The role of stress and geomechanical modelling BEFORE site selection

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The local tectonic stress field and the mechanical properties of the host rock are crucial factors for the site selection process and safe radioactive waste disposal in the subsurface, respectively. Earthquakes, reactivation of tectonic faults, hydraulic properties of natural and induced fractures, geotechnical aspects of construction of a deep depository and extent of the excavation damage zone are just a few examples which highlight the importance of geomechanics for deep geological disposal. The National Cooperative for the Disposal of Radioactive Waste of Switzerland estimates that about 40% of their site selection criteria are affected by the crustal stress state (Nagra, 2008). As a consequence robust stress predictions are mandatory for site selection. Furthermore, they have to be available prior to detailed exploration (drilling, mining) of a specific site as the stress state is crucial for the ranking of competing site options and to provide criteria for exclusion due to unfavourable or critical stress states.

The required stress prognosis has to be simulated with 3D geomechanical-numerical models, which allow incorporating complex geometries of faults and lithological layers as well as non-linear rock mechanical behaviour (e.g., Fischer & Henk, 2013; Hergert et al., 2015). These models have to be site-specific as magnitude and orientation of the local stress field are not uniform, but influenced by local discontinuities like tectonic faults and lithological changes. Model results provide, among others, the complete 3D stress tensor for any arbitrary point in the model domain. This information is not only needed to characterize the stability of underground openings or faults, but also to derive the stress state prior to construction of a deep depository. Furthermore, it can be used to study the short- and mid-term stress changes in relation to the excavation process and self-sealing mechanisms. In addition they deliver the crucial initial conditions for the required scenario simulations that cover geological time spans (ten thousands to one million years) to assess the long-term safety and stability of a radioactive waste disposal site. Examples are the assessment of the reactivation and fracture potential of tectonic faults as well as the quantification of the long-term impact of tectonic processes, thermal and ice loads.

We present the results of 3D geomechanical numerical models for potential nuclear waste disposal sites in Northern Switzerland and the impact of geological structures and rock properties on the local stress field variability. Given the important role of stress and geomechanical modelling for the characterization of potential disposal sites, we present briefly the initiative SpannEnD that has been established to set up and advance the necessary data bases and modelling tools for robust stress predictions in Germany so that they could be made available once the actual site selection process will be started (see also Heidbach et al., this conference, for further details).

References

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