Anisotropic Properties of the Upper Mantle Beneath New England

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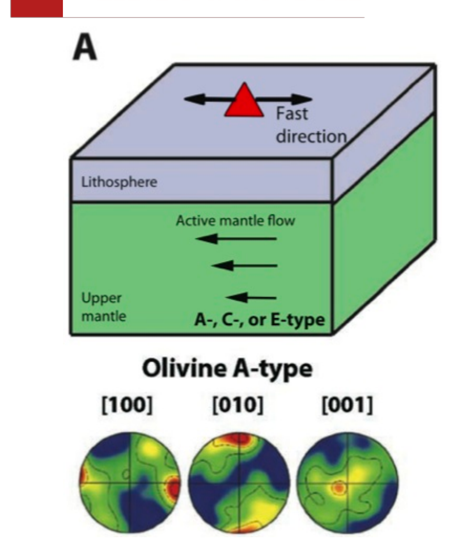
Abstract

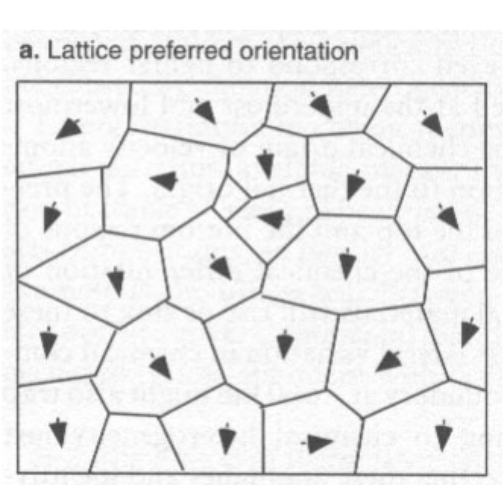
The geologic structure of the deep earth beneath the North East is a complex one, and the product of tectonic processes. An array of fifteen permanent seismograph stations, deployed throughout New York, Connecticut, and Massachusetts, allows us to continuously measure seismic activity in the North East. Seismic anisotropy is the result of millions of years of deformation, which causes there to be variability in the directional composition of the deep earth. Shear wave splitting, a sure indicator of anisotropy, is the main focus of this seismic research. Critical to the measurement of shear wave splitting, is the interpretation of the data which it yields. The splitting of seismic waves will allow us to make inferences regarding the anisotropic structure of the deep earth beneath the North East. By building an image of the deep earth we will be able to understand the flow of the mantle and how these processes have shaped the region over time, as anisotropy is a direct result of deformational processes.

Introduction



Long and Becker, 2010

Anisotropy is the directional dependence of seismic waves. This is important to us as it helps to paint a picture of past and present mantle flow



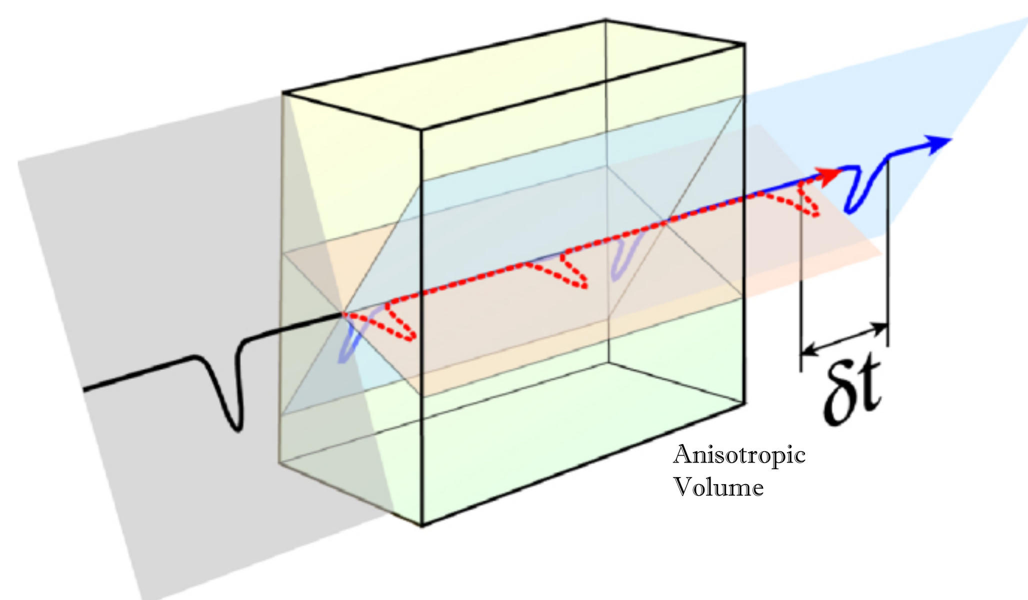
What causes Anisotropy in the Mantle?

