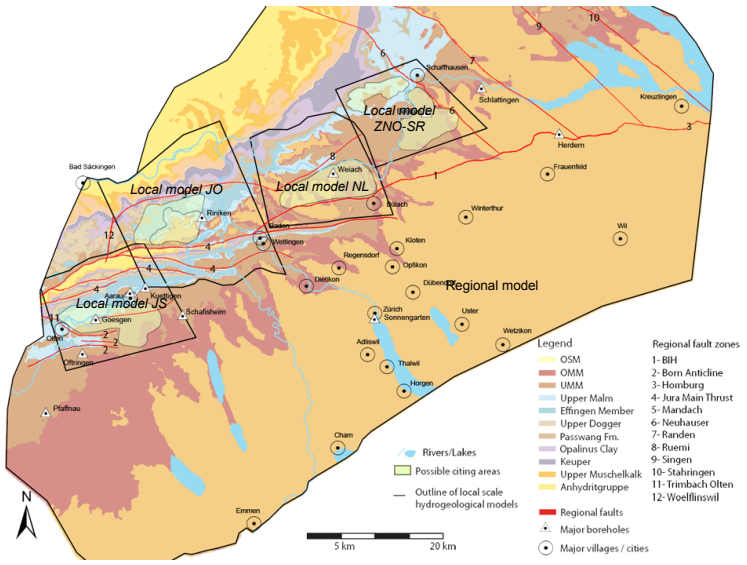
DHI CASE STORY

ELABORATION OF GROUNDWATER MODELS FOR DEEP GEOLOGICAL REPOSITORY SITES

Using FEFLOW

The Sectoral Plan Deep Geological Repositories ("Sachplan geologischer Tiefenlager –SGT", developed by the Swiss Federal Office of Energy SFOE) is the Swiss road map to establish repositories for radioactive waste. SGT Stage 1 with focus on the selection of geologically suitable regions led to the proposal of six geological siting regions for the L/ILW (low- and intermediate-level radioactive waste) repository (Südranden, Zürich Nordost, Nördlich Lägern, Jura Ost, Jura-Südfuss, Wellenberg) and three geological siting regions for the HLW (high-level radioactive waste) repository (Zürich Nordost, Nördlich Lägern, Jura Ost). As a quantitative decision basis for the site selection process, provisional safety analyses studies are to be performed for all relevant repository configurations. One of important tasks is to evaluate the local groundwater flow conditions in the different potential siting regions, considering present and future conditions for relevant long-term evolution scenarios.

DHI-WASY was contracted by Nagra to elaborate four local (detailed) models based on the overall three dimensional (regional) hydro-geological model for the geological siting regions Jura-Südfuss, Jura Ost, Nördlich Lägern, and Zürich Nordost combined with Südranden. The size of the model areas varies from 214 km² to 427 km².



Location overview of the Regional Model and the Local Model areas (after Nagra)

SUMMARY

CLIENT

Nationale Genossenschaft für die Lagerung radioaktiver Abfälle (Nagra) - "National Cooperative for the Disposal of Radioactive Waste", Switzerland

PROJECT PARTNER

- Simultec AG Zürich
- Böhringer AG Oberwil

CHALLENGE

- Complicated geologic- and hydrogeological-tectonic situations,
- characterized by folded multi-layer aquifers,
- and regional faults and overthrusts.

SOLUTION

Numerical Modelling using FEFLOW

VALUE

Helping to adequately understand system behaviours of the complicated hydrogeology, to investigate potential groundwater flow paths in both deep and shallow aquifers.

