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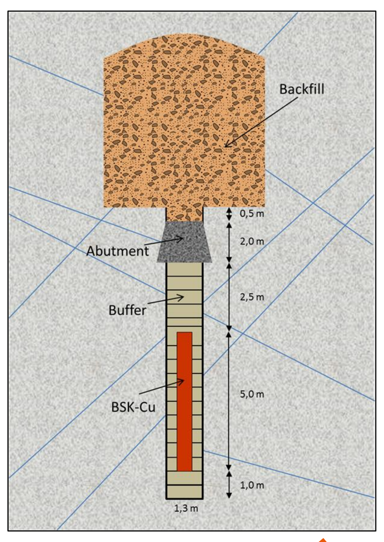
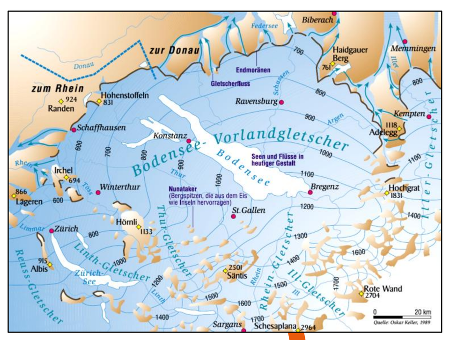
Fundamentals of long-term safety assessments for a high-level waste (HLW) repository concept in crystalline rock

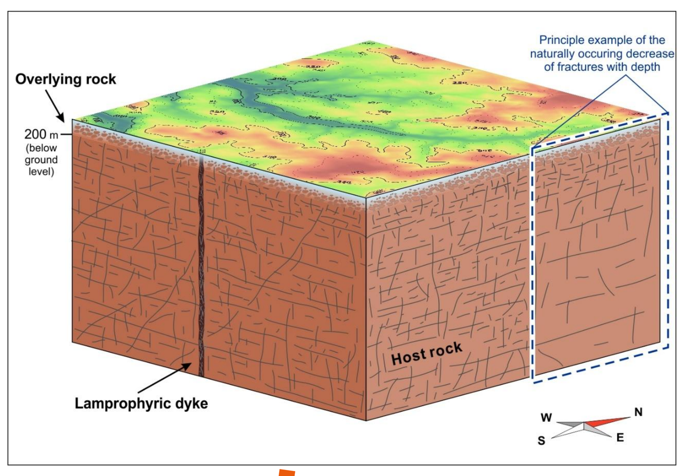
Lommerzheim, A.[1]; Frenzel, B.[2]; Mayer, K.M.[3]; Müller, C.[1]; Neuhaus, M.[1]; Schütz, F.[2], Weitkamp, A.[2]; Wolf, J.[3]

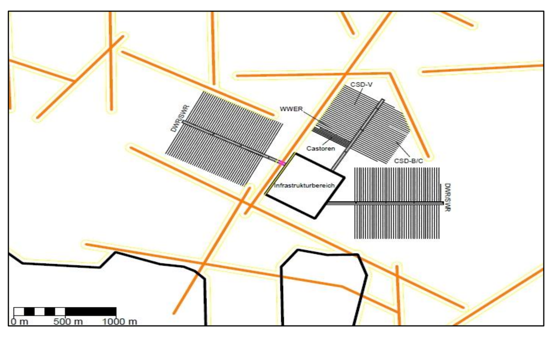
[1]BGE TECHNOLOGY GmbH, [2] BGR, [3] GRS gGmbH

