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TITLE: The Upper Mantle Shear Boundary Layer Is The Source Of Midplate Volcanoes

SESSION TYPE: Oral

SESSION TITLE: T44D. The Origin of Intraplate Volcanism: Hotspots, Nonhotspots, and Large Igneous Provinces II

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ABSTRACT BODY: The lithosphere, lid, low-velocity layer (LVL) and the shallow part of the asthenosphere are all part of the upper boundary layer (BL) of the mantle, which generally overlies the canonical “convecting” upper mantle source (DMM) of ridge basalts. This global BL, Gutenberg’s Region B (=BL), extends to ~200-250 km depth under cratons, which is well known, and to comparable depths under oceans, which is not generally appreciated because lid, plate, lithosphere and BL are often (erroneously) equated. A new BL is superposed on top of the pre-existing older one in oceans. The region above 220±20 km depth supports a high thermal gradient and is the most anisotropic and heterogeneous part of the mantle, indicators of thermal and shear BLs. The magnitude of the anisotropy and the velocity drop into the LVL, plus internal reflections, imply a laminated structure probably with refractory harzburgite lamellae coexisting with melt-rich sills, both normally less dense than DMM. This structure is sheared by plate motions causing shear-driven melt segregation into parallel fine-grained shear-bands, shear-driven upwellings, and decoupling and long-term isolation from DMM. The BL is twice as thick and is hotter at the base than canonical petrological and geochemical models based on McKenzie-Bickle-Steins thin-plate assumptions. The lower part of the shear layer (>150 km depth) is almost stationary with respect to plate motions and is ~200 K hotter than plate boundary magmas, features that are often attributed to mantle plumes. The refractory lamellae preserve ancient isotope signatures such as high 3He/4He ala Albarede; the melt-rich lamellae explain the volumes, compositions and locations of midplate volcanoes. BL is the largest (4x larger than D”) and most accessible of all proposed geochemical reservoirs and has the required chemical, spatial, scale and thermal attributes. It resolves the Hart-Hanan conundrum concerning the Common Component FOZO; this resides in the shallowest mantle but is overwhelmed at ridges. Perhaps the most dramatic effect of a heterogeneous anisotropic BL is its polarizing lens effect on seismic waves travelling to Hawaii, which is as important as crustal effects. With the usual assumption in teleseismic travel-time tomography (TTTT) ala Wolfe-Montelli, the data will appear to image a nearly vertical low-velocity plume-like structure, a well-known streaking artefact of this kind of analysis. The scale, fabric and melt content of the subplate BL not only explain midplate volcanoes but explain why TTTT apparently images a vertical low sound speed cylinder under Hawaii and why more complete datasets and more accurate analyses do not. The unfortunately named “lithosphere-asthenosphere boundary, LAB” is actually a >200 km thick shear BL, while the lid-LVL boundary and internal shear bands are sharp discontinuities.

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