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Mineral chemistry, K/Ar data and microstructures from mylonites to fault gouges: The role of white mica along a retrograde evolution

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We investigate the succession of tectonites from upper greenschist facies mylonites down to fault gouges in the Aar massif (Central Alps, Switzerland). Ductile deformation dominates in the highest temperature range marked by dislocation creep in monomineralic quartz mylonites and viscous granular flow in fine-grained polymineralic ultramylonites. The low temperature end of deformation produced cohesionless fault gouges, which contain a significant amount of smectite. Our main investigations concentrate on the transitional tectonites between the two end members, the so-called low-temperature mylonites. Brittle deformation of quartz and feldspar is accom¬panied by simultaneous viscous deformation of sheet silicates. Sheet silicate deformation includes mineral reactions by dissolution/precipitation. In samples characterized by this transitional deformation style, microstructural criteria in combination with quantitative element mapping are used to define microstructural groups and their relation to equilibration kinetics of the abundant mineral phases. Most evident in these tectonites is a dramatic grain size reduction of the sheet silicates, which results from fracturing, recrystallization, and precipitation of new grains inside the deforming matrix and the generation of pseudomorphs after precursor minerals. Another group of sheet-silicate microstructures is linked to idiomorphic replacement, allowing local changes in chemical composition but without grain size reduction. The combination of these different processes led to both (i) a highly variable mineral chemistry and isotope data as well as (ii) their heterogeneous spatial distribution within an aggregate's microstructure. The quantitative element maps reveal small and highly localized equilibrium volumes. Despite aforementioned highly deformed microstructural domains and the presence of fluids, inherited sheet silicates can survive in different micro¬structural positions. Consequently, this mixture of different generations of sheet silicate within an individual samples result in variable K/Ar ages for such transitional low-temperature mylonites. In contrast, sheet silicates within the upper greenschist facies mylonites show complete recrystallization, resulting in a homogenous mineral chemistry and inconsistent age data documenting the time of the synkinematic recrystallization of the mylonites. The cohesionless low-temperature fault gouges overprinting the high temperature mylonites contain a significant amount of smectite. However, the coexisting K-bearing sheet-silicate phases inside the gouges record no chemical resetting. This suggests a pure brittle refinement of the former mylonitic microstructures without mass transfer and recrystallization. Therefore, K/Ar compositions are inherited and mimic ages of the adjacent mylonites. The resulting K/Ar ages are in the range of adjacent mylonites and not in the range of the surrounding gneisses.