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A combined microstructural and petrophysical study to analyse the mechanical behaviour of shales in the Flysch units, Glarus Alps, Switzerland

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Crustal scale deformation is strongly controlled by the rheological behaviour of sheet-silicate-rich rock types. As these rocks have low rock strength, facilitated by the strong crystallographically controlled mechanical anisotropy and interstitial pore fluid in the aggregate, they are able to accommodate considerable amounts of strain. A close relationship is expected between microstructure, porosity and permeability as function of metamorphic conditions and strain gradients. Thereby, fluids set free by compaction, mineral reactions or deformation play an important role. Rising industries in underground storage such as nuclear waste disposal, shale gas exploration or geological carbon sequestration make use of the advantageous properties of such rock types. Therefore, there is a great demand for research on the interaction of these processes. This study uses samples from Flysch-units of the Glarus Alps (Switzerland) collected along a metamorphic gradient (150-400°C) to unravel the link between the mechanical behaviour of these sheet-silicate-rich rocks at geological conditions and their present-day physical parameters. Investigations include two topics: (1) characterization of such rock types in terms of mineralogy, microstructure and petrophysical properties; and (2) possible reconstruction of deformation processes from microstructures. Quantitative information on the porosity, i.e. the pore sizes, distribution and their interconnectivity is crucial for both topics. Porosity is therefore estimated by: (1) image analysis of high resolution SEM images, (2) He-pycnometry, and (3) Hg-porosimetry. In a first step, differences in their present day physical parameters between low and high temperature sampling sites are shown. The variations inside and between the investigated samples is partly due to initial sedimentological heterogeneity and partly to the changes along the metamorphic gradient. This study will demonstrate how the characterized present day porosity evolved owing to these two prerequisites.