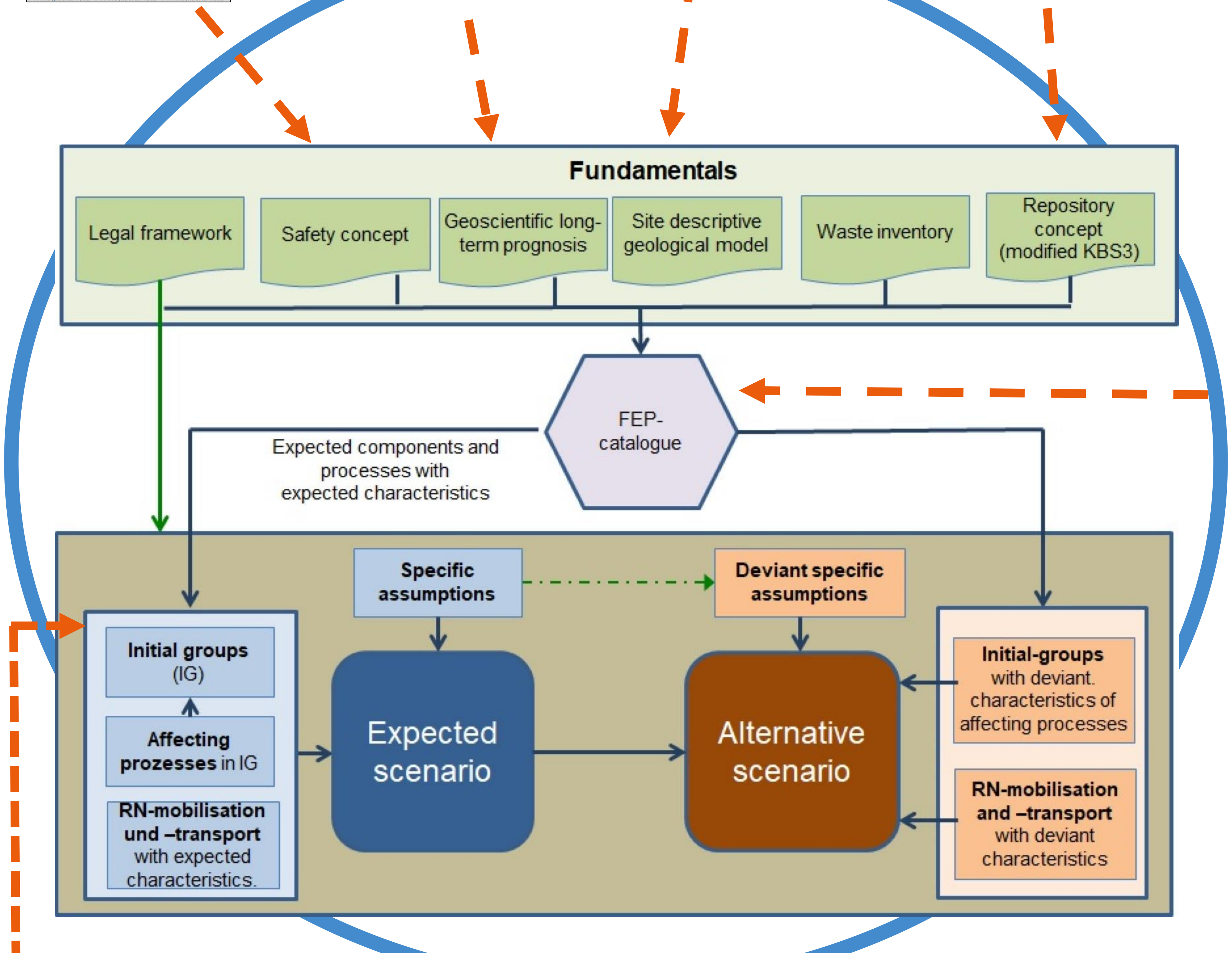
A **safety case** is based on a comprehensive description of the repository system and a prognosis of its future evolution. Therefore, FEP catalogue and scenario development are basic tools for performance assessment and radiological consequence analysis. In Germany, corresponding methodologies have been developed for sedimentary rocks, but this methodology is not directly applicable to crystalline rocks due to specific differences in the rock characteristics and in the safety strategy. Therefore, a modified methodology has been developed in the R&D project CHRISTA III and tested on a generic data set including a site-descriptive geological model, a safety strategy, a repository concept, and a suitable FEP catalogue.





