Atlas of the Underworld: frontier exploration of the mantle to constrain palaeogeography & biogeography

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Abstract

Across the entire mantle we interpret 94 positive seismic wave-speed anomalies as subducted lithosphere and associate these slabs with their geological record. We document this as the *Atlas of the Underworld*, also accessible online at www.atlas-of-the-underworld.org, a compilation comprising subduction systems active in the past ~300 Myr. Deeper slabs are correlated to older geological records, assuming no relative horizontal motions between adjacent slabs following break-off, using knowledge of global plate circuits, but without assuming a mantle reference frame. The longest actively subducting slabs identified reach the depth of ~2500 km and some slabs have impinged on Large Low Shear Velocity Provinces in the deepest mantle. Anomalously fast sinking of some slabs occurs in regions affected by long-term plume rising. We conclude that slab remnants eventually sink from the upper mantle to the core-mantle boundary. The range in subduction-age versus –depth in the lower mantle is largely inherited from the upper mantle history of subduction. We find a significant depth variation in average sinking speed of slabs. At the top of the lower mantle average slab sinking speeds are between 10-40 mm/yr, followed by a deceleration to 10-15 mm/yr down to depths around 1600-1700 km. In this interval, *in situ* time-stationary sinking rates suggest deceleration from 20-30 mm/yr to 4-8 mm/yr, increasing to 12-15 mm/yr below 2000 km. This corroborates the existence of a slab deceleration zone but we do not observe long-term (>60 My) slab stagnation, excluding long-term stagnation due to compositional effects. Conversion of slab sinking profiles to viscosity profiles shows the general trend that mantle viscosity increases in the slab deceleration zone below which viscosity slowly decreases in the deep mantle. This is at variance with most published viscosity profiles that are derived from different observations, but agrees qualitatively with recent viscosity profiles suggested from material experiments. In this talk I will also discuss where interpretation of mantle

structure has aided reconstructions of paleogeography and biogeography, including sea level reconstruction and paleo-climate.