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The role of dissolution-precipitation creep on the development of crystallographic preferred orientation of K-feldspar in granitic mylonites

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Deformation microstructures and EBSD analysis of K-feldspar belonging to lower-amphibolite facies (T=450°-500°C) granitic mylonites of the Gran Paradiso nappe (Western Alps, Italy) suggest that under mid-crustal conditions, strain-induced solution transfer can play a primary role in the ductile deformation of K-feldspar. Mylonitization occurred under relatively wet conditions (ca. 1% vol. fluid phase) and was accompanied by dissolution, precipitation and replacement processes.

Since the early stages of the ductile deformation, K-feldspar porphyroclasts contain dilatant fractures subparallel to the instantaneous shortening direction. Fractures frequently contain a filling of fibrous K-feldspar that also occurs in other dilatant sites, such as micro pull-apart openings and strain shadows. The precipitation of K-feldspar within dilatant domains partly balances the replacement of K-feldspar porphyroclasts by myrmekite, which requires K^+ to be removed from the myrmekite-forming site. At higher mylonitic strains, the initial microcline crystals are generally converted into 100-300 μm thick, nearly monomineralic layers of recrystallized K-feldspar grains (20-50 μm in size). SEM secondary electron imaging of the grain boundary microstructure of recrystallized K-feldspar grains shows the pervasive occurrence of a rough topography, which is interpreted as indicative of dissolution processes. Crystallographic orientation measurements of K-feldspar have been collected by electron backscatter diffraction technique on two different microstructural sites: (1) fibers in a micro pull-apart opening within a Carlsbad twinned K-feldspar porphyroclast, and (2) a nearly monomineralic layer of recrystallized grains. The crystallographic orientation of the fibers is exactly the same as that of the host Carlsbad twins. Therefore,

K-feldspar fibers represent a clear example of host-controlled growth. K-feldspar recrystallized grains within the analyzed layers form an oblique foliation synthetically inclined at ca. 30-40° with respect to the mylonitic foliation and are arranged closely in direction of the extensional ISA. The pole figures show a weak crystallographic preferred orientation (max=2.2). The [100] crystallographic axes (i.e. long axis of the crystals) are preferential aligned in direction of the extensional ISA, and the (010) and (001) planes form traces that are sub-parallel to the shape preferred orientation of the recrystallized K-feldspar grains. Conversely, (100) planes are preferentially concentrated orthogonally to this preferred orientation. The crystallographic preferred orientation is apparently not explainable by the activity of any slip system within K-feldspar, and is most likely primarily induced by dissolution-precipitation creep. According to numerical models and experimental works, dissolution-precipitation creep is able to produce a CPO within polycrystalline aggregates, provided that individual grains are characterized by crystallographically controlled anisotropy in dissolution and/or growth. Our CPO data suggest a slower dissolution/growth rate for the (010) and (001) and a higher dissolution/growth rate for the (100) planes. However, the overall weak CPO of recrystallized K-feldspar and the high dispersion of data indicate that, at the deformation conditions of the Gran Paradiso mylonites, the anisotropy in dissolution/growth rate of K-feldspar is rather low.