Seismic Imaging of the Ups and Downs of the North American Midcontinent

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Cratons are the longest-lived tectonic features of the Earth. Although they are usually thought to be relatively stable, evidence of subsidence and uplift is widely recognized within cratonic interiors around the globe. Multiple hypotheses have been proposed for cratonic subsidence and uplift, including isostatic adjustments due to lithospheric buoyancy change, flexural deformation due to convergence at plate margins, and dynamic topography due to underlying mantle convection. Understanding the formation and evolution of these cratonic ups and downs and their relationships has significant implications for the evolution of the cratonic lithosphere in general. In the past decade, the North American midcontinent has been well-covered by seismic stations, particularly with the deployments of the EarthScope Transportable Array and several Flexible Array experiments. Here we present a 3-D shear-wave velocity model of the crust and upper mantle of the North American midcontinent, using the full-wave ambient noise tomography method. We compare the crustal and upper mantle velocity structures beneath major tectonic features in the study area, including cratonic basins, failed rifts, domes, and arches. We will discuss: 1) the scales of these features in-depth, 2) signatures of magmatic underplating beneath the basins and rifts, and 3) the structural relationship between the basins and domes/arches. The result of this study has broad implications for the mechanisms that drive the long-term evolution (subsidence and uplift) of the cratonic lithosphere.

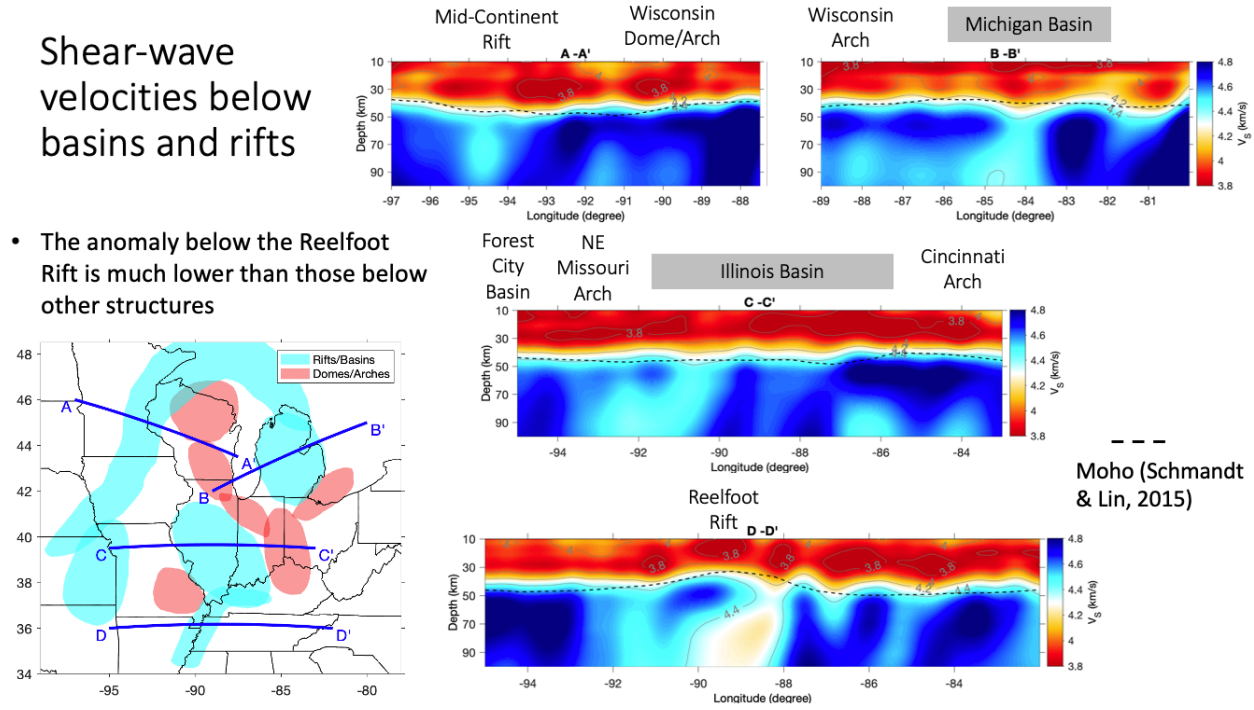

Figure 1. Vertical profiles of the 3-D shear-wave velocities from full-wave ambient noise tomography. The shaded areas in the lower-left panel shows major uplift (red) and subsidence (cyan) features.