ABSTRACT FINAL ID: T43K-03;

TITLE: Seismic evidence for intermittent upwelling of hot lower mantle beneath Yellowstone

SESSION TYPE: Oral

SESSION TITLE: T43K. The Origin of Intraplate Volcanism: Hotspots, Nonhotspots, and Large Igneous Provinces I

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Title of Team:

ABSTRACT BODY: There is long-standing debate as to whether hotspot volcanism is stimulated by plumes of hot lower mantle buoyantly rising to the base of Earth's tectonic plates. A stringent test of the lower mantle plume hypothesis is identification of a narrow region beneath a hotspot where upward deflection of the 660 km discontinuity (660) and tomographically imaged low velocities both indicate consistently high mantle temperatures. Prior attempts to achieve this result revealed ambiguous or inconsistent seismic structure. New seismic images of transition zone discontinuity topography reveal a narrow ~15 km upward deflection of the 660 beneath the Yellowstone hotspot. This feature is interpreted as a manifestation of a thermal plume with a maximum excess temperature of ~240 K that is rising from the lower mantle and decreasing the depth of the post-spinel phase transition. Tomographically imaged low P- and S-velocity anomalies near 660 km depth are consistent with the location of the upward deflection of the 660, and predict similarly high mantle temperatures (~170-250 K). Absence of depression of the 410 km discontinuity indicates vertical segmentation of the high-temperature upwelling, which is consistent with variations in the magnitude of the low-velocity anomaly in mantle tomography. Together these results imply that intermittent upward flux of hot lower mantle stimulates Yellowstone hotspot volcanism. Abrupt upward narrowing of the low-velocity anomaly near 660 km depth suggests that plume segmentation arises from interactions with compositional and rheological transitions near the lower-to-upper mantle boundary. Pulsating plume flux into the upper mantle beneath Yellowstone and other hotspots is a potential driver for observed temporal variations in hotspot magmatic productivity.

KEYWORDS: [8137] TECTONOPHYSICS / Hotspots, large igneous provinces, and flood basalt volcanism, [8121] TECTONOPHYSICS / Dynamics: convection currents, and mantle plumes, [7203] SEISMOLOGY / Body waves.

(No Image Selected)

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SPONSOR NAME: Brandon Schmandt

Additional Details

Previously Presented Material: ~35%

transition zone topography results have not been published or presented previously.

tomography models have been published, but are now updated with additional data:
B. Schmandt, E. Humphreys, Complex subduction and small-scale convection revealed by body-wave tomography of the western United States upper mantle. Earth planet. Sci. Lett., 297, 435–445 (2010).

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