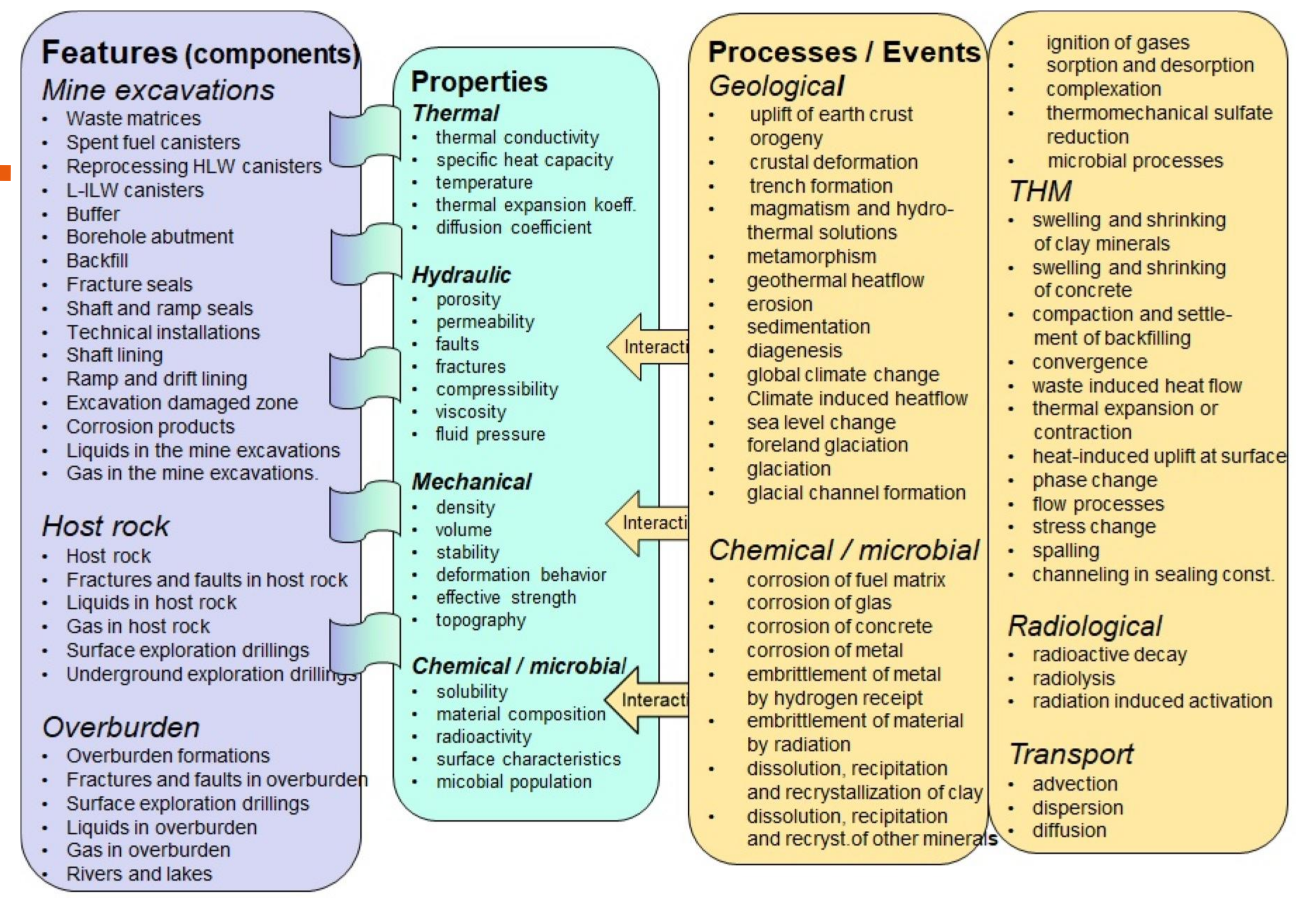


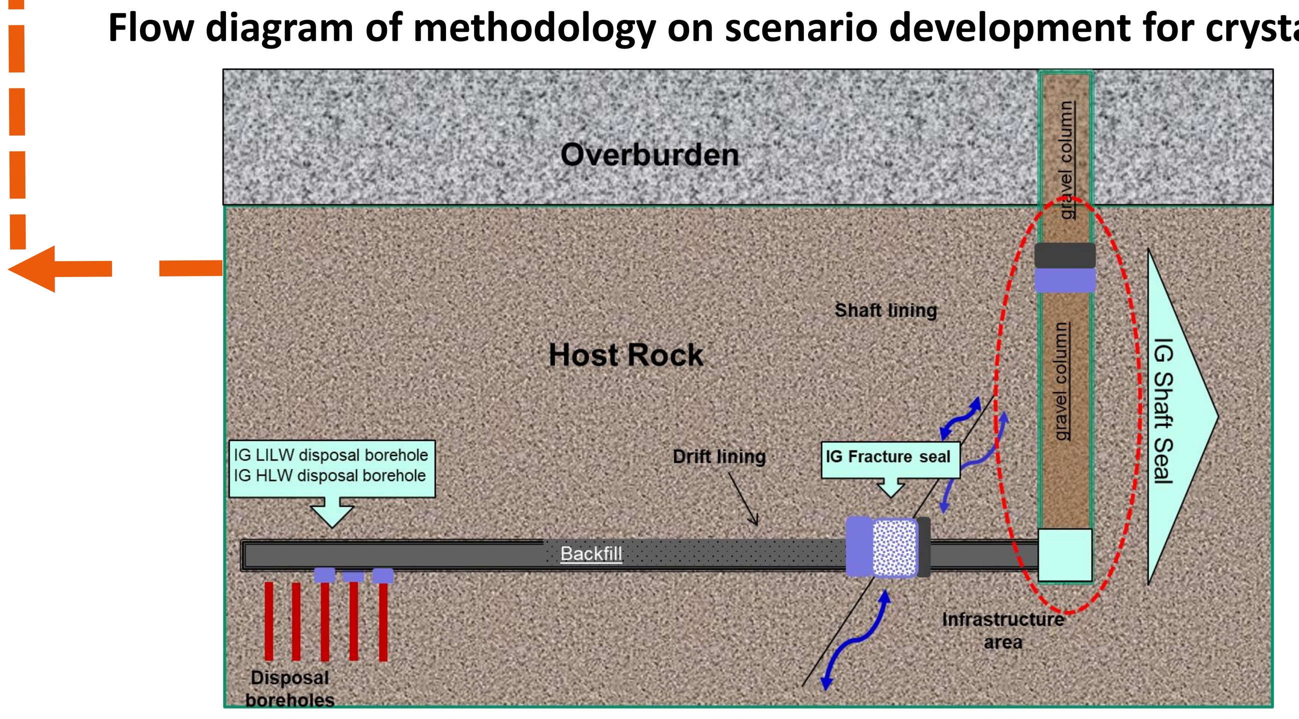




