

Integrating geological structures into hydraulic-geothermal models to evaluate the productivity of alpine geological systems

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regio**uisse**

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Interreg
Alpine Space
Greta



Alpine areas

- rising energy consumption
- reduction of CO₂ emissions from heating
- Country-specific regulations and practices
- Potential of Geothermal Energy in the Alpine Space
- Integration into future plans at different administrative levels



SFOE/ANU/Geotest AG

Exploration Drilling 400 m

Hydraulics	Artesian conditions, 2.6 bar	1200 l/min
Aquifer	Dolomites (Arosa Dolomite)	
Depths of Water inflow	150-270 m	Temp. 14 °C
Pumping Test	max 1760 l/min	GW decline 31 m
GW uptake (2012)	100 000 m ³	
Goal GW uptake 2014	2000 l/min	Estimated GW decline 40 m
Origin of pumped water	70-80 Arosa Do and Q/ 30% from the south	
Bachelor Thesis 2015 (C. Eisenring)	Isotope analysis	70-80% young groundwater

GNAMA (Geothermal use of Alpine Aquifers)

Implementation by Geotest AG
and ISSKA

to determine the balance of
usable water and heat
potential with good data

2014

3 GW observation wells

140-170 m

GRETA (Near-surface Geothermal Resources in the Territory of the Alpine Space)

3D Geologic model - hydraulic
model

The objective of the pilot study:

- Development of geological and hydrogeological models
- Understanding complex groundwater systems
- work out the use potential and productivity of shallow geothermal energy from an alpine aquifer, the „Arosa Dolomite“
- calculation of scenarios for geothermal use
- test the effects of changes of hydraulic regimes at different scales

