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Formation of slaty cleavage along a temperature gradient

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Cleavage is still one of the most important structural elements used in structural geology. The understanding of cleavage evolution under changing physico-chemical conditions is therefore a key for an improved understanding of cleavage forming processes. Recent technical advances in the field of artefact-free preparation of these delicate samples, on high resolution imaging on the base of electron microscopy (BIB-SEM) as well as associated element analytics (EDX), enables to characterise the local microstructure and spatial variation in chemistry down to several nm. In this study, we use these techniques to reassess the formation of slaty cleavage and try to resolve what processes, such as mass transfer, pressure solution and fracturing are related to the formation of slaty cleavage. We investigate background-strain samples along a temperature gradient from about 200 °C – 320 °C in the flysch units of the Glarus Alps (Switzerland). This sample series shows an evolution from relatively undeformed claystones towards slates with an expressed spaced cleavage. In between these end-members, a weak cleavage is formed with no or irregular distances between cleavage planes. The intensity and the spacing of the individual cleavage planes increase with increasing temperature. We quantitatively evaluate (image analysis, autocorrelation function, element mapping) the changes in cleavage spacing, mineralogy and sizes of the different mineral phases as a function of increasing metamorphic conditions. In this way, we unravel the contribution of pressure solution, mass transfer processes, nucleation and growth processes during deformation.