New insights into crustal and mantle structures beneath the New England Appalachians from temporary broadband seismic deployments and integration with geological constraints.

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Abstract

The New England Appalachians provide a fascinating window into a host of fundamental geological problems. These include the modification of crustal and mantle lithospheric structure via orogenesis, terrane accretion, and continental rifting, the evolution of individual terranes through processes such as channel flow and ductile extrusion, and the causes and consequences of the Northern Appalachian Anomaly (NAA), a prominent geophysical anomaly in the upper mantle. Recent and ongoing deployments of dense seismic arrays in New England are providing images of the crust and upper mantle in unprecedented detail, allowing us to address both new and longstanding science questions. These deployments include the Seismic Experiment for Imaging Structure beneath Connecticut (SEISConn, 2015-2019), the New England Seismic Transects (NEST, 2018-present), and the GEology of New England via Seismic Imaging Studies (GENESIS, 2022-present) arrays. Here we present results from these experiments that are shedding new light on the tectonic evolution of New England and the ways in which structures and processes in the upper mantle can affect the structure of the overlying lithosphere. These include detailed new images of crustal architecture beneath central and southern New England, including a sharp transition from thick (~48 km) crust Laurentia terranes to thin (~32 km) crust beneath Appalachian terranes. The character of this offset beneath the SEISConn and NEST arrays suggests an overlap of two Moho boundaries, forming an overthrust-type structure that may have resulted from reactivation of faults during the compression and shortening associated with the formation of the hypothesized Acadian Altiplano. Beneath SEISConn, there is evidence for multiple relict structures preserved in the lithosphere from past episodes of terrane accretion and suturing, as well as anisotropic layering that constrains the kinematics of past lithospheric deformation events. Beneath the NEST line in central New England, we infer a relatively shallow (~80 km) lithosphere-asthenosphere boundary above the NAA upper mantle geophysical anomaly, providing evidence for lithospheric thinning above a presumed asthenospheric upwelling. Finally, preliminary results suggest layered crustal anisotropy beneath the GENESIS array, perhaps corresponding to a past episode of channel flow in the mid-crust.

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