Summary

We request support for 2 years to develop the capability of investigating seismic anisotropy in the upper mantle under the north American continent, using a waveform tomographic approach, in anticipation of the unprecented dataset that will be collected under the USarray effort within Earthscope. This waveform approach will allow us to include information from surface waves, overtones and body waves, and to consider a realistic model of the continental upper mantle, which we plan to parametrize in terms of anisotropy with an axis of symmetry of arbitrary orientation. Such a model is physically plausible, under the assumption that seismic anisotropy is caused by the alignment of olivine (and pyroxene) crystals in the past and/or present deformation strain field and can account for the observation of both radial and azimuthal anisotropy in surface wave data, as well as shear wave splitting.

Our project is designed in preparation for the three component broadband data that will be collected at $\sim$ 100 stations of the USArray/NSN backbone network in north America (and ultimately the even denser sampling by the collection of BigFoot deployments). The modelling approach will use as starting point our past and current global waveform tomography work and will involve adapting our codes to the regional upper-mantle continental scale and the more complex anisotropic parametrization. In general, studies of upper mantle anisotropy consider only partial information: azimuthal anisotropy or radial anisotropy in surface wave data, or splitting of SKS waves. The denser regional sampling of the continent provides an unprecedented opportunity to address the issue of upper mantle anisotropy integrating information from various phases. Most of the elements of the theoretical framework appropriate for our purpose have been developed by several authors in the past, but this type of anisotropic parametrization has been applied only to fundamental mode surface wave dispersion data, and not to complete long period time domain seismograms, as we intend to do. While waiting for Earthscope data to be available, the inversion will be tested using available global and regional network data.

Intellectual Merit: The proposed program aims at addressing timely research questions such as the relation to geological age of the variations in thickness of continental lithosphere, the strength of coupling between the lithosphere and underlying asthenosphere and the nature of the lithosphere/asthenosphere boundary, the relation of upper-mantle anisotropy to present-day flow and/or past tectonic events. A better understanding of the depth distribution and orientation of anisotropy in the lithosphere/asthenosphere depth range under continents (i.e. down to at least 400 km) is important, to address such questions.

Broader Impact: This project will contribute to the training of 1 graduate student and 1 post-doc and result in at least 2 publications in refereed journals. It will benefit a broader community of non-seismologists: geodynamicists and mineral physicists by improving seismological constraints on geodynamical and mineral physics models of the continental upper mantle.