Philip Skemer
Assistant Professor, Department of Earth and Planetary Sciences
Washington University in St. Louis

"Deformation of the Upper Mantle: Experimental and Geologic Perspectives"

Abstract: Earth's tectonic plates are characterized by interiors that may be stable over billions of years. However, the actively deforming boundaries between plates are subject to modification over much shorter time scales through the growth of mountains, the creation or recycling of lithosphere, and the transformation of landscapes by volcanic, seismogenic and hydrologic processes. Earth's particular style of plate tectonics appears to be unique in the solar system and undoubtedly contributes to some of the basic differences between the evolution of Earth and the other terrestrial planets. However, many fundamental questions about plate tectonics persist. What are the patterns of underlying mantle flow and what can we learn from these flow patterns about the convective forces that drive plate tectonics? What are the rheological properties of the rocks that make up the crust and mantle? How do plates form narrow, dynamic boundaries? In this talk I describe some new insights into evolving deformation microstructures and how these modify our understanding of mantle rheology and flow. I highlight two recent studies. First, I discuss new constraints on the microphysics of shear localization, an essential feature of plate boundary deformation. Plausible mechanisms for shear localization are assessed and experiments are described, which help to explain the enigmatic microstructures observed in highly deformed mantle shear zones. Second, I discuss the use of seismic anisotropy to infer patterns of flow in Earth's mantle. I will describe how geological and experimental data constrain the evolution of olivine crystallographic-preferred orientation (CPO), the source of most upper mantle seismic anisotropy. I will focus in particular on some complications introduced by complex deformation histories, and how this modifies typical interpretations of seismic anisotropy near plate boundaries.