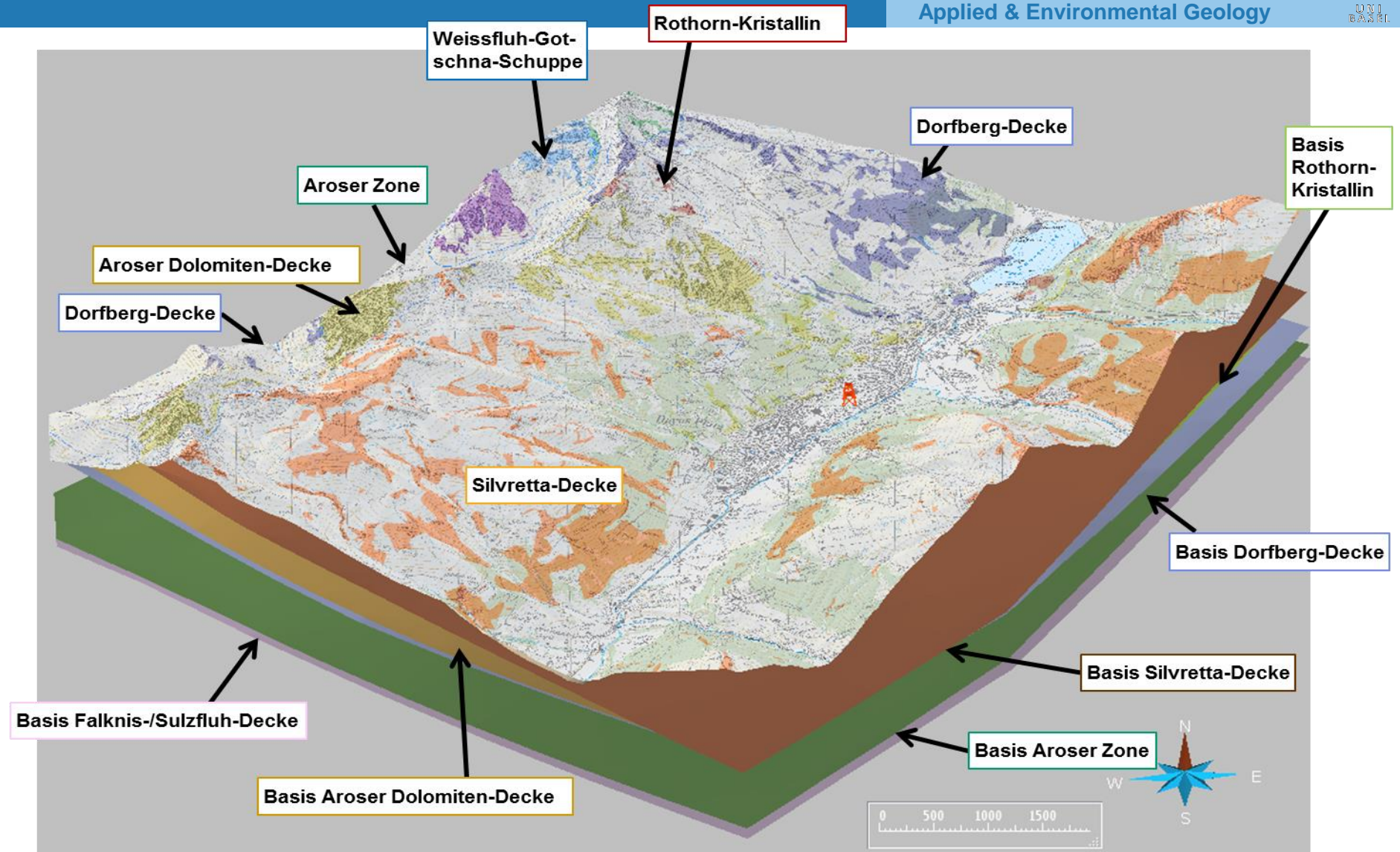

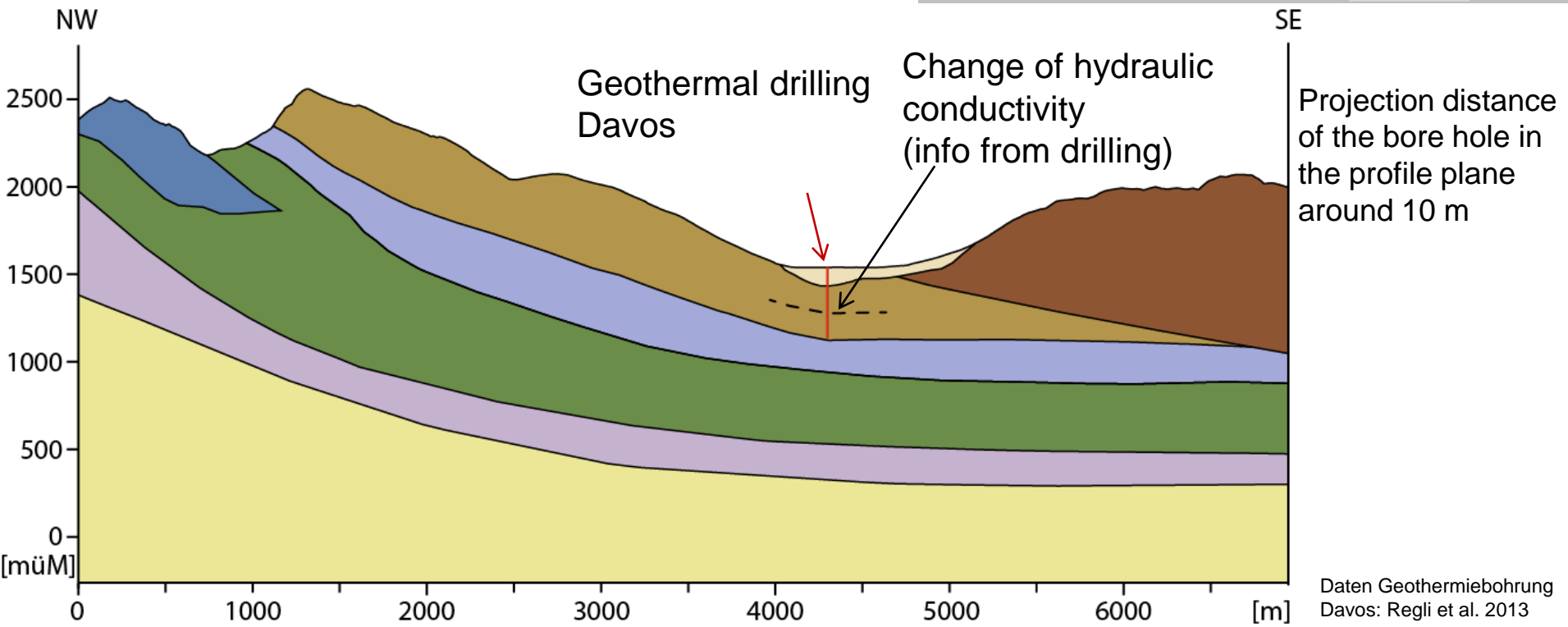
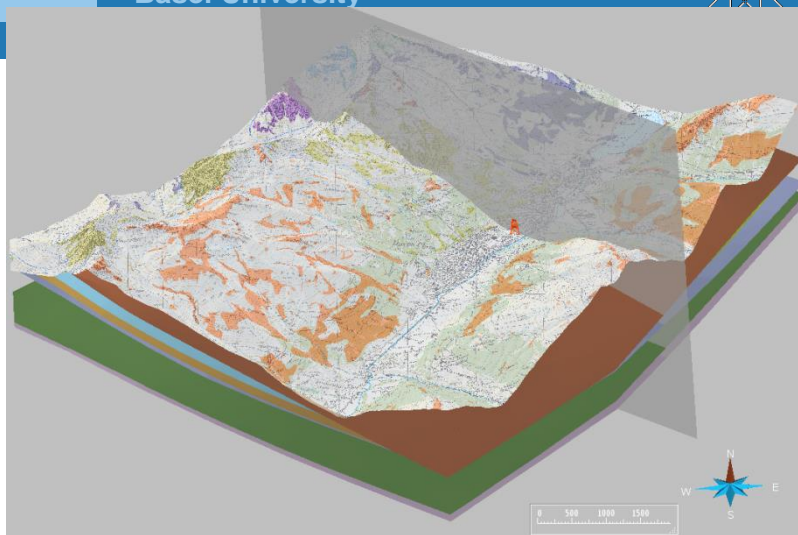


