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The role of micas in the microstructural evolution and strain localization of mid-crustal mylonites

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Phyllosilicates such as micas commonly represent the weakest phase in rocks of the continental mid-crust. In these predominantly quartzo-feldspathic lithologies, micas contribute to strain localization by two main processes; forming interconnected networks of weak micas which deform more easily than the other minerals, and by acting as a second phase which serves to pin the growth of a dominant phase such as quartz, producing a finer grained and potentially weaker material. The marked crystallographic anisotropy of micas inhibits the motion of dislocations in all but the basal plane, meaning dislocation creep, facilitated by dynamic recrystallization processes, is not a viable deformation mechanism. Despite their importance with regard to strain localization in the mid crust, the processes and mechanisms of deformation and grain size reduction in micas are still not fully understood. We examine a suite of samples from the Cossatto-Mergozzo-Brissago line, a mylonitic shear zone in Northern Italy which represents a large scale tectonic lineament that was active in the mid-lower continental crust. Using fieldwork, coupled with optical and electron microscopy techniques, we characterise the microstructural evolution of mica bearing orthogneiss and metasedimentary protoliths, from low to high strain, as well as the degree to which deformation is localised into the phyllosilicate phases. A dramatic grain size reduction of biotite is identified as the most important process with regard to strain localisation and potential rheological weakening, however the mechanism responsible for this grain size reduction is not clear. A disparity in the behaviour of biotite and muscovite is often observed suggesting the type of mica, as well as its proportion and distribution, is a critical consideration in relation to its effect on the rheology of the bulk rock. Phyllosilicate minerals are abundant in the medium grade metamorphic rocks that dominate the mid crust. As such, a better characterisation of the mechanisms and processes that enable them to deform and localise strain in this dynamic and rheologically important region is critical to understanding the distribution of strain in the crust as a whole.