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Characterization of elastic anisotropy in rocks from Pelham gneiss dome, north-central Massachusetts, using electron backscatter diffraction

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Our current understanding of Earth's interior is derived almost entirely from seismology. However, observations of seismic velocity alone are insufficient to distinguish between various rock types and mineral assemblages that may exist in the lower continental crust. Seismic studies have served us well in understanding the mantle and the core, but our knowledge of the continental crust is far less comprehensive. Unlike the mantle, the crust is both compositionally and structurally complex, and conclusive seismic interpretation can be challenging. Seismic anisotropy is the directional dependence of seismic velocity and, if characterized accurately, provides the potential to interpret subsurface deformation conditions and to differentiate between rock types and mineral assemblages.

As rocks are deformed at lower crustal conditions, their constituent minerals respond by aligning in crystallographic preferred orientations (CPO). A rock's elastic properties can be derived from the combinations of the single-crystal elastic tensors for each mineral grain in their constituent orientations. Textures with a strong CPO result in seismic anisotropy. Formulating an accurate interpretation of seismic signals associated with anisotropy requires a simplified assumption of symmetry of the bulk elastic tensors; most commonly, transverse isotropy is assumed. However, the true elastic symmetry of most crustal rocks is far more complicated, and relatively few have been characterized. The effects of inaccurate assumptions of transverse isotropy on seismic inversions have not been evaluated thoroughly and, without a clear understanding of these effects, our use of seismic observations to interpret lower crustal composition and structure is limited.

The objective of this work is to further evaluate the factors influencing the magnitude and symmetry of seismic anisotropy in the lower crust, specifically rocks from the Pelham gneiss dome in north-central Massachusetts, so that we may more accurately model seismic signals with respect to specific rock compositions and structures. We have collected a suite of 77 oriented samples covering the five common rock types in Pelham dome: felsic gneiss, felsic schist, mafic gneiss, mafic schist, and quartzite. We use electron backscatter diffraction (EBSD) to measure mineral CPO, and then calculate the aggregate elastic tensors. We will use symmetry decomposition to evaluate the commonly made symmetry assumptions for Pelham dome rocks. EBSD data from approximately half of our total sample suite will be presented and discussed. Our goal is to improve the ability to use seismically determined elastic tensors to infer rock type, mineralogy, and deformation processes, while adding to the database of elastic tensors for lower crustal rocks.