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Earthquakes in the ductile regime? An attempt to explain fluid-based and ultra-localized deformation along the Glarus thrust

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The Glarus thrust manifests a case of extreme strain localization within a thin but continuous carbonate layer. This carbonate layer, the so-called Lochsite tectonite, originates from mechanical shearing-in of thin slices of carbonate sediments and/or the formation of calcite veins. In this sequence calcite veins are overprinted in a ductile manner by mylonites and the mylonites themselves are overprinted by veins again. This series of events indicates a cyclic behaviour of dissolution processes under the presence of a fluid phase, hydrofracturing, precipitation of carbonates and ductile deformation – A sequence typical for seismic cycles but paradoxical within the ductile regime!
Based on a new approach the paradox of earthquakes in the ductile regime can be explained by a unifying theory. We suggest that the coupling of two fundamental feedback processes, shear heating and chemical pressurization can reconcile the aforementioned strain localization. During this coupling, slow creep deformation raises the temperature through shear heating and ultimately activates chemical decomposition. The subsequent release of highly over-pressurised fluids lubricates the localised high strain Lochsite tectonite. The entire Glarus thrust is suggested to be self-lubricating provoking the precipitation or mechanical incorporation of carbonates as mechanically soft material. In this way, nature provides a possible mechanism for a fault to admit displacements of tens of kilometres on millimetre-thick bands in periodic seismic stick-slip events along very thins slip planes. The critical question related to the presented approach is: can local temperature increase provoke decomposition of the carbonate without inducing a regional temperature rise?