Geothermal use of an Alpine aquifer – Davos pilot study

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Introduction

The INTERREG VB project GRETA (near-surface geothermal resources in the territory of the Alpine Space), aims at unlocking the potential of Near-Surface Geothermal Energy (NSGE) in the Alpine Space through the exchange of best technical and regulatory practices, the identification of most suitable territories for NSGE installations and the development of guidelines for the integration of NSGE into energy planning.

Method

In spite of low data availability regarding the hydraulic conditions of the subsurface the main challenge was to create a regional groundwater model which maps the large-scale circulation systems. The basis for this was the integration of a 3D geological model (GOCAD©) into a numerical groundwater flow model (COMSOL©).

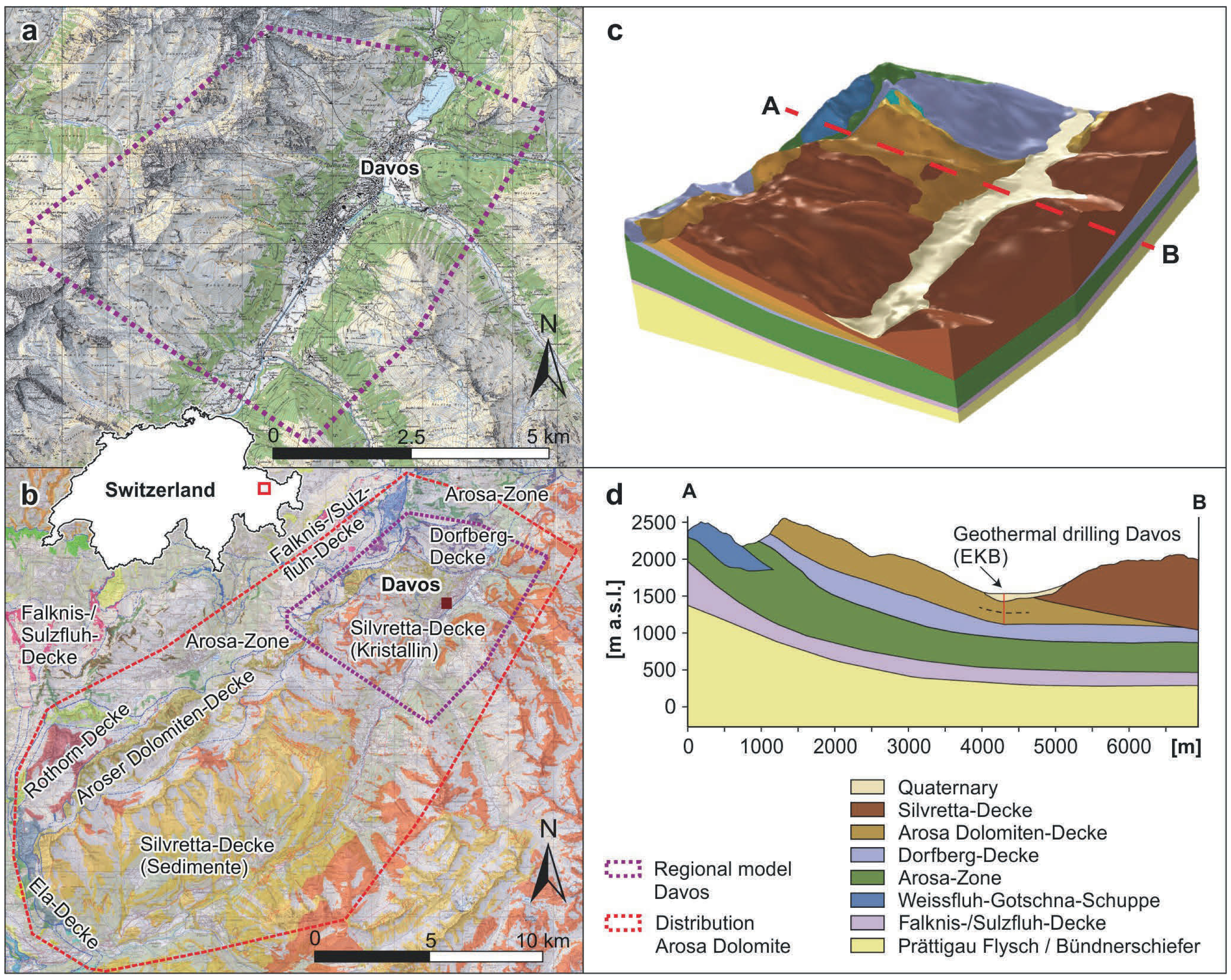

Fig. 1: Model perimeters for the geological and hydraulic models: a) regional perimeter for the hydraulic model, b) perimeter for the tectonic model, c) hydrogeological model with volumes according to the geological 3D model, d) cross section from WNW to ESE through the EKB geothermal well.

