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300 Million Years of Intraplate Igneous Activity in the Americas: Evidence for Hotspots Sourced by Plumes from the Core-Mantle Boundary

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Torsvik et al. [1] showed that the locations of 15 active hotspot volcanoes, 25 Large Igneous Provinces (LIPs) with ages as old as ∼505 Myr and ∼80% of all dated kimberlites erupted within the past ∼0.55 Gyr (n>1000), when they are reconstructed in an absolute (mantle) reference frame to the times of their eruption, closely correlate with narrow (∼20 wide) plume generation zones (PGZs) at the edges on the core-mantle boundary (CMB) of Low Shear-wave Velocity Provinces (LSVPs). The majority of the reconstructed locations (>90%) lay vertically above the edges of the two equatorial and antipodal Large LSVPs, that we term "Tuzo" (**T**he **U**nmoved **Z**one **O**f the Earth's deep mantle, under Africa), and "Jason" (**J**ust **A**s **S**table **ON** the opposite meridian, under the Pacific Ocean). These findings show that the Tuzo and Jason PGZs on the CMB, and therefore the two LLSVPs themselves, have been stable in their present, close to equatorial and antipodal, positions for 0.55 Gyr. We used this stability of the PGZs and the concentration of plume sources on them to test whether individual igneous rocks in a population of 62 igneous provinces that were erupted between ∼300 Ma and 50 Ma into the stable interiors of the North and South American plates overlay plumes derived from a PGZ on the CMB. Radiometric ages were compiled from the literature and used to assign emplacement ages for these localities using the highest-quality isotopic dates and available geologic evidence. We then reconstructed the igneous provinces to positions that they had occupied at their eruption times by rotating the North and South American plates in the global hybrid absolute reference frame of Torsvik et al. [2], and produced a series of maps showing the reconstructed positions with respect to the location of the Tuzo PGZ in 10 Myr time steps. From the analysis of these maps (Fig. 1), we show that igneous rocks in ∼80% of 62 provinces met Morgan's [3] definition of hotspots as: "Igneous rocks erupted above plumes that rose from the CMB," because their reconstructed locations, when projected vertically onto the CMB, lay at or close to the PGZ at the western edge of the Tuzo LLSVP. The origin of the remaining igneous provinces shown on Fig. 1 and not associated with a PGZ, will be addressed.

References

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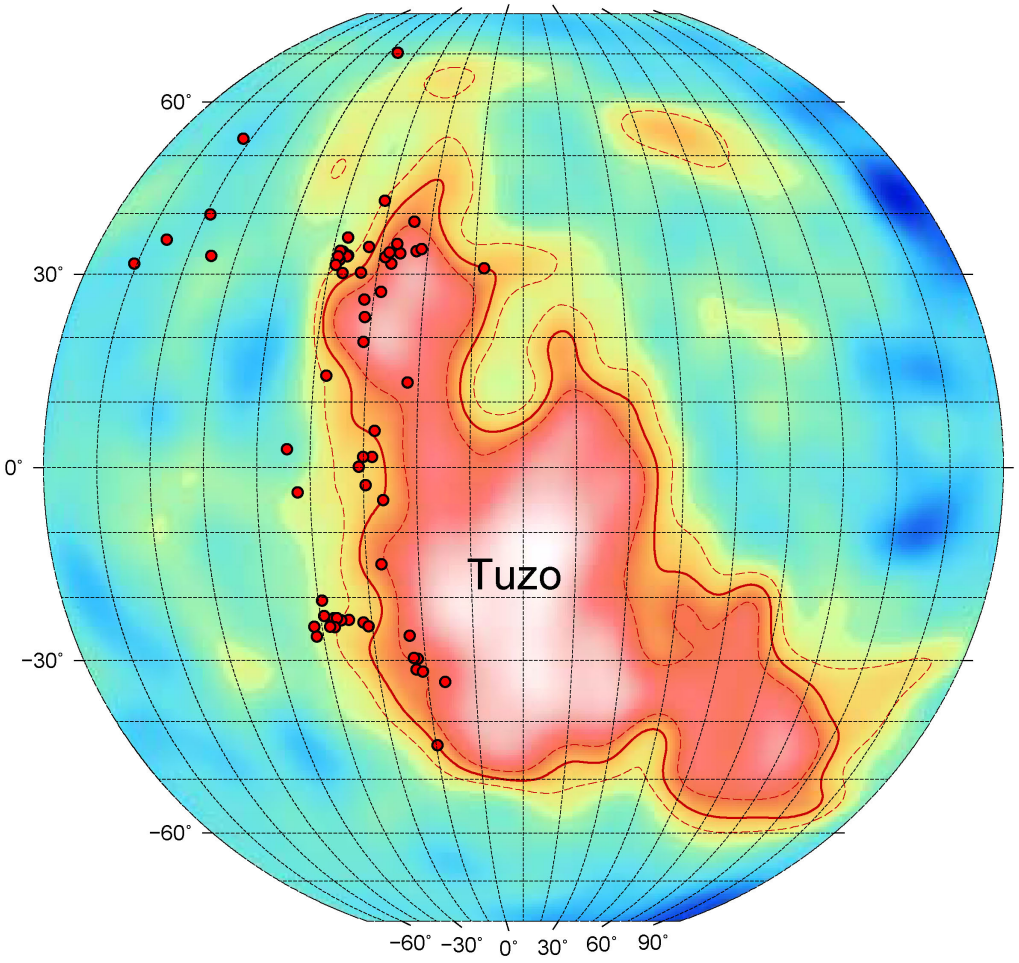

Figure 1: Locations of 62 igneous provinces of the interiors of N. and S. American plates (red dots) reconstructed to the times of their eruption in the hybrid absolute reference frame of Torsvik et al. [2] and projected vertically onto the CMB. Continuous red line shows the Tuzo PGZ and corresponds to the 1% slow shear wave velocity contour from the tomographic model of Becker and Boschi [4]. Dashed red lines show the 0.5% and 1.5% slow shear wave velocity contours.