The Vienna Basin Pilot Area

Scenario modelling studies

Scenario 3: Influence of a high permeable porous layer

Annotations to the video

Introduction

For each pilot area detailed scenario modelling studies have been performed during Transenergy. As there are no major hydrogeothermal utilizations yet existing in the Vienna Basin pilot area, the performed scenario modelling was focused on the estimation of resources for a hydrogeothermal doublet use in one of the most promising near-boundary structures of the pilot area – the so called “Wetterstein Dolomite” structure within the Hydrogeothermal Play VB 04 – Juvavic Nappe System.

The Wetterstein-Dolomite geothermal reservoir has been figured out to be the most promising trans-boundary geothermal reservoir in the Vienna Basin pilot area. Because of the high salinity of the thermal waters of this aquifer the trapped thermal water is not suited for balneological purposes. Hence, the only possible utilisation can be a pure energy usage, realized by a doublet installation with complete reinjection of the thermally deployed brine. As this Hydrogeothermal Play has not been used for geothermal use yet, the scenario modelling is focusing und possible future near-boundary utilization schemes.

The main objectives of the detailed scenario modelling are represented by:

Analyses of the hydraulic influence of (i) fault systems and (ii) the geometrical shape of the reservoir on the coupled hydraulic and thermal conditions of different doublet-use scenarios, represented by different locations and operational settings.

Estimation of the technically extractable amount of heat by assuming several hydrogeothermal doublets.

The area of interest shows a lateral extension of about 15 km x 3 km, striking approximately along a SE-NW direction. The river March and the Austro-Slovakian boarder crosses the body right in the middle in N-S direction. On the Austrian side, large parts of the watersides of the river March are protected by “Natura 2000 - European Nature Reserve”. Hence no surface hydrogeothermal installations, such as wells or heating facilities are considered to be legally allowed in this area. In opposite "Záhorie Protected Landscape area" is situated on the Slovakian side along the river Morava / March. Despite of this fact, the location of the Slovakian hydrogeothermal doublets has been set within this protection area nearby the village of Visoká pri Morave. This was done in order to investigate possible trans-boundary hydraulic flow and thermal influences at the reservoir.

In this study the existence of a highly conductive layer at the lowermost 50 meters of the Neogene sedimentary deposits upon the reservoir is assumed, which may lead to thermal shortcuts. Additionally, the well screens on the Austrian side are set directly underneath the brecciated high permeability layer to demonstrate a quick thermal breakthrough. Both wells of the Austrian doublet are in addition located outside the fault zone in order to enhance the fluid flow through the highly conductive breccia. In contrast the production well of the Slovakian doublet is located inside the fault zone.

Description of contents shown in the video

Scene 1: Introduction

The area of interest is located at the central part of the Vienna Basin Pilot Area at the border region between Marchegg (Autria) and Malacky (Slovakia). Arrows are marking the estimated flow direction between the two wells of the Austrian doublet (Sch-2 – Sch-T1) and the Slovakian doublet (SK-2 – SK-3).

Scene 2: Geometry

Is showing the meshed volume of the thermal water reservoir. Light lines represent the positions of the screen sections of the Austrian and Slovakian doublet. Later, the red colored symbols show the individual nodes, at which the water transfer was realized (pumping or injection). Instead of applying a homogenous line source in order to simulate the screen sections of the wells, we have applied individual point sources (nodes) in order to consider the inhomogeneity of the reservoir. Above the wells there is the highly conductive breccia zone realized by a finer mesh.

Scene 3: Heat and fluid transport

This scene combines the flow paths (streamlines) of the moved water particle due to the circulation between the wells of the doublet with the thermal plume as well as with a temperature profile (graph) at the production well. The blue colored surfaces at the thermal plume represent zones of a relative temperature attenuation of 5K considering the initial situation. In contrast, red colored surfaces represent a temperature rise of 5K. The temperature attenuation is caused by the injected cold water plume of the doublet. The temperature rise is instead caused by hot water from the deeper parts of the reservoir, which has been displaced by the cold water plume or pulled to the production well at highly conductive fault zones offering a vertical flow path.

At the Austrian doublet the cold water quickly propagates along the highly conductive basal breccia causing a thermal breakthrough after an operational period of 10 years. The thermal breakthrough is characterized by a very steep decrease of the production temperature at a range of 15K after a period of 100 years. In contrast no thermal breakthrough is observed at the Slovakian production well, although propagating at a certain extent through the overlaying porous layer. The main difference is given by the fact, that the production well is located at the highly conductive fault zone, so that the pressure change due to pumping is favorably propagating through the fault zone. For that reason a minor raise of the water temperature can be observed in the production well.

Scene 4: Map view of the thermal plume after 100 years of operation

The final map view shows the temperature decrease as a consequence of cold water injection after a period of 100 years. While the major part of the cold water plume is passing through the overlaying porous layer, the dominant share of the plume is remaining in the basement reservoir rocks around the Slovakian injection well. However, as the map shows, there is some significant fluid flow across the overlaying porous layer at the Slovakian part of the study area, but at a lower flow velocity. The decreased velocity leads to a better thermal heat transfer between the circulating fluid and the surrounding rock matrix and as a consequence attenuates the cold water plume.