IMAGING UPPER MANTLE STRUCTURE BENEATH THE ILLINOIS BASIN

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The Illinois Basin is an oval-shaped cratonic basin which covers parts of southern Illinois and Indiana, western Kentucky, Tennessee, and Missouri. The shallow structure of the Illinois Basin is well-defined and provides constraints which may allow the effects of crustal structure to be removed from seismic waveforms during tomographic inversions. We used IRIS data to test if better constraints of crustal heterogeneities will allow better resolution of the upper mantle S-velocity structure beneath the Illinois Basin. This improved imaging of the crust and the upper mantle S-velocities provides insights into the development of the basin, and addresses the issue of whether it is possible to improve seismic waveform tomography on a regional scale by incorporating crustal constraints.

Fundamental and higher mode waveforms from regional events were obtained from the IRIS DMC and were then inverted to image the three-dimensional upper mantle S-velocity structure under the Illinois basin. The method of partitioned waveform inversion, PWI, (Nolet 1990; van der Lee and Nolet, 1997) was applied to the waveforms. Utilizing six mid-continent events, a total of 60 seismograms from the IRIS/IDA Network, the IRIS/USGS Network, the Cooperative New Madrid Seismic Network, the PEPP-Indiana network and PASSCAL experiments were fitted in this study (Figure 1a), incorporating external crustal constraints. These constraints were then inverted along with the constraints from S-velocity model NA00 (van der Lee, 2002).

The linear inversions resulted in S-velocity model IL05. Figure 1b represents the deviation of calculated S-velocities for IL05 from the standard one-dimensional Earth model, MC35, for a profile across the Illinois Basin.

Both NA00 and IL05 image a slightly thinner seismic lithosphere beneath the Illinois Basin. A thinner seismic lithosphere is also observed in both models south of the Illinois Basin, which may be related to the original upwelling of the mantle during the formation of the Reelfoot Rift.