Tracing plume morphology through the mantle using seismic tomography

*Keely Anne O'Farrell[1], Caroline Eakin[2], Carolina Lithgow-Bertelloni[3]

1. University of Kentucky, 2. Australia National University, 3. University College London

The behaviour of plumes in the mantle has the ability to tell us about the vigour of mantle convection, net rotation of the mantle, the roll of thermal versus chemical anomalies and the important bulk physical properties of the mantle such as viscosity structure. Understanding the journey of plumes through the mantle will help us understand the structure of the mantle and the links between the deep mantle and surface. We have developed an algorithm to trace plume-like features in shear-wave (Vs) seismic tomography models based on picking local minima in the velocity and searching for continuous features with depth. We apply this method to recent tomographic models and recover 60 or more continuous plume conduits that are >750 km long. Around a third of these can be associated with a known hotspot at the surface.

We study the morphology of these plume chains and find that the largest lateral deflections occur near the base of the lower mantle and in the upper mantle. We analyze the preferred orientation of the plume deflections and their gradient to infer large scale mantle flow patterns and the depth of viscosity contrasts in the mantle respectively. We find no preferred azimuthal direction to the plume conduits in the mantle. Increases in the plume gradients correspond to the lower transition zone and 1000 km depth (Bullen's layer C). We infer viscosity structure from these deflections and explore the dynamics of a plume travelling through these viscosity jumps. We also retrieve Vs profiles for our traced plumes and compare with velocity profiles predicted for different mantle adiabat temperatures. We use this to constrain the thermal anomaly associated with these plumes. We use these thermal anomalies in conjunction with our measured plume tilts/deflections to further explore the dynamics of plume conduits in the lower mantle and transition zone.

Keywords: plume, seismic tomography, viscosity

