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Microscale Rock mechanics: Determination with finite strain analyses

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Analysis of the mechanics of rocks and rock masses play a fundamental role in the crucial risk assessment with respect to destruction of e.g. installations, tunnels, bridge constructions geothermal boreholes and cables. To constrain the mechanics of the rocks and rock masses under compressive and extensional stress regimes, finite strain analysis techniques are used to quantitatively estimate the amount of deformation. This method is an uncommon but powerful tool for strain determination even if marker particles are rarely in mechanical contrast to the matrix. The deformation of such markers is related to shearing, rotation and flattening during compaction, extension or reloading of the rocks. The deformation and rotation of the corresponding strain ellipse (R-value: ratio sigma1/sigma3) indicates the degree of the rock alteration during compaction, erosion or other deformation processes. Information about the orientation of the long axis of the strain ellipse relative to bedding direction or core axis could be given (phi-values).

We present first results of laboratory compression tests on core samples of limestone, sandstone and conglomerate according to different matrix types and with varying grain sizes. Under varying applied pressures (from 5 MN/m^2 to 52 MN/m^2) strain analyses were used to estimate the amount of deformation. Limestone samples show an increase of deformation grades with an increase of the applied pressure (e.g. R=1.26-1.35), while in the sandstone and conglomerate samples the degree of deformation decrease with increasing applied pressures (e.g. Sandstone: R=1.43-1.38, Conglomerate: R=1.09-1.07). In addition, the conglomerate samples are characterised by a strong variability high phi-values (78° to 110°), while the phi-values of the limestone and the sandstone samples are constant around at 87° to 90°. Both high phi-values strain may indicate a high rotation of sigma1 related to one-dimensional compression.