TRANSENERGY

Transboundary Geothermal Energy Resources of Slovenia, Austria, Hungary and Slovakia

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Session Geothermal: GIS and Databases
OUTLINE

- Introduction
  - The Western Pannonian Basin
  - Goals of TRANSENERGY
  - Approach & workflow

- Preliminary Results

- Lessons Learned (so far)

- Outline: Web-based dissemination

http://transenergy-eu.geologie.ac.at
The TRANSENERGY Region (western Pannonian Basin)

- Home of more than 10 mio. inhabitants.
- Involving 4 different EU member states (A, H, SK, SLO).
- Mainly represented by the western Pannonian Basin.
- Intra-mountainous basins (Vienna Basin, Styrian Basin, Zala Basin)
- Confined by Alpine, Carpathian and Bakony Orogeny
The TRANSENERGY Region (western Pannonian Basin)

- Situated at the transition zone between Alps Carpathians and Dinarides
- Extensional basins with strong strike-slip component (Miocene to present)

Tectonic map of the Mediterranean (Woudloper, 2009)
The TRANSENERGY Region (western Pannonian Basin)

- Crustal stretching leading to a significant heat-flux anomaly...

Heat Flow Map of Europe (Cernak & Rybach, 1979)
The TRANSENERGY Region (western Pannonian Basin)

- Active recharge at the margin of the Basin leading to various hydrodynamic systems....

- Different hydrogeothermal reservoir types
  
  (1) Miocene basin fillings
  
  (2) Fractured basement rocks

- Closed- as well as open systems leading to heterogeneous conditions!

Hydrogeological cross section through the southern Vienna Basin (Schubert, 2008)

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The TRANSENERGY Region (western Pannonian Basin)

- The Neogene reservoirs (porous basin fillings)....

Hydrogeological map of Europe (UNESCO), edited
The TRANSENERGY Region (western Pannonian Basin)

- The basement reservoirs (fractured and karstified sedimentary rocks)
The TRANSENERGY Region (western Pannonian Basin)

- A region of intense geothermal utilization...

- Thermal Spas
- Electric power generation (ORC)
- Heat Supply

- Dunajska Streda
- Murska Sobota – district heating
- Thermal well Patnice

- Bad Voeslau near Vienna
- ORC unit at Bad Blumau
- Spa Bad Blumau designed by Friedensreich Hundertwasser
- Bükfürdő
The TRANSENERGY Region (western Pannonian Basin)

- And conflicts…

- Overexploitation
- Environmental impacts due to single well use
- Mining (de-watering)
- Conflicts of interest with hydrocarbon industry
- Water supply

- Note that most of these conflicts affect >1 countries

- Overexploitation

- Environmental impacts due to single well use

- Mining (de-watering)

- Conflicts of interest with hydrocarbon industry

- Water supply

E.g. Lutzmannsburg – Zsira Region

- Water level drawdown due to intense balneological use

E.g. Raaba River

- Water pollution at Raaba River probably caused by injection of reservoir fluids

Note that most of these conflicts affect >1 countries
The TRANSENERGY Project (2010 – 2013)

- Implemented through the CENTRAL EUROPE program, co-financed by the ERDF.
- Area of Intervention 3.1. (Developing a high quality environment by managing and protecting natural resources).
- Central aim: User-friendly web-based decision supporting, which transfers expert know-how about hydrogeothermal utilization (single-well – balneology and doublets – geothermal energy) and sustainable reservoir management to stakeholders.
- No scientific research project but science based policy supporting!
The TRANSENERGY Project (2010 – 2013)

- **Central aim:** User-friendly **web-based decision supporting**, which transfers expert know-how about **hydrogeothermal utilization** (single-well – balneology and doublets – geothermal energy) and sustainable reservoir management to stakeholders.

- Assessment of geothermal potentials at different levels (HIP, LTP, LEP)
- Complex evaluation of thermal groundwater bodies (quality and quantity)
- Scenario models for different water extractions: predictable changes
- Experiences of present (cross-border) interactions, recommendations for harmonized management and sustainable utilization
- 2 different scales (supra-regional, pilot areas)
- Existing use and stakeholder requirements
- Interactive web-portal

[Interactive web-portal](http://transenergy-eu.geologie.ac.at/)
The TRANSENERGY Project (2010 – 2013)

Strategic Management Board

WP1: Project management and coordination

WP2: Communication, knowledge management and dissemination

WP3: Utilization aspects

WP4: Transnational data management

WP5: Cross-border geoscientific models

WP6: Implementation tools for transboundary geothermal resource management

External Evaluation Board

The Transenergy EEB board consisting of:
- Representatives from federal authorities
- Representatives from regional authorities
- Industrial representatives (heat & energy supply)
- Users (spas)
- International associations (IGA, EGEC)

- Web-based multilingual resource information tool
- Strategy paper on geothermal use in the Western Pannonian Region

http://transenergy-eu.geologie.ac.at
WP 5 Cross-border geoscientific models

- **Supra-regional scale** (1:500k)
  - Geological Model (2D, 3D?)
  - Hydrological Model (2D, 3D?)
  - Geothermal Model (2D, 3D?)

