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Sub-Urban

TU1206-WG1-017

Basel

TU1206 COST Sub-Urban WG1 Report

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Content

Basel City case study

Brief introduction

The Basel region, which borders both Germany and France, is one of the most dynamic economic regions in Switzerland and acts as a vital regional as well as interregional traffic junction. Moreover, Basel has a variety of natural environments as well as highly vulnerable groundwater systems in river valleys and adjacent karstified areas. Environmental changes include the development of subsurface infrastructure (e.g., tunnel highways) and urban subsurface structures in general which permanently impact groundwater flow and thermal regimes. The existence of evaporites and mixtures of marl-bearing evaporites in the Triassic formations as well as the fact that Basel is located in the seismologically most active area of central Europe come along with the potential occurrence of geohazards. Some of these hazards are natural whereas others are triggered by human activities.

In the last ten years these sites have been equipped with extensive groundwater monitoring systems. At the same time, high-resolution geological and hydrogeological models were set up and calibrated with long-term datasets that allow comprehensive investigations of subsurface resources, groundwater flow regimes and the description of relevant boundary fluxes. The models have predictive capabilities and have already been successfully used for scenario development. These already existing tools provide substantial contributions to the understanding of hydrogeological processes and are the basis for hypothesis testing.

City description

Key city data

Size

- surface area
  Approx. 23 km²
- number of inhabitants
  Approx. 175‘000 (http://www.statistik.bs.ch) without agglomeration

- *density / land use intensity*
  - population
    7,300/km^2 (19,000/sq mi)
    http://www.statistik.bs.ch
  - housing
    http://www.statistik.bs.ch/haeufig-gefragt/wohnviertel.html
  - vehicles
    http://www.statistik.bs.ch/zahlen/tabellen/11-verkehr-mobilitaet.html
  - network infrastructure (transport, communication)
    http://www.statistik.bs.ch/zahlen/tabellen/11-verkehr-mobilitaet.html
  - underground land use
    detailed data are currently in preparation for a publication
    Generally, underground land use in Basel includes several tunnel highways as well as diverse building structures (housing, industry and carparks) which can reach into groundwater and even can be constructed down to the bedrock.
- The city proper itself covers the cantonal area of approx. 23 km², at the border of the city the agglomeration expands seamless to the Swiss cantons Basel-Landscape, Solothurn and St.Louis in France as well as Weil a. R., Lörrach and Grenzach-Whylen in Germany.
- http://www.stadtplan.bs.ch/geoviewer/index.php?cps=2611780.05,1267207.96,10000

Geological setting of the Basel area (after Huggenberger and Epting (2011))

A general overview of the geology in the Basel area is given in Figure 1, with the stratigraphic units being defined in Table 1. The dominant tectonic feature is the eastern master fault of the Southern Rhine Graben separating the Rhine Graben and Tabular Jura. The vertical offset at the border fault of the Rhine Graben is about 1400 m. Within the Rhine Graben (on the down-thrown side), the Mesozoic strata (Triassic to Jurassic; UPM, MES, PCB) are covered by 500 to 1000 m of Cenozoic sediments. Three main Graben structures can be distinguished in the Basel area. The Cenocoic sediments in the area were deposited in the asymmetric syncline of St. Jakob-Tüllingen (SJT) adjacent to the main border fault. To the west the Rhine-Graben then rises to the Horst of Basel (HB). Further west follows the “Allschwil fault zone” (AF), which sets off the Graben sediments in the order of 500 m. The profile provided in Figure 2 illustrates these structures.

