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Rheological Bridge Zone: Initialization of Localization

He Feng, Christopher Gerbi, and Scott Johnson
University of Maine, School of Earth and Climate Sciences, United States of America (he.feng@maine.edu)

Strain localization occurs throughout the crust, in both the brittle and viscous regimes. The causes of strain localization remain under discussion. However, realistic rock records indicate that variations of material properties (e.g. active deformation mechanisms, crystallographic orientation, phase distribution, grain shapes, etc.) are likely to be the dominant factor for weakening. Determining the cause(s) of localization requires investigation of the earliest stages of strain concentration in different P-T conditions. Our study focuses on two rocks that experienced low macroscale strain at amphibolite and/or granulite facies conditions yet exhibit localization on the millimeter and smaller scale. We combine optical and electron beam petrography with chemical mapping and electron backscatter diffraction to characterize these rheologically important domains. Morphologically, these localized zones appear to mechanically link rheologically weak phases or domains. These “bridge” zones typically comprise a band of relatively fine grains with weak crystallographic preferred orientation. The major element compositions of like phases inside and outside the bridge zone are similar, but the modal mineralogy and trace elements vary somewhat. Bridge zones result from not only in-situ grain size reduction (due to, for example, nucleation, recrystallization, or cataclasis), but also chemical processes resulting in phase mixing or element mobility on a short spatial scale. Their spatial distribution suggests that the small modal fraction of microstructural change represented by the bridge zones can lead to a high degree of bulk weakening.