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If you get the stress data, you've always asked for

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The upper Earth crust is increasingly used by mankind, to extract, transport, store or dispose materials, energy, or waste. Regardless of the objective, long term safety and stability is essential and thus, the contemporary stress state of the upper crust is one of the key variables. To estimate a continuous description of the 3D stress tensor, geomechanical numerical models are used. The most important parameters to set up such models are the knowledge of the underground structures, the distribution of rock properties as well as the stress data, on which the models are calibrated. In the model, the vertical stress results from the gravitational volume forces due to the density distribution and the horizontal stresses from the Poisson effect as well as appropriate lateral displacement boundary conditions. The latter are determined by finding a best-fit with respect to given stress magnitude data of the maximum and minimum horizontal stress S_{Hmax} and S_{hmin}, respectively.

A unique dataset of stress magnitude data has been recently acquired within the exploration phase for deep geological repository of radioactive waste in Switzerland. Nine cored boreholes in three potential siting areas have been drilled and besides a wide range of logging runs, and laboratory tests of rock properties, more than 120 Mini-Hydraulic Fracturing (MHF) and Sleeve Re-Opening (SR) tests were successfully performed in different stratigraphic units to estimate the magnitudes of S_{hmin} and S_{Hmax}

Here, we present a 3D geomechanical-numerical model that shows both, the best-fit to the measured stress magnitudes as well as the range of stress magnitude variability in the volume of the different stratigraphic units. This variability results from MHF/SR measurements uncertainties and from the variation of rock properties within the lithologies. Furthermore, one has to assess how representative each MHF/SR measurement is for a larger rock volume. To represent the stress variability within the lithologies, many model simulations that cover the distribution of possible rock parameters were performed. The distribution is given by the cumulative density function (CDF) for the Youngs modulus and the Poisson number for each stratigraphic unit. Based on the range of model simulations we visualize the variation of the stress components along virtual well paths in analogy to the statistical variation. Such plots allow to quantify and visualize

the potential variation of the present-day stress state within the stratigraphic column because of the petro-physical variability within the stratigraphic units. Furthermore, using the CDF, we can assign to each model simulation a probability that allows us also to estimate a probability distribution of the stress variability in the different units.