LOCATION / COUNTRY

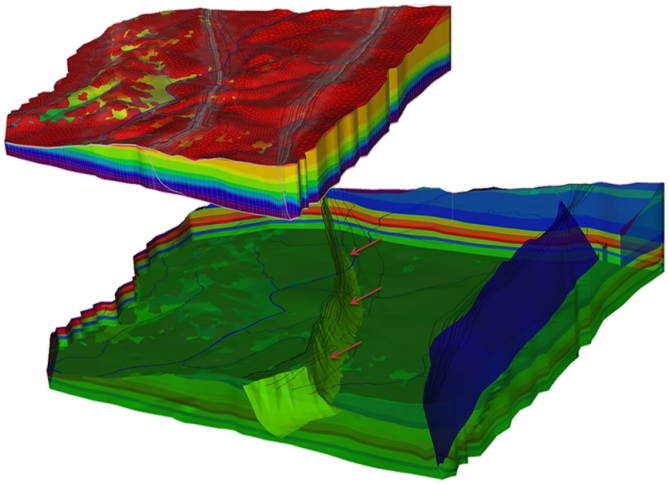
Northern Switzerland

The areas are located within the northern Alpine foreland of Northern Switzerland. The current tectonic and geological setting mainly originated from the Alpine Orogeny during the early Tertiary and the syn- to post-collisional thrusting and erosion processes as well as several transgressions and regressions along the European continental shelf. The intensity of deformation, generated by the Alpine Orogeny and subsequent relaxation and rebound of the continental crust, decreased from W to E and has led to the formation of the following tectonic areas: Folded Jura, the Deformed Tabular Jura and the Tabular Jura. Other notable tectonic areas within the region of interest include the Northern Swiss Molasse Basin, the Upper Rhine Graben, the Hegau-Bodensee Graben and the Black Forest Massive. The hydrogeology is characterized by both regionally distributed aquifers in different depths and locally deposited shallow aquifers.

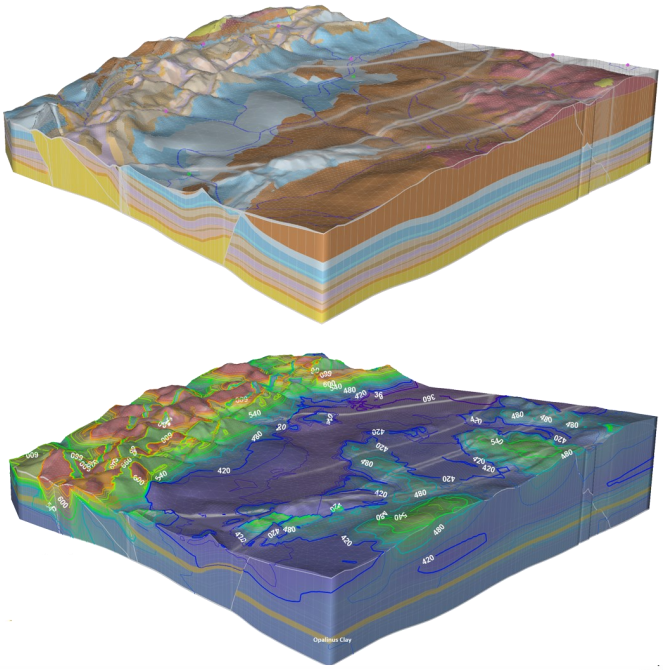
The general objectives of the local scale models focused on evaluating the local groundwater flow conditions in the different potential siting regions under consideration of present and future conditions for relevant long-term evolution scenarios. In future, local scale modelling may also include the effect of the repository construction and operation on the use of groundwater (groundwater resources, mineral and thermal water exploitation).

One important requirement for the modelling is an adequate implementation of regional faults and/or thrusts in the groundwater models. The relevant regional faults are implemented in the FEFLOW models according to their geological-tectonic occurrences (dip and strike), either as inclined or vertical faults. The resulting model for Jura-Südfuss consisted of more than 25 mio. elements and by using the newest solver in FEFLOW it was shown that such models could be handled in an efficient way.

With the site specific numerical FEFLOW models, scenario simulations have been successfully carried out, covering a wide spectrum of likely groundwater flow behaviours with potential significance in the context of safety assessment. The scenarios considered e.g. a set of complementary hypotheses on hydraulic features of the regional faults (sealed, open or partly sealed). The plausibility and consistency of simulations with the present conditions was evaluated by comparison with the available field data. Sensitivity analyses were performed to investigate both conceptual and parameter uncertainties.



Implemented inclined faults in FEFLOW Local Model Nördlich Lägern (NL)



Numerical FEFLOW Local Model of site region Jura-Südfuss (JS)
above: Complicated hydrogeological-tectonic situation
middle: Simulated hydraulic head distribution in a 3D-view
below: Simulated hydraulic head distribution along a cross-section

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