Results from Prior NSF Support

Title: Collaborative Research: Complex Upper Mantle Structure Beneath Northeastern US Investigated Through Shear Wave Tomography (collaborative project between LDEO and Yale University)

Period 08/15/97-07/31/99
William Menke(LDEO), **Award Number:** EAR-9706195, **Amount:** $63993.00
Jeffrey Park & Vadim Levin (Yale), **Award Number:** EAR-9707189, **Amount** $53193.00

The purpose of this research was to test the proposition that the mantle beneath northeastern North America is divided into several "anisotropic domains" that are the seismic expression of the plate tectonic process of "terrain accretion". Were such the case, we would expect different directions of the shear wave fast direction and different mean shear wave velocities in each of the several terrains (whose existence has been established geologically).
Thus we assembled shear wave traveltime and splitting databases for all the broadband seismic stations that were operated - even only temporarily - in northeastern North America for the past 5 years. We analyzed the splitting data by comparing it to synthetic measurements drawn from synthetic seismograms computed for anisotropic models. We tomographically inverted the traveltime data. Much of the data analysis and modeling code was custom-written (by us) for this project.

The results are quite suprising, and show:

- The pattern of shear wave fast directions across northeastern North America is very homogeneous. No anisotropic domains occur.
- At a given station, the pattern of shear wave fast directions varies rapidly with the backazimuthal angle to the earthquake epicenter. This pattern has a strong "four-theta" component that can be explained in a most excellent manner by postulating two layers of mantle anisotropy. .
- These layers are laterally homogeneous across northeastern North America.
- The top layer has a shear wave fast direction oriented toward/away from the center of the craton. We believe it to be unrelated to the dynamics of the Precambrian craton, and instead to be related to a period of intense strain experienced by all the terrains during a lithospheric delamination, likely to have occurred during the during the Appalachian orogeny.
- The bottom layer has a shear wave fast direction oriented parallel to the edge of the craton. We believe it to be related to asthenospheric flow.
- Shear wave velocities at 100 km depth are quite heterogeneous, with the western Adirondacks being particularly slow. We postulate that this is a chemical heterogeneity that is unrelated to the strain-induced anisotropy.

We have written these papers describing the results:
Levin, V., W. Menke and J. Park, 1999. Shear wave splitting in the Appalachians and the Urals: A case for multilayered anisotropy **J. Geophys. Res.** Vol. 104, No. B8, p. 17,975-17,987.
Levin, V., J. Park, M. Brandon and W. Menke, Thinning of the upper mantle during the late Paleozoic Appalachian orogenesis, **Geology** 28, 239-242, 2000.
Levin, V., W. Menke and J. Park, No Regional Anisotropic Domains in Northeastern US Appalachians, **J. Geophys. Res.**, Vol. 105 , No. B8 , p. 19,029, 2000.

Data and other products This project collected no new data. Some software that was written for the project is available at http://www.ldeo.columbia.edu/user/menke/software/