Examining the Base of the Mantle Using IRIS FLED PASSCAL Data

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The Florida-to-Edmonton (FLED) PASSCAL array provided a unique opportunity to examine the velocity structure at the base of the mantle. This array (for details, see the previous one-pager "Investigating Crust and Mantle Structure with the Florida-to-Edmonton Broadband Array") followed upon the success of the MOMA (Missouri-to-Massachusetts) array in being an excellent way to examine both crust/upper mantle structure as well as the structure of the core-mantle boundary region (CMBR). The FLED array data are being used in several different ways to look at CMBR structure because North America is well-situated with respect to the seismicity of the Pacific rim to record large numbers of high-quality core phases. One project underway involves using core-reflected ScS and SdS waves from primarily South American earthquakes to look at the velocity and discontinuity structure of the CMBR beneath Central America. Another project uses the phase SPdiffKS to examine the ultralow velocity layer at the base of the CMBR.

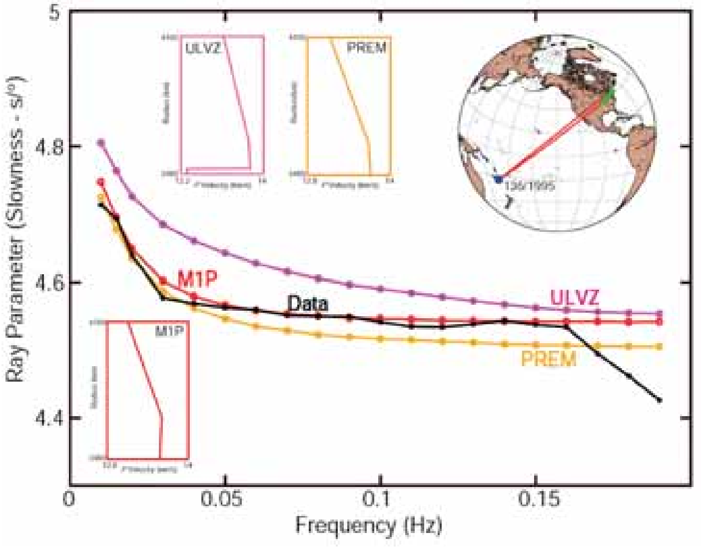

Figure1. An example of using a Pdiff-wave dispersion curve to constrain CMBR vertical velocity structure, shown for a western Pacific earthquake recorded at the MOMA array. The Pdiff dispersion suggests velocities at this region of the lowermost mantle beneath the eastern Pacific that are slower than PREM, fit by the M1P model shown. The dispersion curve cannot be fit by an ultralow velocity zone model, which would have the wrong shape.

In the example shown in the figures here, the dispersive nature of core-diffracted P waves is used to examine lateral variations in the vertical velocity structure of the lowermost mantle. The ray parameter of core-diffracted waves varies as a function of frequency due to the vertical change in velocity at the base of the mantle. Understanding the vertical velocity structure is important because it can provide constraints on the strength of the thermal boundary layer in the CMBR, and therefore of the amount of heat conducting from the core into the mantle. We generate synthetic dispersion curves for different models of the CMBR and then compare them to data. We find that many regions (most of our coverage is beneath the Pacific) are compatible with a PREM-type velocity model for D′′, while others require slower velocities. There are no regions of the CMBR beneath the Pacific we have found that display velocities faster than PREM. In certain areas of D′′, such as beneath the northern Pacific, the data suggest a structure with a discontinuity at the top of D′′, but most Pacific regions do not require this.

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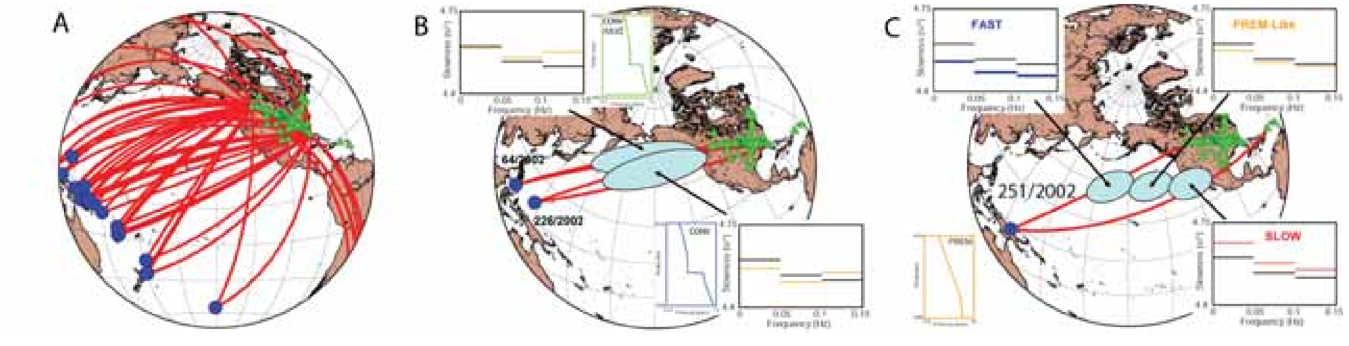

Figure 2. Using Pdiff waves recorded at FLED and nearby stations to examine lateral variations in the vertical structure above the CMB. A. Map showing earthquake locations (blue circles) and ray paths. B. Two earthquakes that sample a region of the lowermost mantle well-modeled by a velocity discontinuity at the top of D" in the manner of Solomatov and Moresi. C. Region of the lowermost mantle that shows no evidence of a D" discontinuity, but shows significant lateral variation in D" velocity structure beneath the northern Pacific.