Results

Regional groundwater flow is characterized by the topography driven groundwater circulation in the large-scale context.

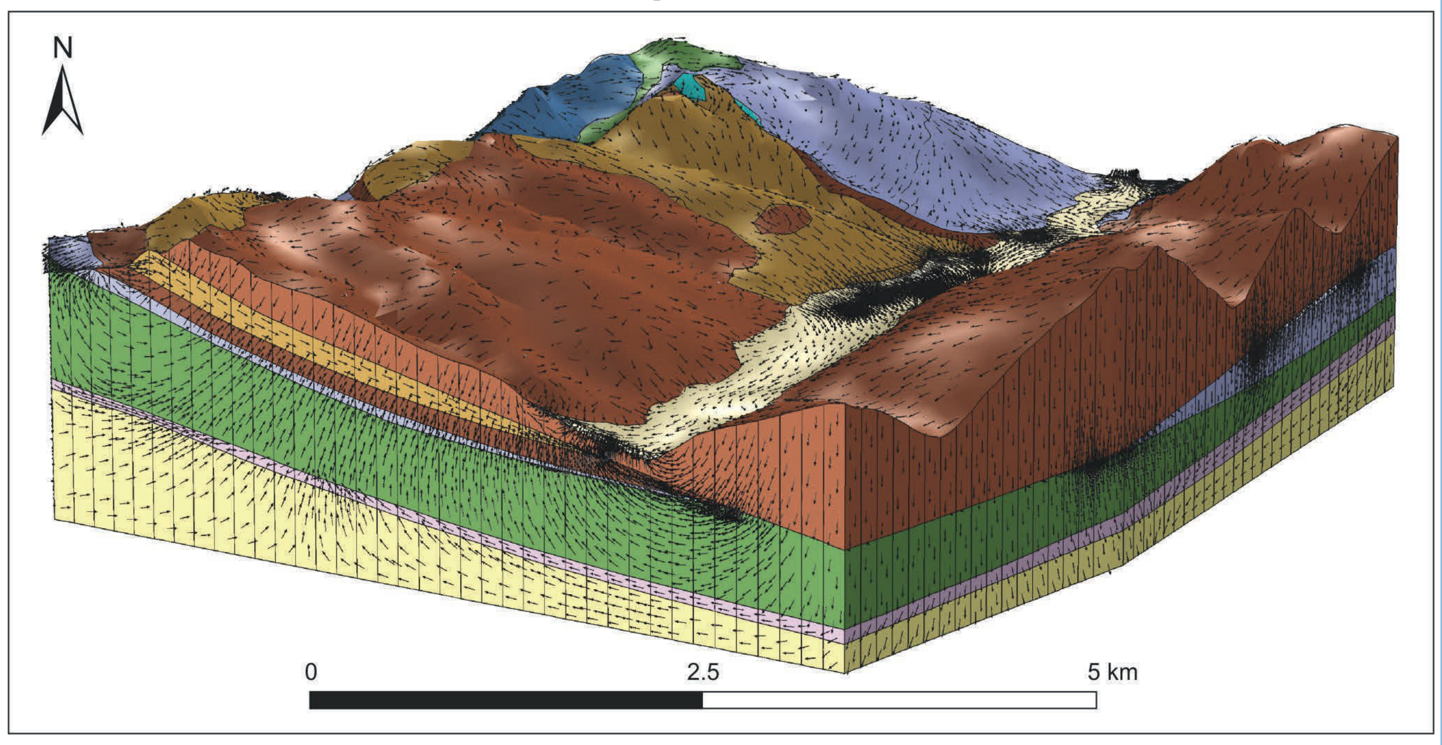

Fig. 2: Result of regional scale groundwater modelling: the *arrows* represent the flow direction. The density of the *arrows* is based on a Gaussian distribution and is not to be equated with a volume or a velocity.

Groundwater budgets and their temporal change were calculated for the different hydrogeological units (Fig. 3), including the exchange between single units. For licensing practice the model was used to define different zones with respect to hydraulic potential. The groundwater potential (Fig. 4) is calculated for the top of the Arosa Dolomite, and afterwards intersected with the high-resolution digital elevation model. The mutual influence of future geothermal wells is illustrated in Figure 5.

