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Stratification of seismic anisotropy beneath the East-central United States

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A key problem in seismology is to resolve the radial distribution of azimuthal anisotropy beneath continents. Seismic anisotropy can be related to rock deformation that occurs during various geodynamical events, and can thus be used to better understand the deformation history of continental lithosphere. Array studies of azimuthal variations in surface-wave phase velocity are well suited to recover the radial distribution of anisotropy, provided that dispersion curves can be measured in a broad enough period range. Using broadband inter-station dispersion curves of the Rayleigh-wave phase velocity (C), we built an anisotropic model of C that clearly resolves the radial distribution of azimuthal anisotropy beneath the East-central United States. We have then estimated the amplitude of Vs-anisotropy as a function of depth, from the lower crust to the upper asthenospheric mantle ($<$400 km). Beneath the orogenic provinces, we identify three distinct anisotropic layers, with different origins. Around the Moho (period range 20-35s), anisotropy is likely related to frozen deformation recorded at the end of the Appalachian orogeny. Around 100 km (period of 60s) anisotropy might be related to frozen deformation due to past (160-125 Ma) plate motion. Around 150 km and deeper (periods of 140s and higher), anisotropy is very likely due to deformation related the current motion of the North-American plate. Beneath the cratonic plains, there is no evidence for strong anisotropy down to 250 km. The dichotomy between these radial distributions of anisotropy reflects major differences in the deformation history of the lithosphere beneath these two provinces. The sub-orogenic lithosphere might have thinned by delamination at the end of Appalachian orogeny, and then started to cool down and grow again up to its current thickness, around 150 km. The sub-cratonic lithosphere, on the contrary, did not experience major deformation and remained stable and thick (at least 170 km) during the last 1.8 Ga.