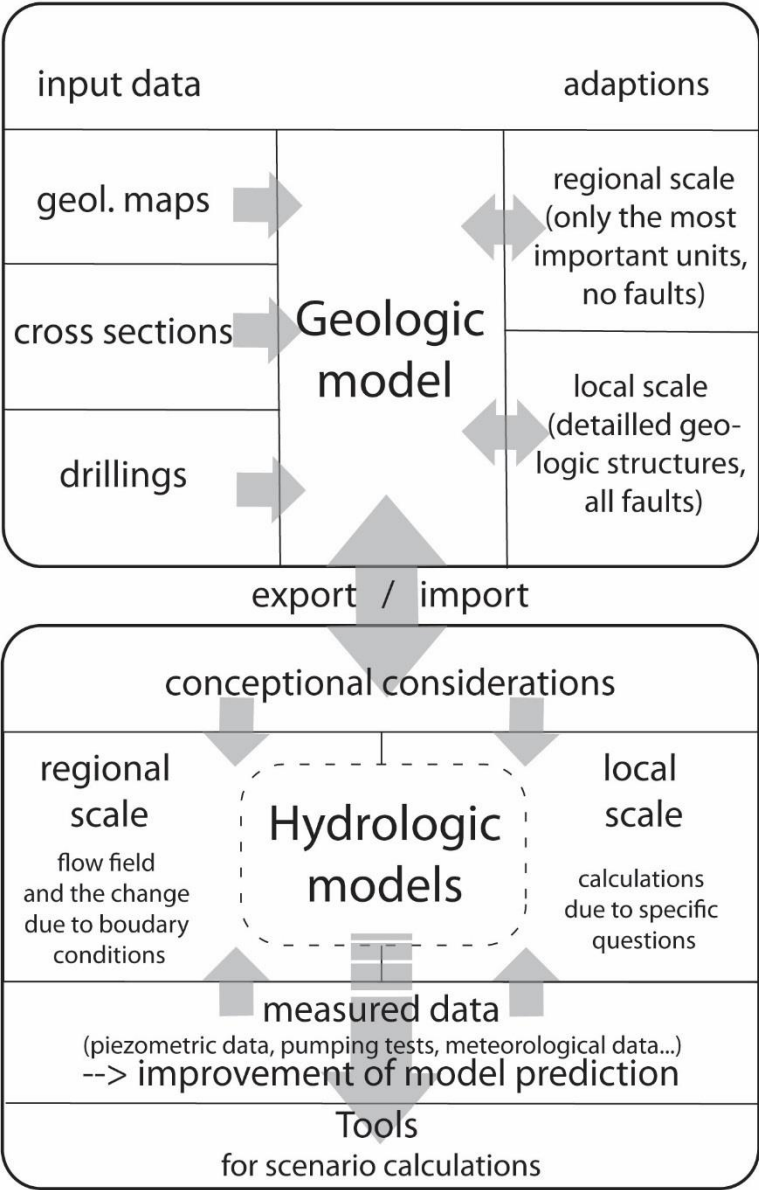
Illustration is vertically exaggerated
Tectonic zones: from WMS server Canton Grisons

