Geophysical Research Abstracts
Vol. 18, EGU2016-14097, 2016
EGU General Assembly 2016

Partial melt and seismic properties: A case study from the Seiland Igneous Province

Amicia Lee, Andrew Walker, Geoff Lloyd, and Taija Torvela
University of Leeds, School of Earth and Environment, Leeds, United Kingdom (t.m.torvela@leeds.ac.uk)

The geological evolution of orogenies is partly controlled by partial melting in the middle and/or lower crust. However, seismic methods cannot reliably quantify the amount of melting at depth in tectonically active mountain belts. We have developed a numerical modelling method to assess the impact of melt on seismic properties and applied this to samples from a transect across a migmatitic shear zone in the Seiland Igneous Province, Northern Norway. These rocks represent an analogue to lower crustal shear zones undergoing orogenic collapse. Compressional and shear waves reduce when melt is introduced but the effect on seismic anisotropy is unclear and recent evidence suggests the melt-seismic property relationship is not simple.

We have measured crystallographic preferred orientations in sheared migmatites using EBSD and use this data as input for multiple numerical models designed to quantify the variation of seismic properties with melt volume. Three ‘end member’ models have been developed: a reference ‘isotropic model’ consisting of a rock matrix comprising randomly oriented grains with distributed spherical melt pockets, the ‘shape fabric model’ an isotropic matrix with ellipsoidal melt inclusions, and the ‘CPO model’ consisting of a textured mineralogical matrix with randomly distributed spherical melt pockets.

The isotropic and matrix dominated models give end member seismic properties for the isotropic and anisotropic dominated regimes. Importantly, these models do not consider the shape of the melt fractions, and instead the melt is averaged over the whole rock. The shape fabric model calculates the seismic properties of an isotropic inclusion within an isotropic matrix. The results of this modelling show that an oblate ellipsoid has the greatest effect on seismic properties. It is also the most likely shape for melt pockets as it is an analogue shape for extensional melting during orogenic collapse; a large oblate ellipsoid produces a high S-wave anisotropy.

Partial melt greatly affects the seismic response from the lower crust, but the relationship is not linear with melt volume. Mineral composition, melt shape, CPO of restite and wave propagation direction can result in large variations of the same seismic property. Thus, multiple seismic properties should be used to predict melt volume in the lower crust.