The deformation of mineral crystals over long periods of time, typically causes the crystals to align in certain directions. The resulting patterns are known as **crystallographic preferred orientation (CPO), or Lattice (LPO)**

Methodology

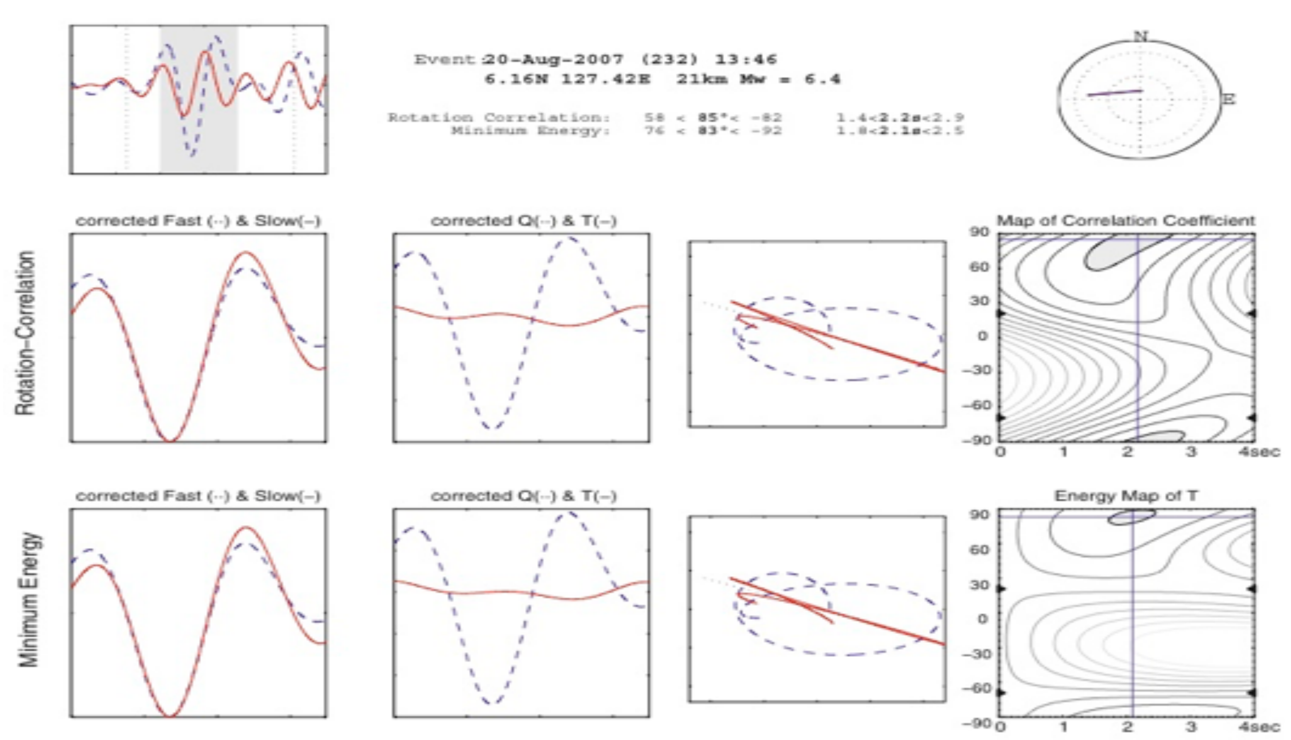
Shear Wave Splitting

A shear wave is split into two orthogonal components that travel with different wavespeeds. The fast polarization orientation (ϕ) and time separation(δt) depend on the characteristics of the anisotropic medium.

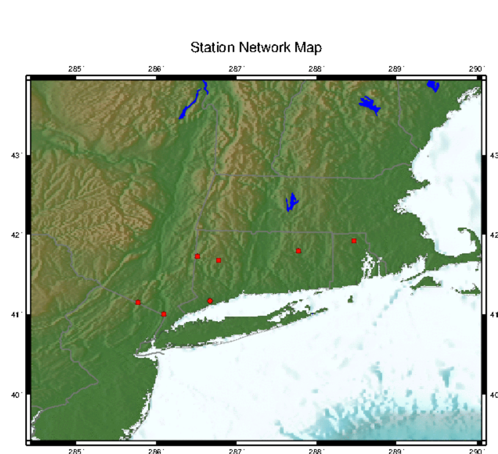


Transverse Component Minimization Method

First introduced by Silver and Chan (1991), this method identifies the splitting parameters (ϕ, δt) by utilizing a grid search. When the effect of splitting is accounted for, these parameters best minimize the amount of energy on the transverse component.