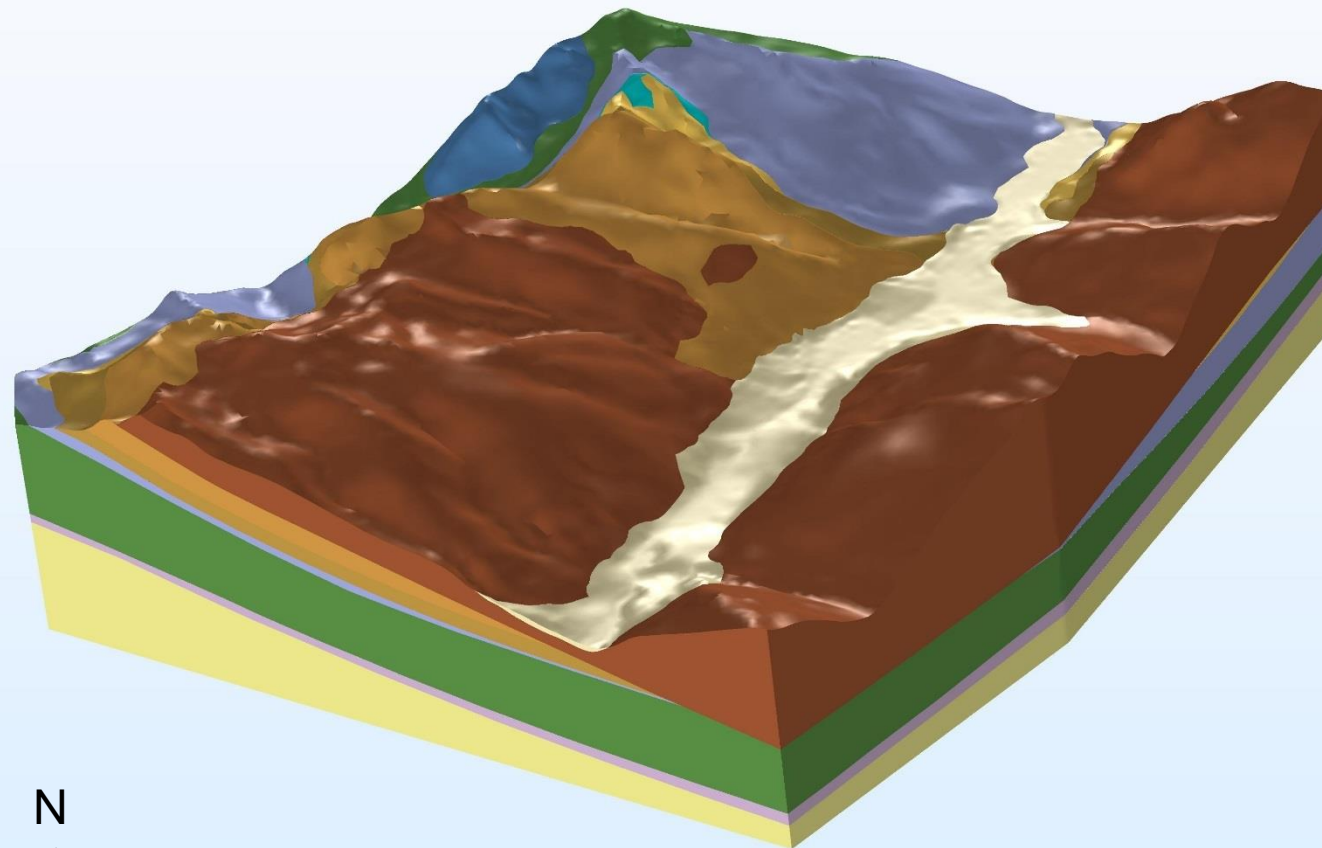
 Geothermal Drilling Davos



target formation







Quaternary

Silvretta Decke

Aroser Dolomiten
Rothorn Schuppe

Weissfluh- Gotschna
Schuppe

Dorfberg Decke

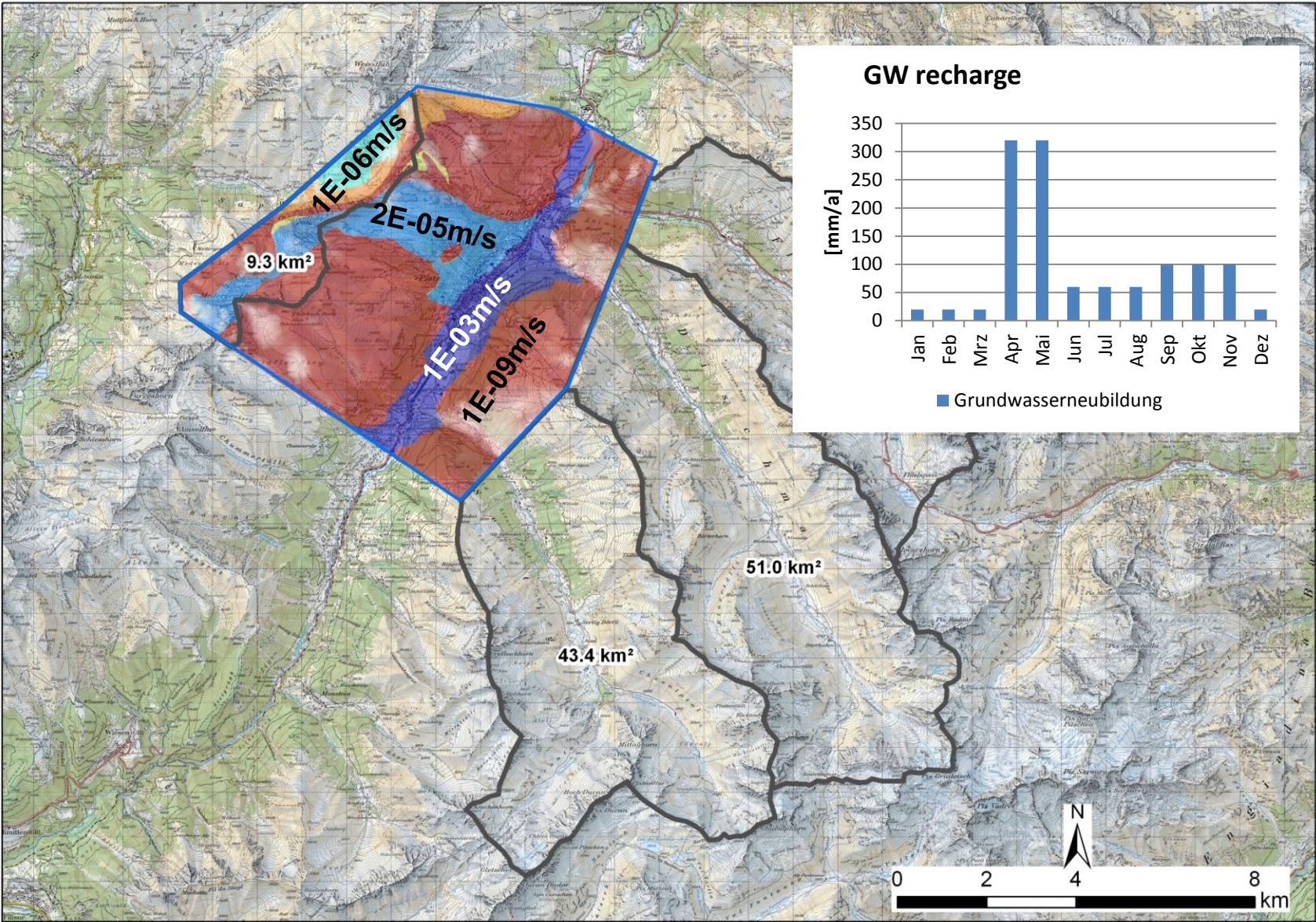
Aroser Zone