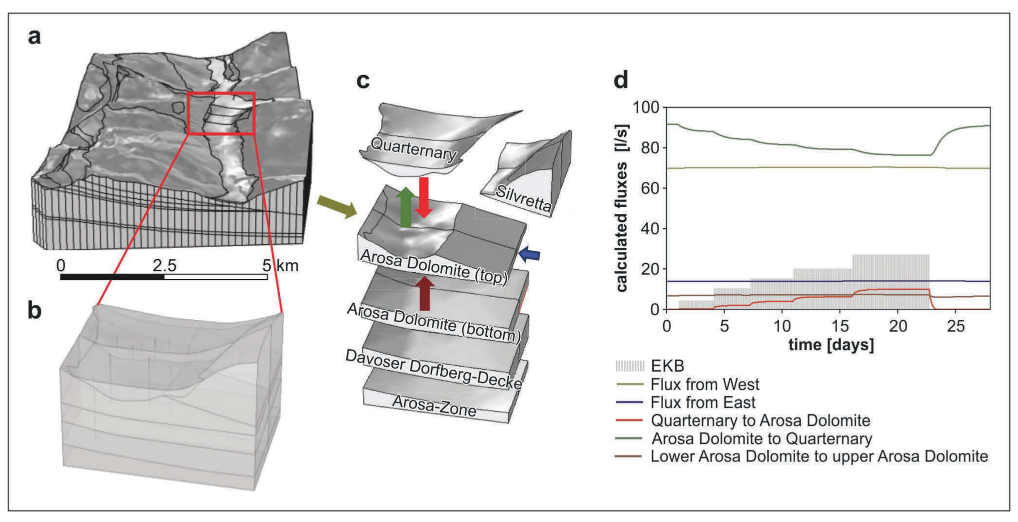

Fig. 3: Hydraulic model with the budget box for the calculation of water fluxes: a) hydraulic model, b) budget box, c) separated volumes of the budget box with the main groundwater fluxes, d) calculated fluxes as a result of the pumping test.

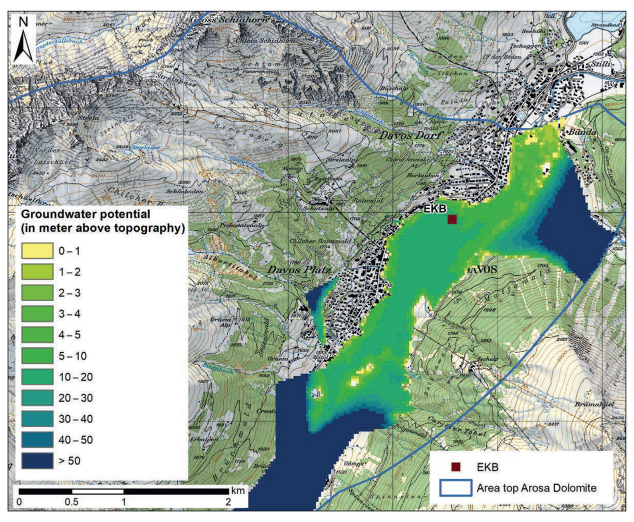

Fig. 4: Calculated groundwater potential for the top of the Arosa Dolomites *(blue border).*

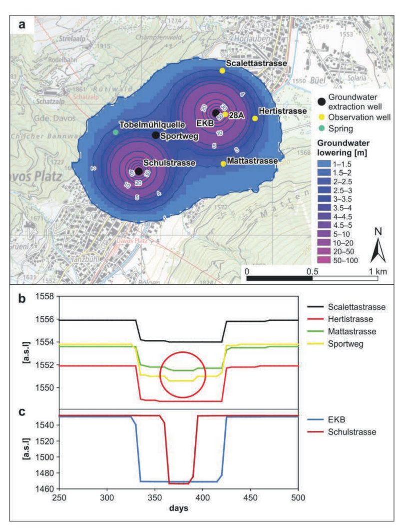

Fig. 5: Mutual influence of two extraction wells.

Conclusions

- The model is an expandable tool for ground-water management (shallow geothermal and regional circulation systems)
- Development of an understanding on ground-water budget and its temporal change
- Changes in the origin of water components of wells at large water withdrawals (see Fig. 3)
- Tool which may clarify changes in the ground-water flow regime
- Groundwater potential maps (Fig. 4)
- Calculations for the mutual influence additional groundwater extraction wells have (Fig. 5)

References:

1. S. Scheidler, B. Anders, C. Regli, S. Bolay, P. Huggenberger, Geothermal use of an Alpine aquifer - Davos pilot study. Grundwasser (2019) DOI: 10.1007/s00767-019-00433-y.
2. S. Scheidler, P. Huggenberger, C. Butscher, H. Dresmann, Tools to simulate changes in hydraulic flow systems in complex geological settings affected by tunnel excavation. *B Eng Geol Environ* 78, 969-980 (2019).
3. C. Butscher, S. Scheidler, H. Farhadian, H. Dresmann, P. Huggenberger, Swelling potential of clay-sulfate rocks in tunneling in complex geological settings and impact of hydraulic measures assessed by 3D groundwater modeling. *Eng Geol* 221, 143-153 (2017).

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