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Spatial analysis of fractured rock around fault zones based on photogrammetric data

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The location of hydrocarbon, geothermal or hydrothermal fluids is often bound to fault zones. The fracture systems along these faults play an important role in providing pathways to fluids in the Earth's crust. Thus an evaluation of the change in permeability due to rock deformation is of particular interest in these zones.
Recent advances in digital imaging using modern techniques like photogrammetry provide new opportunities to view, analyze and present high resolution geological data in three dimensions. Our method is an extension of the one-dimensional scan-line approach to quantify discontinuities in rock outcrops. It has the advantage to take into account a larger amount of spatial data than conventional manual measurement methods. It enables to recover the entity of spatial information of a 3D fracture pattern, i.e. position, orientation, extent and frequency of fractures.
We present examples of outcrop scale datasets in granitic and sedimentary rocks and analyse changes in fracture patterns across fault zones from the host rock to the damage zone. We also present a method to generate discontinuity density maps from 3D surface models generated by digital photogrammetry methods. This methodology has potential for application in rock mass characterization, structural and tectonic studies, the formation of hydrothermal mineral deposits, oil and gas migration, and hydrogeology. Our analysis methods represent important steps towards developing a toolkit to automatically detect and interpret spatial rock characteristics, by taking advantage of the large amount of data that can be collected by photogrammetric methods. This acquisition of parameters defining a 3D fracture pattern allows the creation of synthetic fracture networks following these constraints. The mathematical description of such a synethtical network can be implemented into numerical simulation tools for modeling fluid flow in fracture media.
We give an outline of current and future applications of photogrammetry in rock mechanics, petroleum geology, hydrogeology, and structural geology.