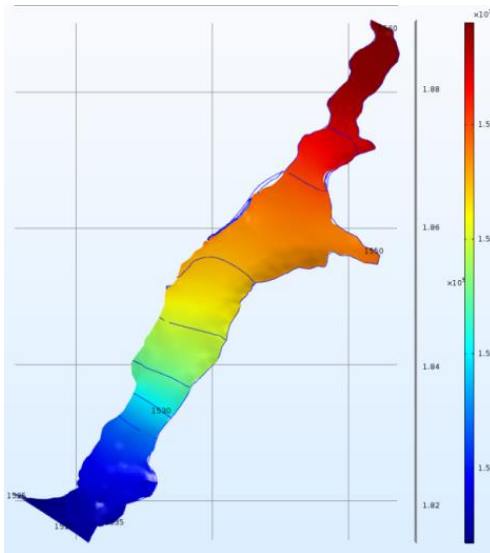
Falknis-/
Sulzfluhdecke

Praetigau Flysch /
Bündnerschiefer

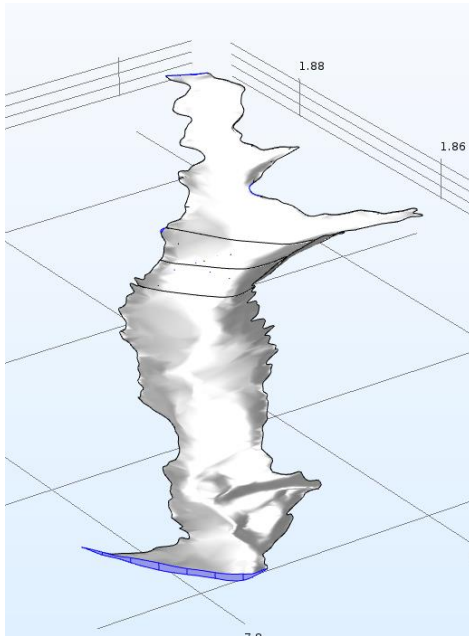


0 2.5 5 km

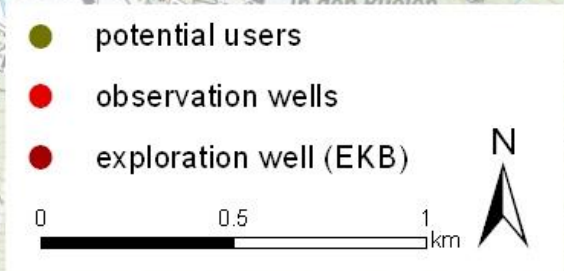




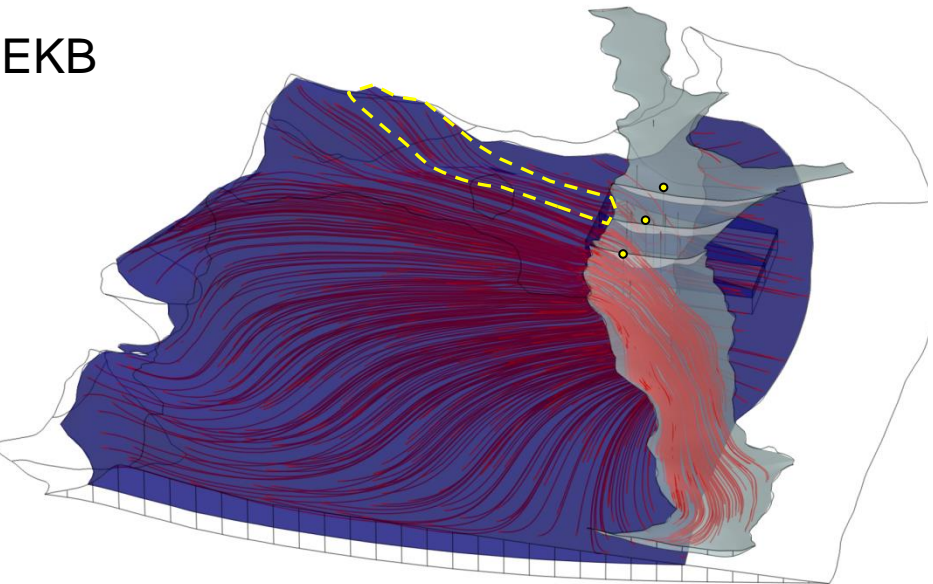
- **Quaternary:** GW levels as «head» boundaries