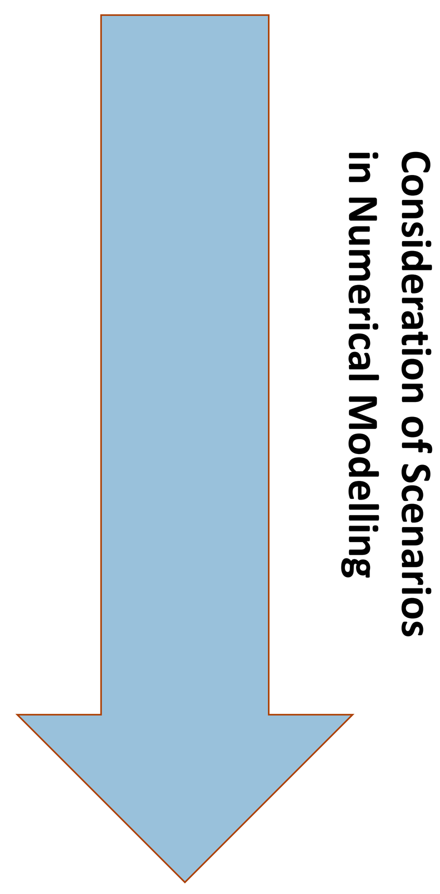
Flow diagram of methodology on scenario development for crystalline rocks