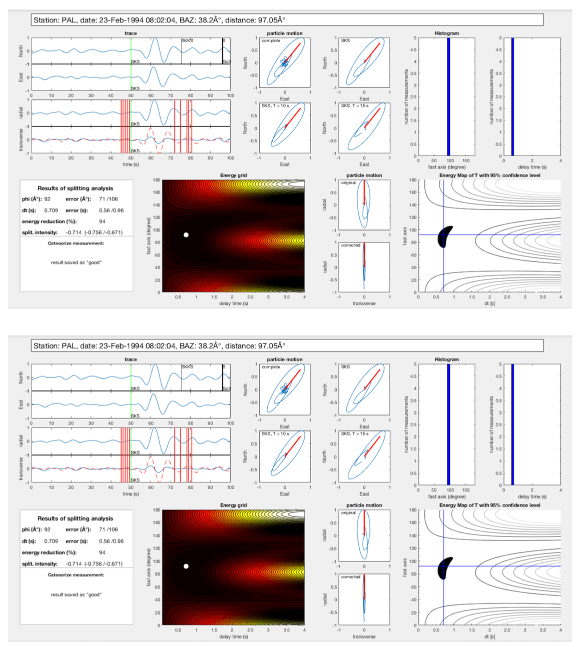


Data

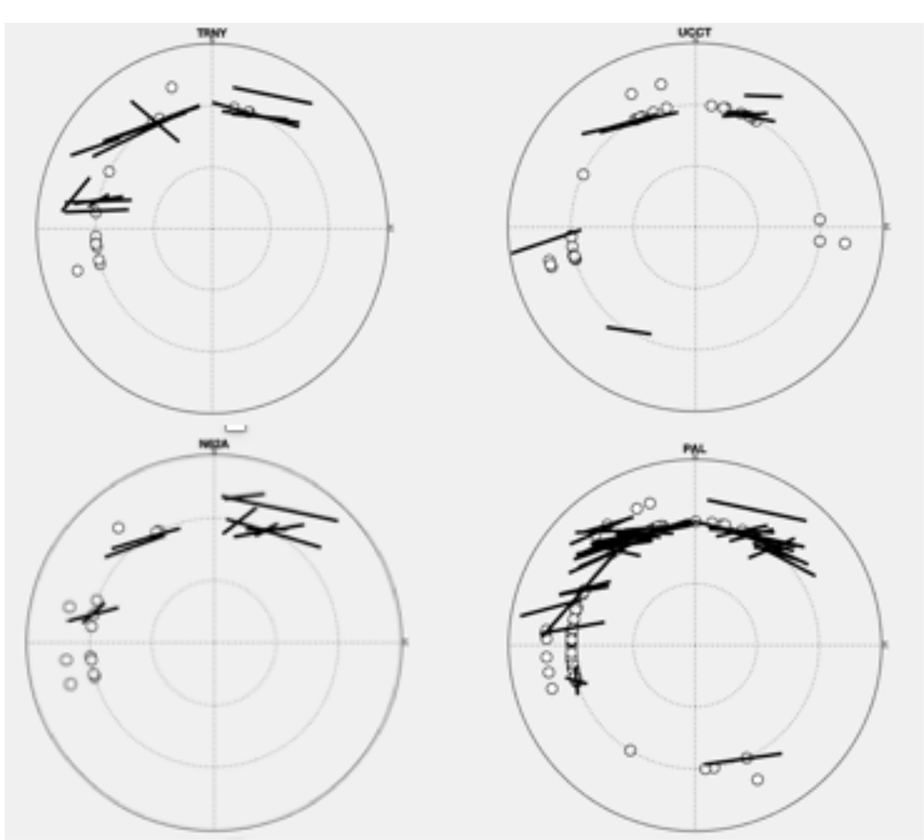


Data collection begins with the assembly of a seismic station. Stations are strategically placed to help answer specific questions.

