Project Summary

We propose to investigate lateral variations in temperature and chemical composition, in particular water content, in the earth's upper mantle, through a combined seismological and mineral physics study in which both elastic and anelastic properties are considered.

Global seismic tomography allows us to investigate lateral variations in temperature and composition of the mantle indirectly, through the dependence of phase and amplitudes on elastic velocities and Q. The most standard procedure involves the inversion of travel time or phase data for elastic velocities and of amplitudes for Q, and subsequently interpreting the results in the light of mineral physics knowledge on the dependence of velocity and Q on physical parameters relevant to mantle dynamics. To date, the resolution in Q is much poorer than that in velocities, because of strong competing effects affecting seismic wave amplitudes.

We here propose a collaborative study between seismologists at UC Berkeley and mineral physicists at Univ. of Minnesota, to explore the feasibility of inverting seismic long period waveform data directly for 3D variations in effective temperature and major element chemistry in the upper mantle. Effective temperature will include the effects of temperature and water content, which cannot be easily separated from seismic data we will consider (namely long period SH waveforms) alone. Water content is likely to have large effects on rheology and therefore has significant influence on the dynamics of the Earth's mantle. We use the mineral physics framework to delineate contributions from these various factors. Effects of major element chemistry can be distinguished from that of water, because water has a large influence on anelasticity whereas major element chemistry does not. On the other hand anelasticity is more strongly dependent on temperature than seismic velocity.

We will build upon the complementary expertise of the two groups in, on the one hand, global waveform tomography, and, on the other, relating seismic parameters to geodynamically relevant factors. The driving motivation behind this direct inversion approach is to exploit the stabilizing influence of the seismic phase (or travel time) information, while enhancing the latter with the greater temperature sensitivity of amplitudes (i.e. Q). The data used will be the collection of SH waveforms assembled at UC Berkeley in the course of the construction of global mantle models SAW12D (*Li and Romanowicz,* 1996) and SAW12B16 (*Mégnin and Romanowicz*, 1999).

With this entirely new approach, we hope to gain new insights on temperature and composition distributions, down to transition zone depths, and thereby obtain new constraints on global mantle dynamics and evolution.