Structure of a FEP catalogue

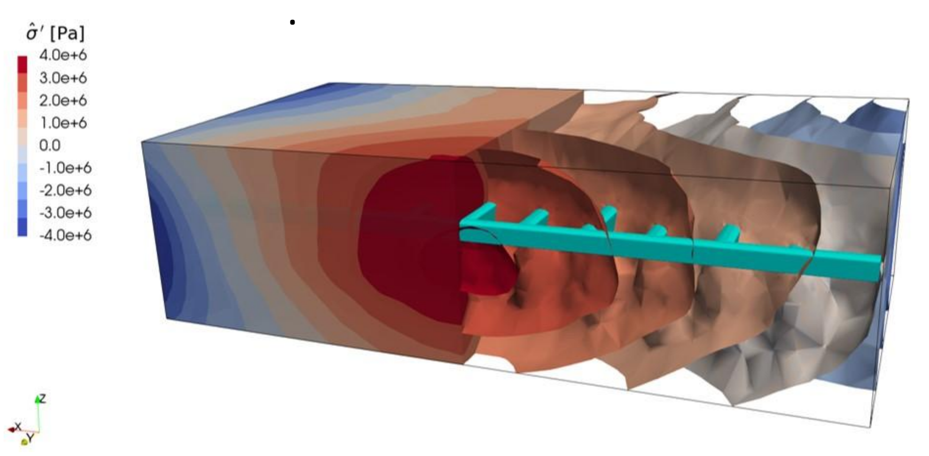




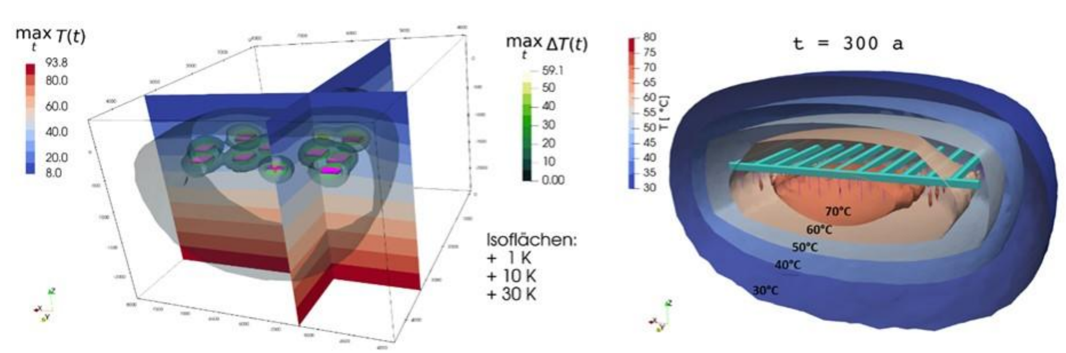
Initial groups in a schematic repository system



The **safety concept** for fractured crystalline rocks is based on long-term stable waste container, which are protected by a buffer. The methodology of scenario development is based on key barriers, processes impairing the barrier function, and processes linked to "radionuclide mobilisation and transport". To consider the effects of the fractured host rock on the barrier function and groundwater flow, the nearfield of the key barriers has been described in **initial groups**. The barriers' nearfield will be affected by a spectrum of THMC processes during system evolution. For **expected scenarios**, specific assumptions, likely characteristics of components, and the probable intensities of the processes have been assumed. **Alternative scenarios** can be derived by deviations from specific assumptions, less probable properties of components and intensities of processes.



Evaluation of the fluid pressure criterion based on THM calculations



Results of thermal calculations for the nearfield of disposal areas

Examples for model calculations from Thiedau, J., Maßmann, J., Guevara Morel, C., Weihmann, S., Alfarra, A. (2021): CHRISTA-II - Analysen zur Integrität von geologischen Barrieren von Endlagersystemen im Kristallin. Ergebnisbericht, Bundesanstalt für Geowissenschaften und Rohstoffe, Hannover

Outcome

- Using the new methodology, plausible scenarios have been derived in a transparent manner. They were successfully taken into account in the development of conceptual models for numerical calculations in the context of performance assessment and radiological consequence analysis.
- The proposed systematic approach for scenario development increases understanding and transparency of future system evolution and thus supports the communication between implementer and stakeholders.

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