Impact of phyllosilicate distribution, spatial arrangement and interconnectivity on quartz recrystallization, Raft River Mountains detachment shear zone, Utah

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The presence of secondary minerals strongly affects viscous deformation. For example, the presence of muscovite in a quartzite has been shown to alter the relative rates of quartz dislocation creep, recrystallization, and overall strength of the aggregate. Muscovite tends to form an interconnected network of grains during the development of S-C fabrics. This interconnection of muscovite marks a change in rheological properties, in which the weak phase, muscovite, accommodates stress and strain, resulting in a weaker aggregate. Muscovite also inhibits the process of dynamic recrystallization by grain boundary migration, preventing quartz grain growth, and encouraging other mechanisms such as dislocation glide in micas, and grain boundary sliding in quartz.

To understand how muscovite affects quartz deformation processes, we focus on the Miocene detachment shear zone associated with the Raft River metamorphic core complex (NW Utah). The Raft River detachment shear zone is localized within the Proterozoic Elba quartzite, which is composed of ~90% quartz and 5 to 10% muscovite. Imaging of muscovite distribution by X-Ray computed tomography shows different grain shapes and spatial distribution patterns: 1) short and thin, rhomb-shaped, isolated grains, 2) large oblate disc-shaped grains, and 3) long, rod-shaped interconnected grains. Preliminary petrographic and electron backscattered diffraction observations, show that the style of muscovite distribution (rod or disc, connected vs. isolated grains) correlates with a change in quartz grain microstructures, grain size, and grain shape. Quartz microstructures associated with isolated rhomb-shaped muscovite grains exhibit distribution of relict and recrystallized grains. The relict grains typically display a strong undulose extinction and often exhibit deformation lamellae. The small rhomb-shaped muscovite grains typically pin quartz grain boundaries. Quartz microstructures associated with the rod-shaped interconnected muscovite grains exhibit high aspect ratio relict grains pinned against muscovite, and greater amount of recrystallized grains. Recrystallized grains form layers or bands subparallel to the mylonitic foliation, that are typically capped above and below by sheets of muscovite. These results have important implication on the application of flow laws in quartzite mylonites, and strain localization mechanisms in mid-crustal shear zones.