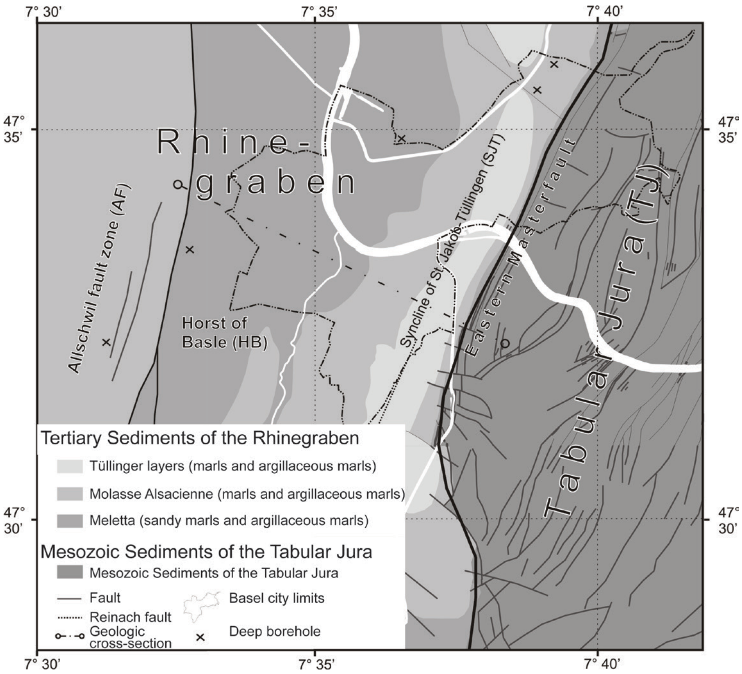

Fig. 1 Geological overview of the Basel area (Huggenberger and Epting 2011, Noack 1993).

The sedimentary composition of the Cenozoic layers to the west of the Rhine Graben master fault is known by outcrops located predominantly at the Graben borders, 6 deep drill holes (>1’000 m), and a dense network of more than 10’000 boreholes (0 to <1’000 m) drilled, e.g., for geotechnical and groundwater investigation purposes (Chapter 4.1). The following formations can be distinguished in the boreholes (Table 1). Argillaceous marls and clays of the Meletta layers (MEL, max. 350 m thick), the sandy “Molasse Alsacienne” (ALS, max. 350 m thick) and Tüllinger layers (TUE, max. 200 m thick) which consist of calcareous to argillaceous marls alternating with freshwater carbonates.

Table 1 Stratigraphic units represented in the 3D-model and their abbreviations (Huggenberger and Epting 2011).

Abbreviation	Stratigraphy
QUA	Quaternary sediments
TUE	Tüllingen layers (Tertiary); marls and argillaceous marls
ALS	Molasse Alsacienne (Tertiary); sandy marls
MEL	Meletta layers (Tertiary); sandy and argillaceous marls
UPM	Lower Tertiary/ first Mesozoic sediments; Sannoisien (Tertiary) and upper Mesozoic sediments down to Lias
MES	Lower Mesozoic; Mesozoic sediments of the Lias and older
PCB	Lowest Mesozoic sediments (“Buntsandstein”), Paleozoic sediments (“Rotliegendes”) and crystalline basement.

To the east of the Rhinegraben master fault the Dinkelberg block as a part of the Tabular Jura is bounded by larger faults such as the Rhine Graben master Fault, the Kandern Fault, the Werratal Fault and the Zeinigen Fault. The block boundary is poorly defined in the South. The entire Dinkelberg block is characterized by a set of NNE-SSE striking narrow Graben structures. The southern part of the Dinkelberg block, the ESE-WNW striking Adlerhof Anticline, represents a compressive structure.

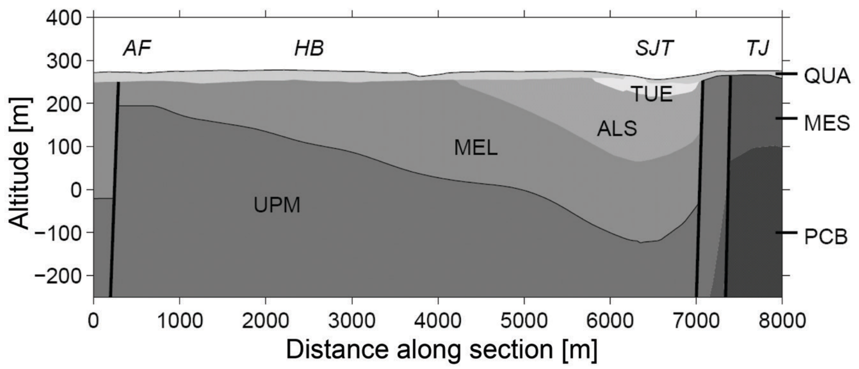

Fig. 2 Geological overview of the Basel area (Huggenberger and Epting 2011, Kind 2002).

