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Fluid-assisted annealing of carbonate mylonites: kinetics and geological implications

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Recognition and knowledge of the amount of annealing of deformed microfabrics crucial for the interpretation of deformation in shear zones in the earth's crust and mantle. Based on monomineralic rocks, however, such discrimination often is problematic in nature, since microstructural criteria are not unambiguous in monomineralic aggregates. The study of polymineralic microfabrics, with a dominating matrix phase, represents a way out of this dilemma, because the relationship between matrix grain size and Zener parameter (size of second phases/volume fraction of second phases) allows to distinguish between deformation and static conditions. In this sense, the effect of annealing can be investigated.

Within a vertical section across the Doldenhorn thrust (Helvetic Alps), microstructures of polymineralic carbonate mylonites show typical deformation structures at the thrust contact, while they change into annealed microfabrics already 0.5m above the thrust contact. The amount of annealing, however, varies within the hanging wall section, owing to spatially varying time intervals of annealing, i.e. different times for the termination of deformation. In other words, episodic deformation intervals could be unraveled by calculation back the amount of annealing. For this purpose, knowledge on grain growth kinetics and T-t path is required. The latter can be estimated by considering the exhumation history of a shear zone, while information of grain growth kinetics can be derived either from experiments or investigations on contact metamorphic natural situations undergoing static grain growth. In case of the samples investigated, all of the published experimental data on grain growth kinetics would imply grain sizes too small compared to the observed natural ones. Only grain growth kinetics involving the presence of fluids would allow the grains to grow large enough

at the required low temperature conditions and annealing times available. In case of the Doldenhorn nappe, presence of fluids is confirmed by syn- to post deformational veins, as well as by stable isotope compositions.

Since many shear zones in crust and mantle represent important pathways for fluids and melts, enhanced mass transfer kinetics during annealing due to the presence of fluid/melt phases may present a severe modification process of deformation microfabrics. The presented results are therefore of particular importance for fine-grained ultramylonites, where microstructures of diffusion creep or granular flow dominated deformation are very similar to annealed ones.