Research Statement

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Previous and Ongoing Work

By training I am a solid Earth geophysicist with a strong foundation in geology, data analysis, and computer programming. My primary research interest is in understanding the thermal and chemical evolution of Earth. To do this, I use techniques that integrate numerical modeling of mantle flow, seismology, and mineral physics. When used together these tools provide powerful constraints on the Earth's internal structure and dynamics. Furthermore, they allow us to further understand the forces that drive tectonic plate motion, and create the stresses that cause destructive earthquakes.

Much of what we know about the interior structure of the Earth comes from seismic imaging. However, our current picture of the deep Earth is fundamentally incomplete, largely due to sparse data coverage. One area in particular where our knowledge is lacking is in understanding the role that thermal upwellings, known as mantle plumes, play in Earth's dynamics. Thus far, plumes have proven elusive to unambiguous seismic detection which has triggered intense debate on their importance to mantle convection. My dissertation research adds a piece to this puzzle by helping to better quantify how we expect plumes to be manifested in seismic data. Through this work, I was able to analyze the resolution of mantle plumes in past tomographic experiments, and determine the conditions under which plumes are likely to be seismically visible. These insights will help guide the design of future seismic experiments aimed at deep Earth imaging. Skills I have learned from this project include numerical modeling of mantle convection and seismic wave propagation on large high-performance computer clusters, advanced signal processing techniques, and tomographic inversion.

In addition to my basis in theoretical geophysics, I have experience in observational work. I am experienced with the receiver function technique, which is a classical tool commonly used in imaging the Moho and lithosphere-asthenosphere boundary. I applied this technique to study the lateral variations of the mantle transition zone beneath North America in order to gain insight into the subduction history of the Farallon plate. For this project, I developed software for downloading and processing large datasets of seismograms recorded by the USArray, as well as tools for calculation and 3D migration of receiver functions.

Future Research Goals

I am excited to apply the knowledge I have gained over the course of my dissertation research to new problems. Many of my strengths, including signal processing, finite-element modeling, and inverse theory, have a wide range of applications in Earth science. I have a strong history of collaboration, and have worked closely with scientists in the fields of computational seismology, geodynamics, and mineral physics. In the next stages of my career I will maintain and grow these connections. I have continued interest in mantle dynamics, and will keep exploring the problems in this field that excite me the most. These problems include the nature of the Large Low Shear Velocity Provinces (LLSVPs) beneath Africa and the south Pacific, the dynamic history of North America, and the global scale variability of the mantle transition zone. I am also interested in branching out into areas which have a more tangible human impact. In particular, I am interested in seismic hazard assessment through physics-based ground motion modeling, as well as induced seismicity research.
My research uses a mixture of seismic data analysis, computational modeling, and geophysical inverse theory, in order to...