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Fluid-assisted strain localization in the Glarus overthrust (Switzerland).

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In high-strain shear zones, deformation under retrograde conditions is a common feature, where the width of shear zone decreases continuously with ongoing deformation. The occurrence, degree, and geological significance of strain localization were studied for the Glarus nappe complex. Here, Permian Verrucano was thrusted over the sedimentary Infrahelvetic complex while the famous 'Lochsiten calc-mylonite' served as lubrificant, which was sandwiched between hanging and footwall. From front to rear, the peak metamorphic conditions increase from anchizone to lower greenschist facies, respectively.

Along the entire thrust, steady state microfabrics occur characterized by a temperature/stress controlled balance of grain size reducing mechanisms and grain growth. As a consequence, the mean grain size continuously increases along the thrust plane with increasing metamorphic conditions (i.e. from N to S). In a section perpendicular to the thrust, however, the grain size continuously decreases towards the center of the shear zone. In an opposite manner to the grain size reduction, calcite twin density increases. These changes in microfabrics go hand in hand with stable isotopes, where both δ^{16}C and δ^{18}O also decrease (Badertscher, 2001). This fact, in combination with the occurrence of synkinematic veins, indicates the presence of fluids during deformation.

The modifications in microfabric resulted from changes in deformation conditions due to ongoing thrusting and exhumation induced cooling. As a consequence strain localized, i.e. the width of the large-scale shear zone continuously decreased with time and reduced temperature. A texture weakening with continuous localization points to a simultaneous change in predominant deformation mechanisms from grain size insensitive to granular flow (dissolution-precipitation and grain boundary sliding processes). The enhanced isotopic fractionation towards the shear zone center is based

on 3 major parameters directly attributed to strain localization: (1) ongoing dynamic recrystallization particularly grain boundary migration, (2) localization induced small grain sizes and therefore higher permeabilities, and (3) higher finite strains.

The latest stage of deformation occurred under brittle conditions as manifest by sharp well defined brittle faults and local cataclasites.

References:

Badertscher, N., 2001. Deformation mechanisms and fluid flow along the Glarus overthrust, eastern Helvetic Alps, Switzerland. PhD Thesis, Université de Neuchâtel, Switzerland, 286 pp.