these to the mountain building zones from which they are likely to have originated. Assuming that these remnants sank vertically through the mantle, we reconstruct the longitude at which they were subducted. Our estimates for the location of the subduction zones are offset by up to 18 degrees compared with plate tectonic reconstructions for the corresponding period. We derive a lower-mantle slab sinking velocity of 12 +/- 3 mm/year. We did not detect oceanic plate remnants from the Carboniferous period (300–360 Myr ago), or before, suggesting that the tomographic visibility of subduction is limited to the past 300 Myr. Possibly these old slabs have been recycled in the deepest mantle and have initiated and sourced nearby mantle plumes.