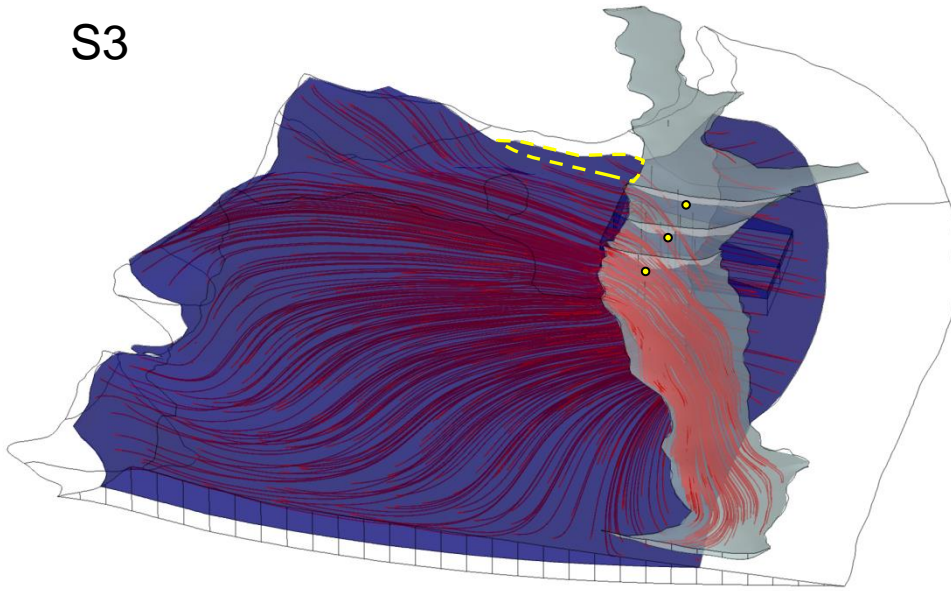
- **Quaternary-AD:** Exchange across boundary Arosa Dolomite-Quaternary as semipermeable Boundary («Conductance») layer with defined hydraulic properties



