A sharp gradient in seismic anisotropy across the Appalachian Mountains constrained by observations of Love-to-Rayleigh wave scattering

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Abstract
The Appalachian Mountains of eastern North America are the product of a succession of Paleozoic orogenies. While a record of these events is preserved in the surface geology and present-day topography, it is not well known how deformation associated with orogenesis was accommodated in the lithospheric mantle. Sharp lateral gradients in seismic anisotropy in the upper mantle can manifest as Love-to-Rayleigh surface wave scattering, also known as quasi-Love waves. Here we present observations of quasi-Love wave arrivals at seismic stations of the MAGIC array, deployed across the Appalachian Mountains, from the magnitude 8.3 Illapel, Chile earthquake in September 2015. Quasi-Love arrivals on vertical component seismograms are nearly coincident with the main Love wave arrival and provide evidence for a pronounced change in upper mantle anisotropy near the stations; however, stations located to the east of the Appalachians do not exhibit significant Love-to-Rayleigh scattering. In combination with SKS splitting measurements at Transportable Array stations in eastern North America, this observation implies a sharp lateral gradient in upper mantle anisotropy at the edge of the Appalachians. Such a sharp gradient suggests in turn that the mantle lithosphere participated in deformation during orogenesis, with a distinctive, regional signature.

Map of stations, event, and raypaths used in this study. Stations of the MAGIC experiment are shown in red; stations of the US and N4 networks are shown in blue. Black lines indicate great circle paths for seismic waves arriving from the 2015 Illapel, Chile earthquake; thick lines indicate paths that exhibit Love-to-Rayleigh scattering, while dashed lines indicate paths with a weak or absent quasi-Love arrival. Inset shows the location and focal mechanism of the event.