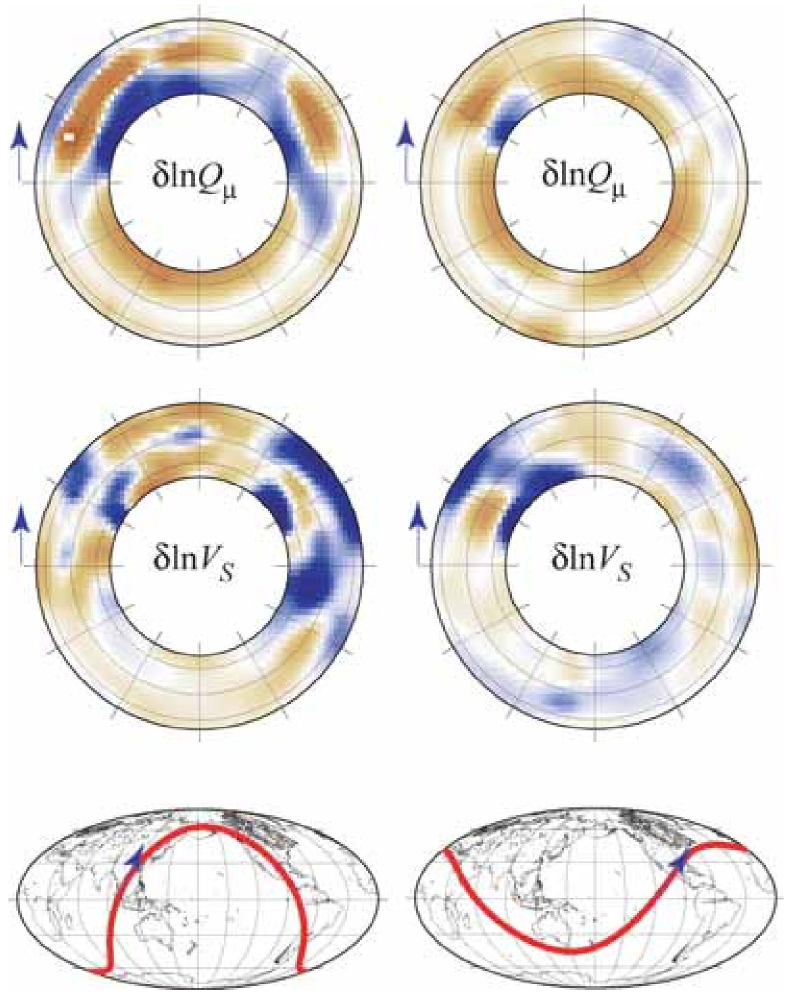
Whole-Mantle 3D Seismic Attenuation: Evidence for Global Mass Flux

Jesse Fisher Lawrence • *Washington University, now at University of California, San Diego*

Michael Wysession • *Washington University*

By combing through available broadband digital data from the IRIS DMC, we constructed a three-dimensional tomographic model of the seismic shear wave attenuation in the mantle. The model was obtained from all available digital broadband records during 1990-2001. The data consist of over 70,000 high-quality differential attenuation measurements of ScS-S, SS-S, ScS-SS, S-S, sScS-sS, sSS-sS phase pairs. The use of differential measurements removes contaminating source effects, which is the same in both phases, as well as near-source and near-receiver structural anomalies. The result is that our data have the best resolution in the lower mantle, which has previously been largely unexamined with 3D modeling. The differential attenuation measurements (taken as t* values) are inverted using the LSQR routine over a long-wavelength 5 x 5 degree grid for a 3D model of shear wave quality factor (Q). These t* star measurements are also used to generate a whole-mantle 3D shear wave velocity model. While the velocity model does not have resolution equal to other models that incorporate surface wave and normal mode data, because it uses the same paths as went into the Q model, it is of interest in interpreting the attenuation anomalies. There is a very strong suggestion of whole-mantle flow in the attenuation tomography. High-Q sheet-like anomalies extend from the surface to the core-mantle boundary region (CMBR) at subduction zones, dominating the model. The African and Pacific superplumes involve low-Q anomalies that extend from the CMBR to the surface. For the Pacific superplume, the low-Q anomalies extend vertically from core to crust, but with the African superplume, the low-Q anomalies do not extend directly up into the sub-African upper mantle, but rather branch east and west up towards the Atlantic and Indian Ocean spreading centers. While the interpretation of seismic Q in terms of anelasticity is challenging (as there are other factors such as seismic scattering, water content, grain size, and deviatoric strain that can influence it), if we assume that the Q anomalies are influenced to the first order by temperature variations, then this model strongly supports whole-mantle mass flux between the surface and the base of the mantle.



Two global slices through the shear velocity and attenuation models of Lawrence and Wysession (2004), obtained from differential shear wave phases.

Lawrence, J. F., and M. E. Wysession, QLM9: A new radial quality factor (Q) model for the mantle, *Earth Planet. Sci. Lett.*, 2005 (in press).

Lawrence, J. F., and M. E. Wysession, 3D Whole-Mantle Velocity and Quality Factor, Eos Trans. AGU, 85(17), Jt. Assem. Suppl., Abstract S43A-05, 2004.

NSF Grant #: NSF-EAR-0207751