Seismological constraints on Earth's structure

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Seismic tomography is one of few techniques to illuminate the structure of the deep mantle. Yet, the limited sampling of the mantle by seismic waves renders tomographic images with heterogeneous resolution that are difficult to interpret (Figure 1 and 2). The resolution of seismic structure is especially variable in the transition zone (300–1000 km depth), where chemical and physical boundaries may stratify flow [*Ritsema et al.*, 2004].

I will discuss the pitfalls in the interpretation of tomographic images that largely stem from heterogeneous data coverage and the simplification made in tomographic modeling. I illustrate how Backus-Gilbert resolution analysis can be helpful in estimating the distortion of real earth structure in tomographic images. In particular, I discuss my take on recent suggestions that slabs penetrate to a variable depth in the lower mantle and that plumes can be traced from Earth's surface to the core-mantle boundary.

References:

Ritsema J., van Heijst H.-J., and J.H. Woodhouse. Global transition zone tomography, J. Geophys. Res., 109, doi:10.1029/2003JB002610, 2004.

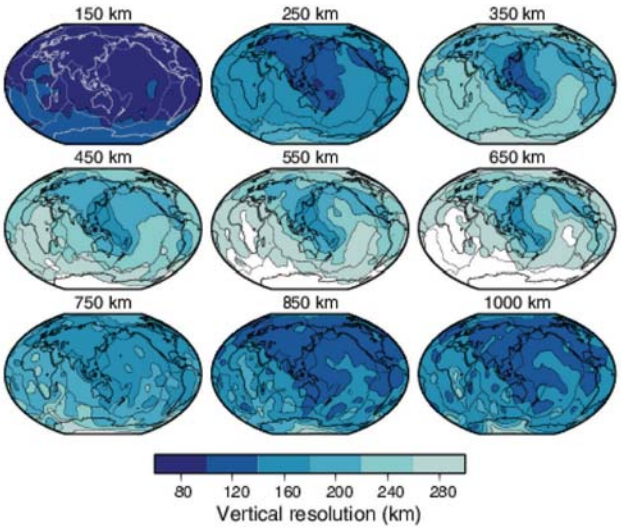

Figure 1. Maps illustrating the variable vertical resolution of shear velocity heterogeneity in tomographic model S20RTS. The vertical resolution is estimated

from the vertical extent of Backus-Gilbert resolution kernels. Vertical resolution is best (worst) in the regions shaded dark blue (light blue). Note the low vertical resolution in the transition zone, where data sampling by overtone Rayleigh waves is poorest.

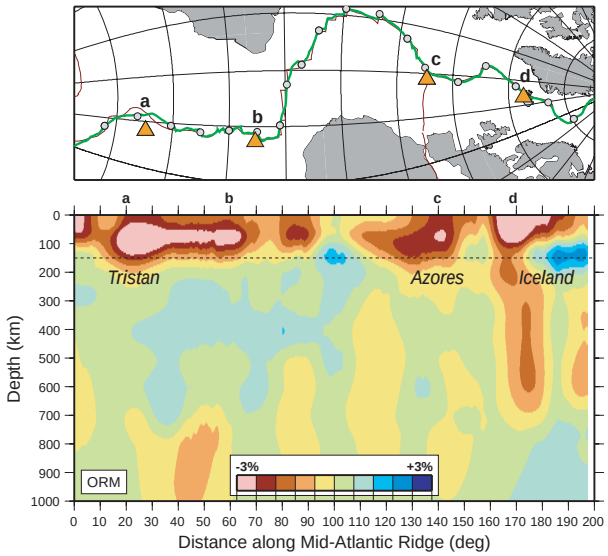

Figure 2. Cross-section through S20RTS illustrating shear velocity heterogeneity beneath the Mid-Atlantic Ridge (green line). The letters a, b, c, d indicate the location of ridge-centered hotspots. Note that reduced shear velocities (from PREM) beneath the Mid-Atlantic Ridge are confined to the upper 150 km of the mantle. Reduced shear velocities beneath Iceland extend deep into the transition zone. I will discuss the uncertain depth extent of the "Iceland Anomaly", due to the poor vertical model resolution in this region of the mantle (see Figure 1).