- **Pilot areas** (1:100k, 1:200k)
  - Vienna Basin (3D)
  - Danube Basin (3D)
  - Lutzmannsburg Area (3D)
  - Bad Radkersburg – Hodos Area (3D)
  - Komarno – Sturovo Area (3D)

Geological Models
- Hydrological Models
- Geothermal Models

Hydraulic BC

Thermal BC
Geological Models

Supra-regional Scale

- Still under progress…

- Different kind of input data (borehole data, grids)
- Compiled geological surface map (1:200k)
- Countour maps of 8 main units
  - Base of the Quaternary formations (Pre-Quaternary)
  - Base of the Upper Pannonian formations (base of delta front sands)
  - Base of the Lower Pannonian formations (Pre-Pannonian)
  - Base of the Sarmatian formations (Pre-Sarmatian)
  - Base of the Badenian formations (Pre-Badenian)
  - Base of the Neogene formations (Pre-Neogene)
  - Base of the Cenozoic formations (Pre-Cenozoic)
  - Base of Cretaceous formations (Pre-Cretaceous)

- Aims to provide geometrical framework for thermal and hydraulic modelling!
Geological Models

Pilot Areas

- Launched…
- Individually prepared by 1 responsible partner
- Provide geometrical framework for later hydraulic and thermal modeling
- Different types of input data and approaches

<table>
<thead>
<tr>
<th>Area</th>
<th>Type of Input Data</th>
<th>Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vienna Basin</td>
<td>Borehole data, contour maps, cross-sections</td>
<td>GOCAD™, Geomodeller™</td>
</tr>
<tr>
<td>Danube Basin</td>
<td>Borehole data, contour maps, seismic data</td>
<td>Petrel™</td>
</tr>
<tr>
<td>Lutzmannsburg - Zsira</td>
<td>Borehole data, contour maps, seismic data</td>
<td>JewelSuite™</td>
</tr>
<tr>
<td>Radkersburg - Hodos</td>
<td>Borehole data, contour maps, seismic data</td>
<td>JewelSuite™</td>
</tr>
<tr>
<td>Komarno - Sturovo</td>
<td>Borehole data, contour maps, seismic data, gravimetric maps</td>
<td>JewelSuite™</td>
</tr>
</tbody>
</table>
Geological Models

Pilot Areas

- Geological 3D Models at the pilot areas based on different approaches

Model of the Komarno – Sturovo pilot area established with Jewel Suite™

Model of the Danube Basin pilot area established with Petrel™
Hydrological Models

Supra-regional Area

- Launched…

**Objectives:**
- Main flow systems and their relation
- Regional scale hydrological processes
- Serve BC for local scale modeling (pilot areas)

- 2D modeling (MODFLOW™)
- Stepwise increasing complexity (top ➔ basement)

**Input Data:**
- Gauging stations
- Hydraulic classified surface
- Precipitation
- Evapotranspiration

**Calibration and validation**
- Observed pressure at wells
- Hydrochemical attributes and isotopes

Used gauging station network at main rivers within the project area

Hydraulically classified geological surface map

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Geothermal Models

Supra-regional Area

- In progress…

- Objectives:
  - Provide thermal BC for local scale modeling
  - Geothermal resource estimation (qualitative and quantitative)

- Step 1: interpolation based on individually provided data

- Step 2 (aimed): 3D pure conductive modeling using Comsol Multiphysics™

- Input Data:
  - Calculated surface HFD (1D processing)
  - Interpolated and extrapolated borehole temperatures (BHT, DST, logging)

- Calibration and validation
  - Corrected BHT
  - DHT temperatures
  - Logs (as far as available)
  - Existing maps

Available observed HFD at boreholes within the project area

Existing HFD maps covering parts of the project area: above – SK; beyond - H

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Geothermal Models

Supra-regional Area

- **Compiled HFD map**

  - Low correlation with lithosphere thickness (regional HFD trend)
  - Strong local to regional scale influence of descending surface waters at mountain ranges
  - Significant regional scale HFD anomaly at southwestern part of project area
  - Local scale anomalies due to thermal water ascent
**Geothermal Models**

**Supra-regional Area**

- *Compiled Temperature Maps*

Combination of crystalline basement relief and 150°C isothermal surface at the Austrian part of the project area (Vienna Basin)

Combined geological and thermal cross section through the Vienna Basin (extracted from GOCAD)
Lessons learned (so far)

General Approach

- Scientific questions (utilizations aspects) vary significantly within the project area …. even partly at national level!
- … resulting in geological different targets and varying approaches!
- Harmonization of input data a greater challenge as assumed (e.g. data policy at national level)

Geoscientific Models

- Harmonization of geological units great challenge due to different geological targets
- Technical challenges due to heterogeneous type of geological input data (grids vs. boreholes and contour lines)
- … led to delays concerning the supra-regional scale geological model!
- Harmonization of HFD data with less effort than expected
Outline (interactive web-portal)

- Reports (WP3.. WP6)
- Multilingual database
- WMS or/and WFS services
- Interactive maps
- 3D model viewer (static models)
- Scenario modeling based on pre-calculated solutions (php)

http://www.geotis.de/

http://www.thermogis.nl
TRANSENERGY

Transboundary Geothermal Energy Resources of Slovenia, Austria, Hungary and Slovakia

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