Tectonic Implications of Lithospheric Discontinuities in the Ozark Plateau and Southern Illinois Basin, Midcontinent USA

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We analyzed 27501 receiver functions for 140 Flexible Array stations of the OIINK (Ozark, Illinois, INdiana and Kentucky) network, 65 USArray Transportable Array stations, 8 Cooperative New Madrid Seismic Network stations, and station CCM of the Global Seismographic Network. We used Common Conversion Point (CCP) stacking and 3-D plane wave migration to image lithospheric discontinuities along a swath from Missouri to central Kentucky. The IASP91 Earth model was used to convert the P-to-S lag time to depth, with corrections for station elevations.

The results (Figures 1 and 2 attached) show features in crustal and uppermost mantle structures beneath the study area that have not been described previously. Specifically, our results indicate the St. Genevieve Fault zone, which runs parallel to the Mississippi River, is the surface expression of a profound crustal boundary. Crustal thickness (depth to Moho) as well as the discontinuity structure of the crust and uppermost mantle change across this boundary. The Moho lies at a depth of about 50-55 km beneath the Illinois basin. Outside of the basin the Moho depth is about 45 km. Thus, the Moho depth changes significantly at the boundary between the Illinois Basin and Ozark Plateau. Beneath the Wabash Valley seismic zone and the Rough Creek graben, on the eastern and southeastern parts of the basin, respectively, the crust displays two layers with a bright conversion marking the boundary at about 17-22 km depth. According to previous studies, earthquakes in the Ozark Plateau and Illinois basin regions are constrained within the top 20-25 km within the crust. This is comparable with the inferred thickness of the upper crust beneath the Wabash Valley seismic zone, and the base of the middle crust in the Ste. Genevieve seismic zone

Change in crustal structure that correlate with the Ste. Genevieve and the Wabash Valley seismic zones provide a potential explanation for the contrasting seismogenic characteristics of the two regions. A distinct mid-crustal layer occurs beneath the Ozark Plateau. This layer pinches out to the east, beneath the Illinois basin. The presence of this layer may explain the contrasting subsidence histories between the plateau and the basin.

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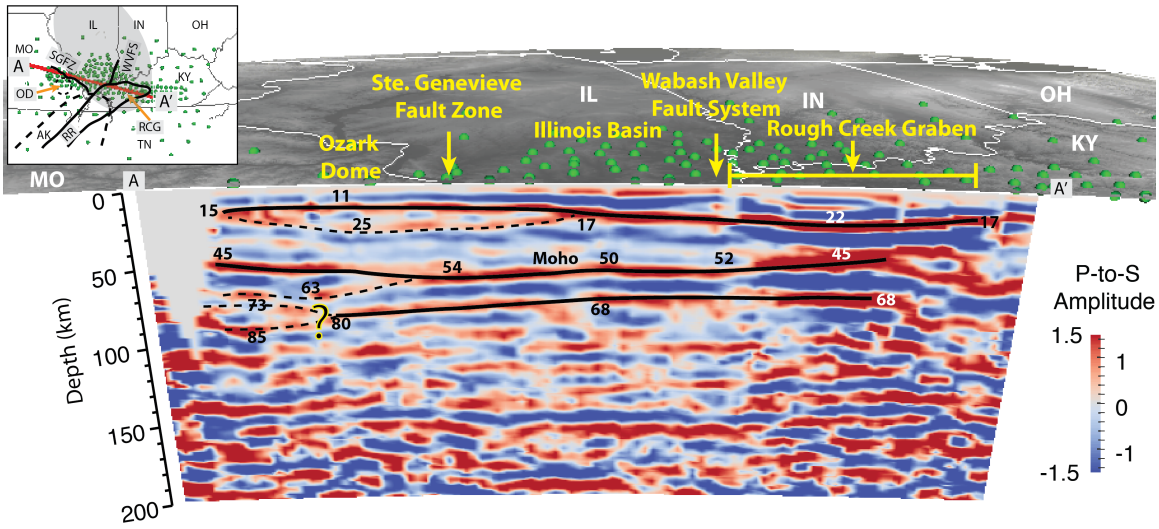

Figure 1. NW-SE cross-section (A-A') viewing downward to the northeast of CCP stack produced from receiver function data. P-to-S amplitudes are shown after applying $Z^{1.5}$ gain with depth. Green spheres are stations used in this study. Major structures surrounding the Illinois basin (shaded elliptical area) are shown in the inset figure including the Ste. Genevieve fault zone (SGFZ), the Ozark dome (OD), the Reelfoot rift (RR), the Rough Creak graben (RCG), and the Wabash Valley fault system (WVFS). The Mississippi embayment is outlined by the dashed curve around the Reelfoot rift. Locations of the major structures are projected and marked on the cross-section A-A'. Major discontinuities are highlighted using solid and dashed black lines and labeled with there depths in kilometers.

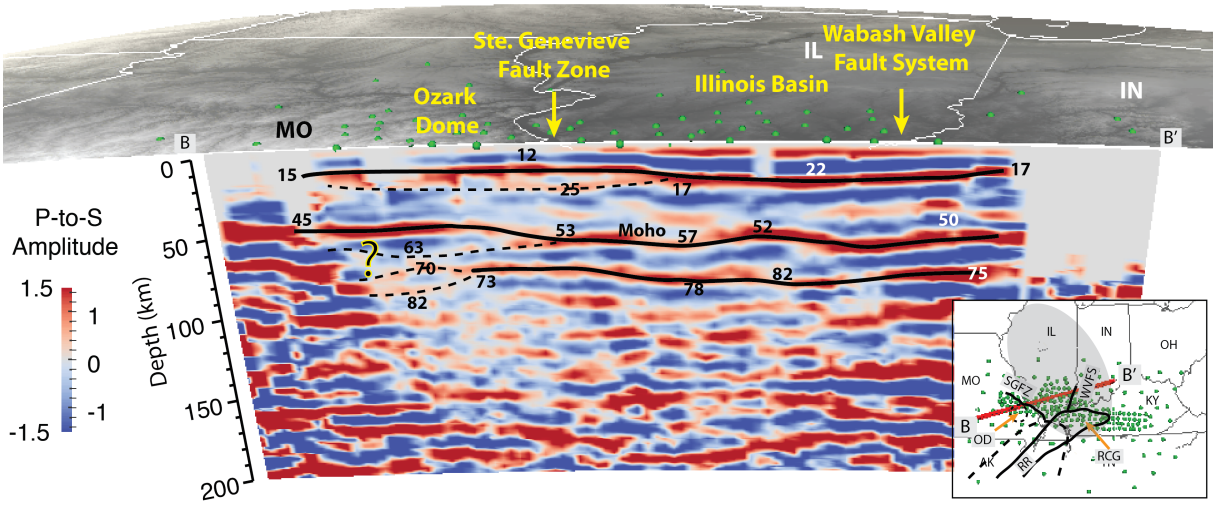

Figure 2. SW-NE cross-section (A-A') viewing downward to the northwest. Image volume is the same as in Figure 1, but sliced in a different direction. See Figure 1 for explanations of the symbols and the major structures.