Geophysical Research Abstracts
Vol. 18, EGU2016-2324, 2016
EGU General Assembly 2016

Geometry of structures within crystalline bedrock constrained in 3D and their relevance for present day water infiltration.

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Fluid circulation in crystalline rocks is of key importance when exploring crystalline basement in light of, for example, deep-seated geothermal energy projects or selection of sites for nuclear waste repositories. Due to their enhanced permeability, fluid circulation within crystalline bedrock is mainly controlled by fault zones, which may originate from ductile mylonites but show a strong brittle overprint. In order to better constrain 3D flow paths, a well-founded knowledge on the 3D nature of the fault zone pattern is indispensable. We attempt to constrain the geometry of a complex 3D fault zone pattern in a case study of the Grimsel Test Site (GTS, central Switzerland). The constraints are based on mapping of both the surface as well as the GTS underground tunnel system, offering a unique opportunity to test the 3D model and associated uncertainties. We investigate the effect of increasing geoinformation on the quality and accuracy of the 3D model by using: (i) remote sensing surface data only, (ii) field surface mapping in combination with (i), and (iii) underground data combined with (i) and (ii). This approach allows for defining different steps in 3D geological modelling of a specific area, including a measure of the remaining uncertainty after each step. We obtain a best-estimate model by fitting results between surface and underground data by using a combination of field data and orientation obtained by Delaunay triangulation. We incorporate novel approaches to uncertainty analysis of fault orientations and investigate different fault planes showing the possible variation range of the structures investigated.