The basement rocks from the southern Black Forest have been affected by regional metamorphism, large-scale thrust tectonics and extensive magmatic activity during the Variscan orogeny (e.g., Hann and Sawatzki (2000)). At the end of the Variscan orogeny numerous intramontane basins were formed, as for example the so-called Permo-Carboniferous Basin of Northern Switzerland from the Burgundy to the Lake Constance. With the onset of the Triassic transgression, coastal and marine conditions developed. The principal decollement horizons of the Jura Mountains are Middle and Late Triassic evaporites. From the Late Triassic until the end of the Mesozoic, marine conditions prevailed resulting in a sedimentary stack between 1'000 and 1'500 m thick, and consisting mainly of limestones, marls, and clays. Cretaceous deposits occur only west of the study area. Tertiary deposits are conserved in the Bresse and Rhine Graben as well as in the Molasse Basin. In the Jura Mountains, erosional remnants of Tertiary deposits are only found within synclines (Allenbach and Wetzel 2006).

Due to the slight dip of the Triassic and Jurassic strata to the Southeast, there are areas, where subrosion altered the mechanical behavior of the evaporite zone, which at several locations can resemble more to a non-consolidated rock sequence. The Hauptmuschelkalk is one of the main aquifers in the area and often shows characteristic karst phenomena, which also altered locally the mechanical behavior of this unit.

The Quaternary sediments were deposited in the main river valleys Rhine, Birs and Wiese on a late- to post Tertiary erosional surface. They consist mainly of fluvial gravels that are up to 40 m thick and which are locally covered by Loess. During deglaciation and Holocene times, a series of river terraces formed separated from each other by terrace bluffs. The geometry of the surface morphology gives some indication of the development of the valley fills. Due to the high permeability and porosities, the fluvial gravel deposits represent the most productive groundwater reservoirs in the area. Pronounced sedimentary structures and textures in the gravel deposits are important for the interpretation of the complex groundwater flow field and flow regime.

- **top layer** (soils, sediments, artificial grounds, geotechnical stability, quarrying, archaeology)

  http://www.stadtplan.bs.ch/geoviewer/index.php?cps=2611780.05,1267207.96,10000
- **groundwater** (aquifers, groundwater management)

  http://www.grundwasserleiter-hochrhein.de/index.html
- **mining** (energy and mineral resources, mining legacy)

  http://www.geopotenziale.org/home?lang=2

Full case description

The actual case description is a free exercise as far as I'm concerned. Based on what we heard during the presentations, we will have a very heterogeneous set of cases, ranging from holistic subsurface planning approaches to dealing with very specific challenges. With the above structure we will hopefully achieve common ground and a good basis for comparisons. This will also help me in writing the discussion part and drawing some generic conclusions.

Links to further infornation:

http://www.entwicklung.bs.ch/
http://www.planungsamt.bs.ch/
http://www.pd.bs.ch/
http://www.springer.com/gb/book/9783034801843
http://link.springer.com/article/10.1007%2Fs10040-007-0242-5

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Hann, H.P. and Sawatzki, G. (2000) Neue Daten zur Tektonik des Südschwarzwaldes. Jber Mitt Oberrhein Geol Ver 82:363-376.
Allenbach, R.P. and Wetzel, A. (2006) Spatial patterns of Mesozoic facies relationships and the age of the Rhenish Lineament: a compilation. International Journal of Earth Sciences 95(5), 803-813.