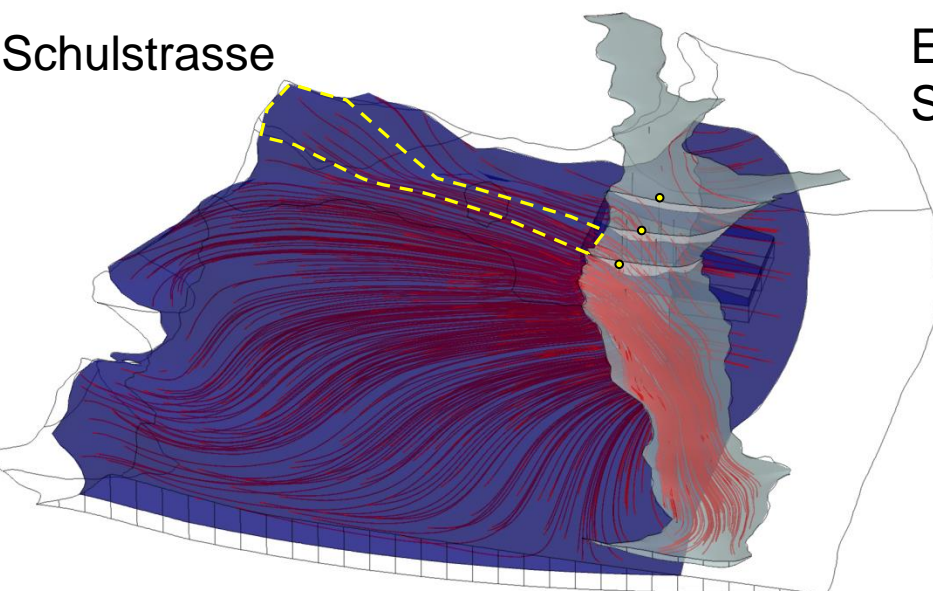
EKB



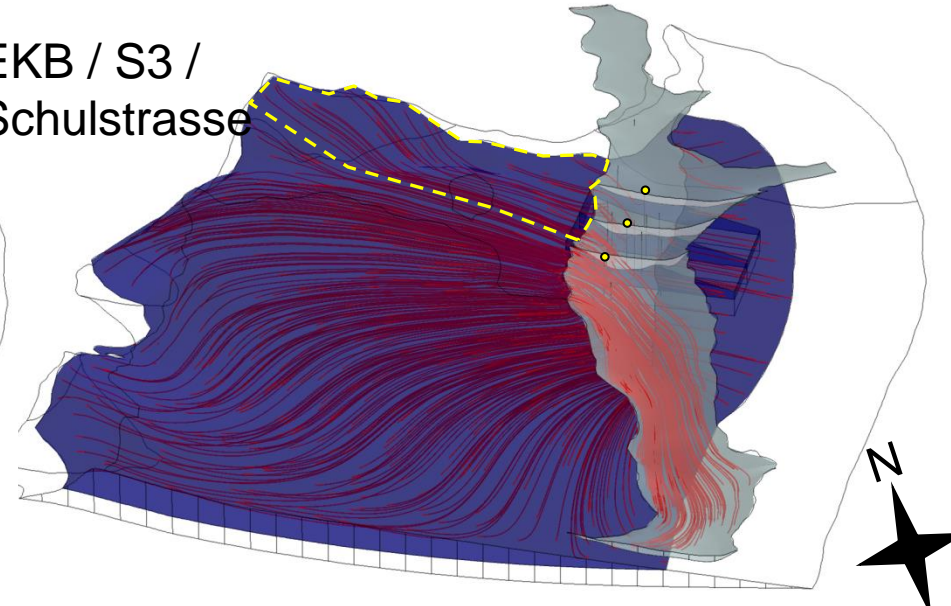
S3

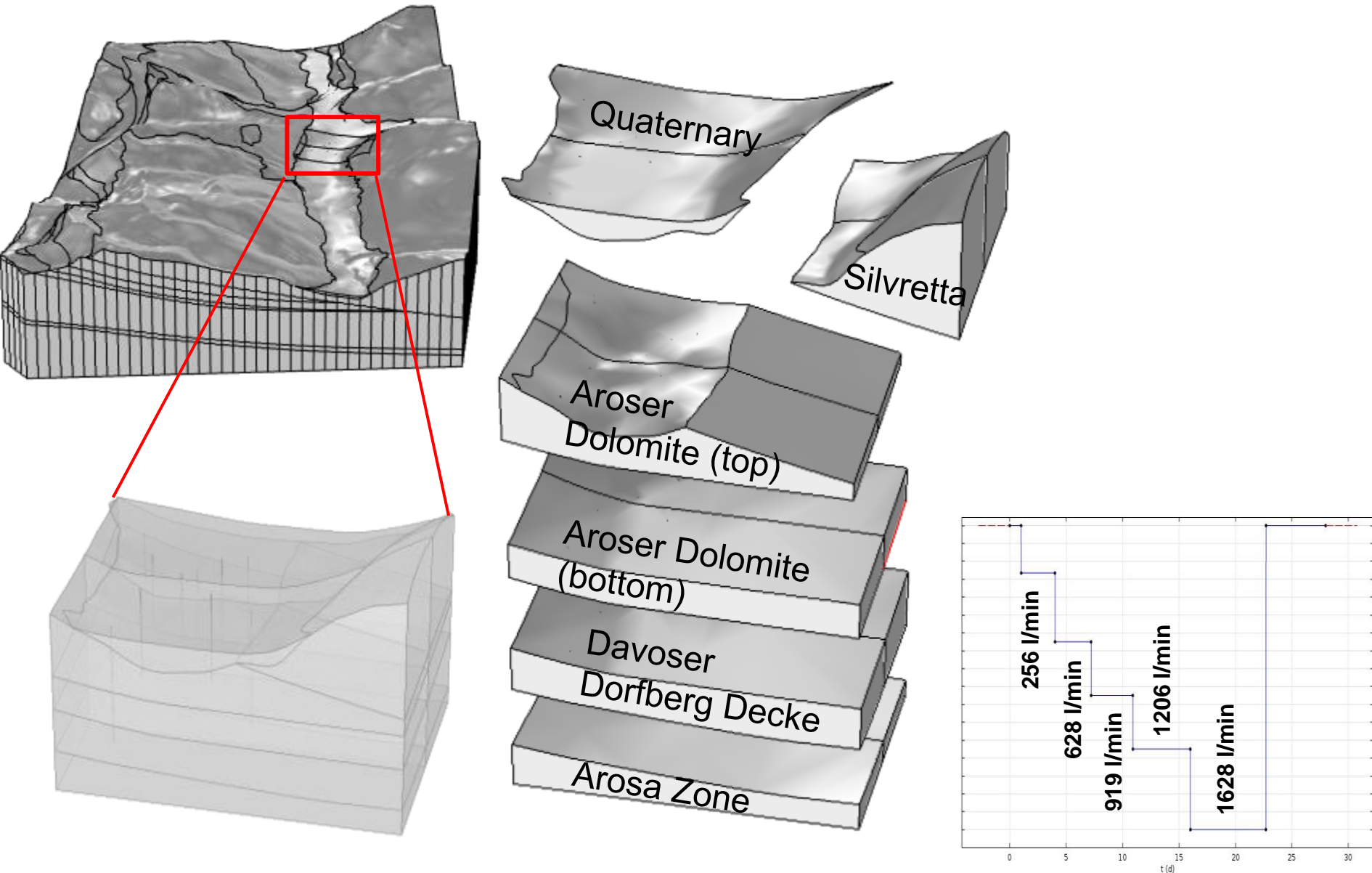


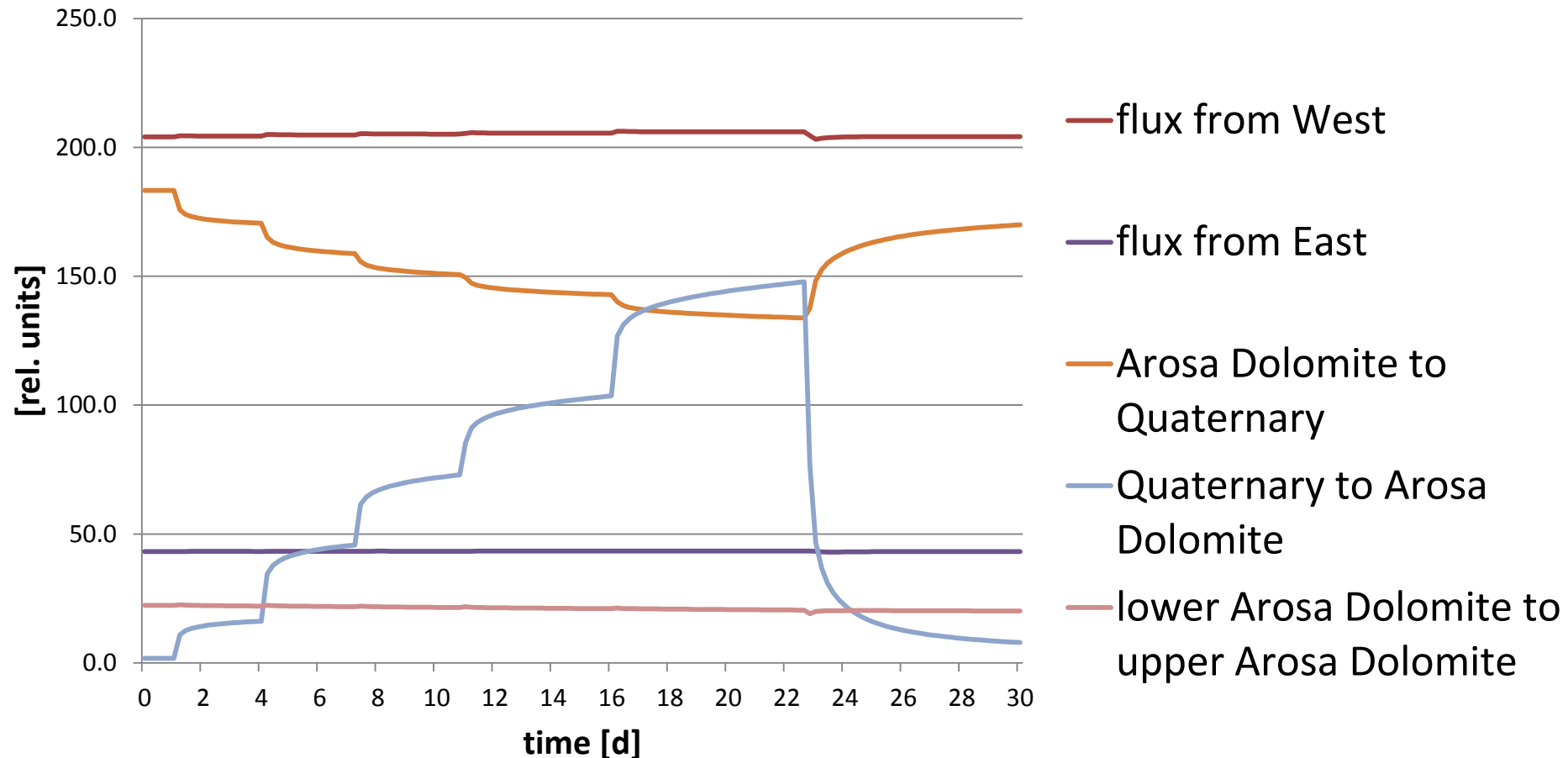
Schulstrasse



EKB / S3 /
Schulstrasse







Model tool allows

- to calculate the head distribution in the Arosa Dolomite in dependence of groundwater discharge
- to simulate response of pumping tests
- to calculate flow budgets from different boundaries
- to visualize the non-stationary capture zones of wells
- to calculate the changing contribution of the Quaternary deposits
- to use szenario techniques

Future

- **How much energy can be produced (Scenarios)**
→ **Potential**
- Coupling of flow and thermal processes



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