Results



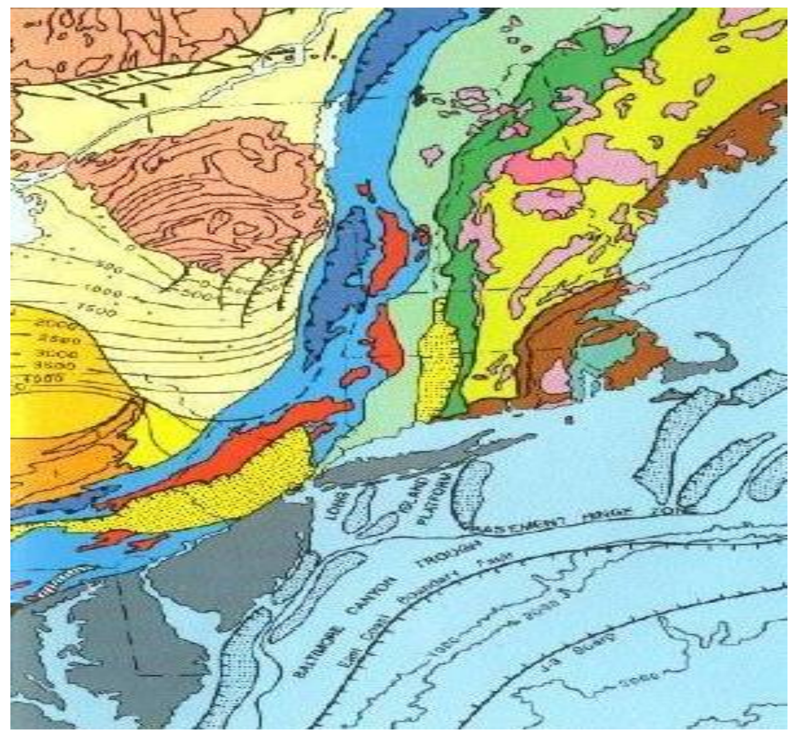
After each event is examined for its quality, a splitting analysis is performed. Split measurements are then rated "Null", "Poor", Average, "Good"



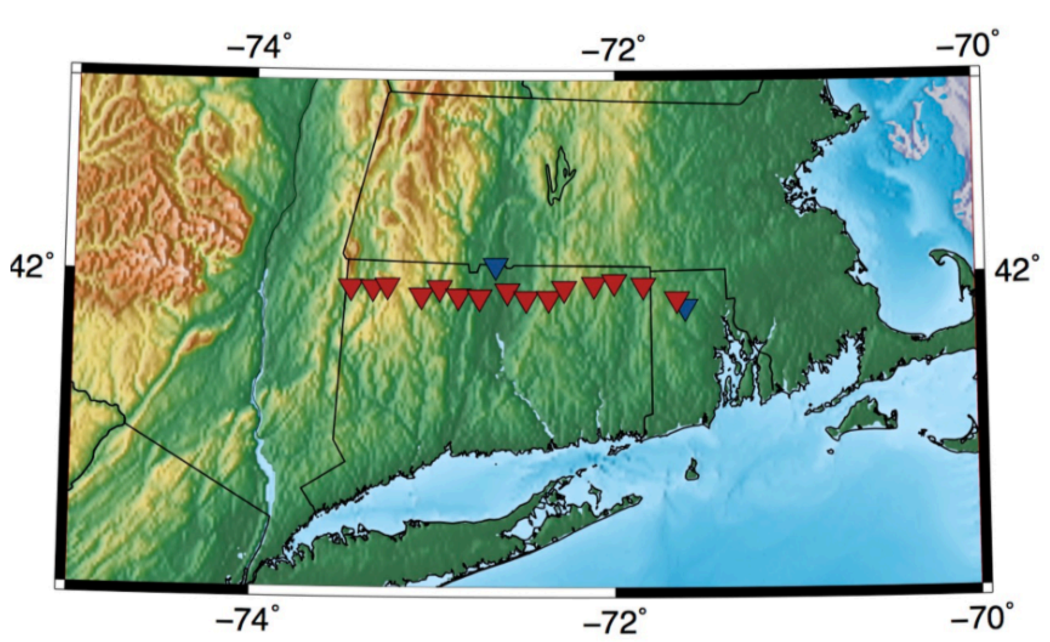
The above data depicts individual splitting measurements with regards to back azimuth and the incidence angle.

Discussion

The splitting measurements made during our research appear to show a trend throughout the NE. We see splitting, along a fairly consistent range of backazimuths, along what is known as the Connecticut Rift. This shows that there is complex anisotropy beneath Southern New England. An anisotropic layer in the lithosphere can help to tell us about past deformational processes, where a layer in the asthenosphere can tell us about the processes that are currently underway.



Future Work and Acknowledgements



SEISCONN Array

Future research will include the mobilization of stations stretching from Maine to New York. Theses new stations, along with current data which includes the SEISCONN array, will help us to better understand how the Northeast was formed through movement in the upper mantle.

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