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# Evolution of polymineralic deformation microstructures in different large-scale shear zones under different influence of fluids.

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Calcite microstructures of polymineralic carbonate mylonites from different Helvetic nappes (Morcles, Diablerets, Doldenhorn, Glarner nappe) in Switzerland were analyzed in regard of variations due to temperature/stress and impurity content (i.e. second phase minerals). The aim was to determine the variability of microstructures (mean grain size of calcite $D_{cc}$ and second-phases $d_p$) between the different nappes, which were all deformed at similar conditions (peak temperature$T$ /stress and volume fraction of second-phases $f_p$). Grain sizes of both matrix calcite and second phases are dynamically stabilized resulting in steady state microstructures maintained by cycles of nucleation, growth and consumption.

$D_{cc}$ of every sample is affected by second-phase particles (predominantly sheet-silicates) in a similar way in all nappes. The second-phase influence is expressed by the Zener parameter ($Z$), a geometric factor defined by $Z = d_p/f_p$. Therefore, it is possible to compare different second-phase affected microstructures by taking $D_{cc}$ for equal $Z$ values. Hence, the relationship *log*$D_{cc}$ *vs. 1/T* and the resulting activation energies ($Q_{cc}$) for each nappe can be determined. This relationship is identical for all nappes. However, $Q_{cc}$ varies within the nappes with $T$, showing an increase from around 20 to 80kJ/mol for the temperature range of 250 to 390˚C, respectively. This suggests that for the aforementioned cycles the relative contribution of grain growth and grain size reduction change with temperature in an opposite manner.

In contrast to $D_{cc}$, the second-phase grain size $d_p$ for constant $f_p$ differs between the nappes. The slopes of the relation *log*$d_p$ *vs. 1/T* are constant and so are the resulting activation energies for second phase growth ($Q_p$ 30kJ/mol). In nappes with higher

synkinematic fluid flow the overall $d_p$ is smaller. This indicates that second-phase grain growth is transport and dissolution controlled. Fluids enhance rates of dissolution - mass transfer - precipitation for the second phases. Therefore, cycles of growth and consumption are faster and consequently $d_p$ smaller in mylonites affected by fluids.

Hence, coupled grain coarsening of both matrix and second phases define the bulk microstructure while the deformation conditions control growth and grain size reducing processes of the associated phases.