Microstructural evolution during the deformation of polymineralic rocks

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

Mylonites are ubiquitous structural features of dynamic plate boundaries, and are widely assumed to represent the product of localized deformation at high pressure and temperature. There are two features of mylonites that distinguish them from typical host rocks: grain-sizes that may be reduced by orders of magnitude and mineral phases that generally well-mixed. Together, these microstructural characteristics are thought to promote rheological weakening over long geologic intervals, an essential feature of Earth-like plate tectonics.

This talk will review recent progress towards understanding the processes of grain-size reduction and phase mixing. New experimental data up to shear strains of $\gamma > 50$ will be presented to illustrate the highly strain-dependent nature of dynamic recrystallization and phase mixing. We show that with increasing strain the density of grain and phase boundaries increases. The thickness of monomineralic domains decreases as they are stretched and thinned. Grain-size is reduced, in some cases well below the grain-size predicted by single phase piezometers. Roughness along the phase boundary interface is observed, corresponding to the locations of newly formed triple grain junctions. Some mixing occurs by grain switching/migration across these interfaces, however most mixing appears to result from the geometric thinning and necking of monomineralic domains. Phase mixing is determined to be the product of several independent mechanisms, the relative importance of which depends on pressure, stress, strain, composition, and the ratio of the initial grain-size to the recrystallized grain size.