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Future hydrogeothermal resource management and mitigation of utilization conflicts based on numerical modelling in the frame of the Central Europe project

Transenergy

The Vienna Basin Pilot Area

G. Goetzl (Geological Survey of Austria)



**EUROPEAN GEOTHERMAL CONGRESS,
PISA 3 – 7 JUNE 2013**

THE PROJECT TRANSENERGY

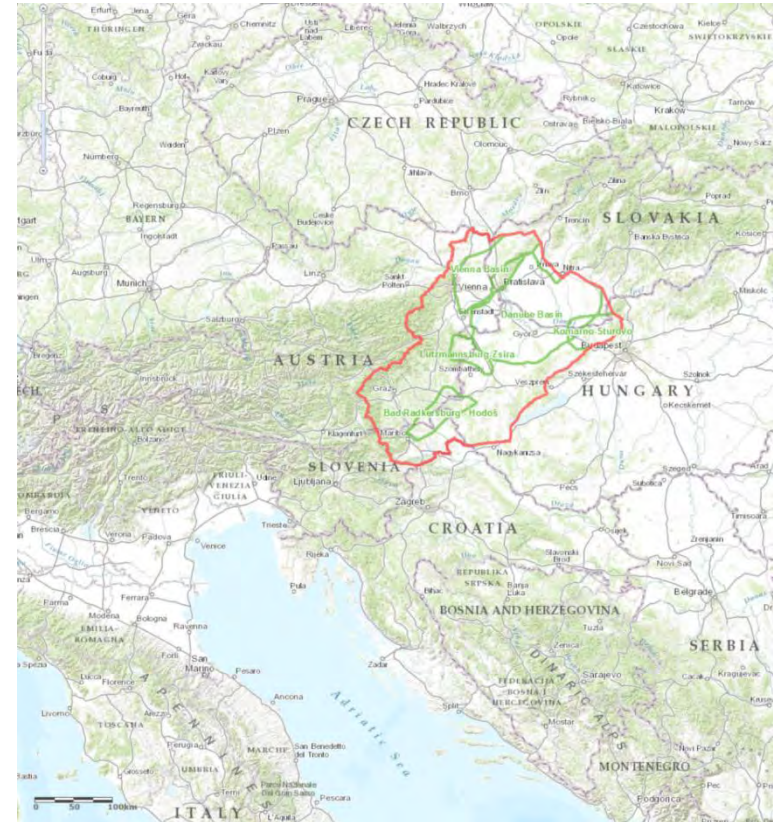


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TRANSENERGY – Transboundary Geothermal Energy Resources of Slovenia, Austria, Hungary and Slovakia” (2010 – 2013)

- **Funded by** CEU Program, Area of Intervention 3.1. (developing a high quality environment by managing and protecting natural resources)
- **Geographical Focus:** Western Pannonian Basin
- **General aims:** Support future management of transnational hydrogeothermal resources.
- **5 Pilot areas:** Different objectives and scientific questions using harmonized approaches.
- **Vienna Basin pilot area:** Great future potential (AT, SK), minor existing utilization.

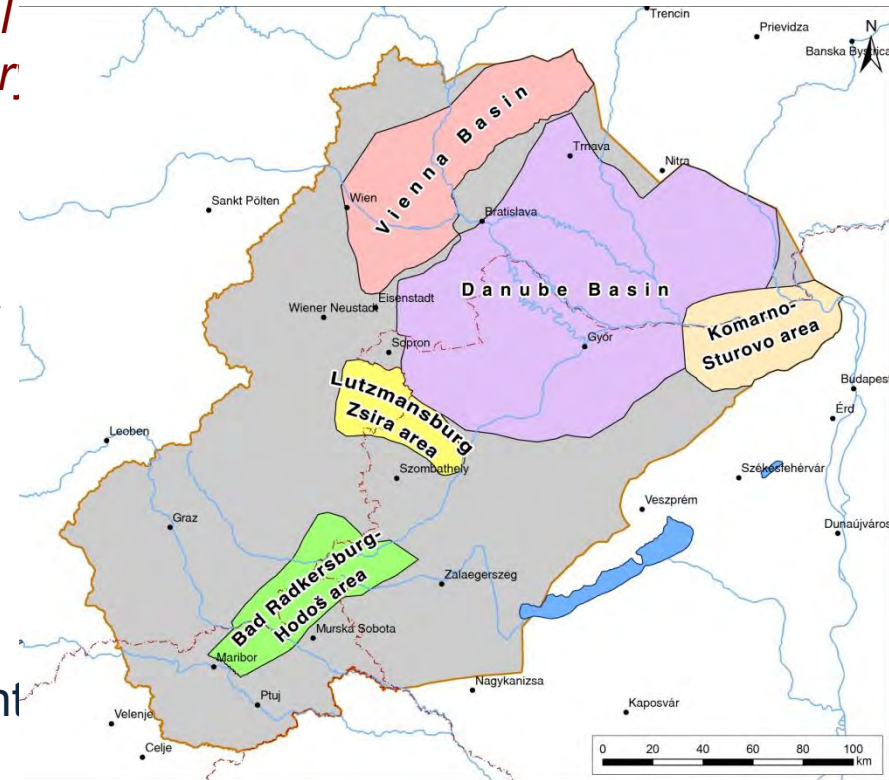


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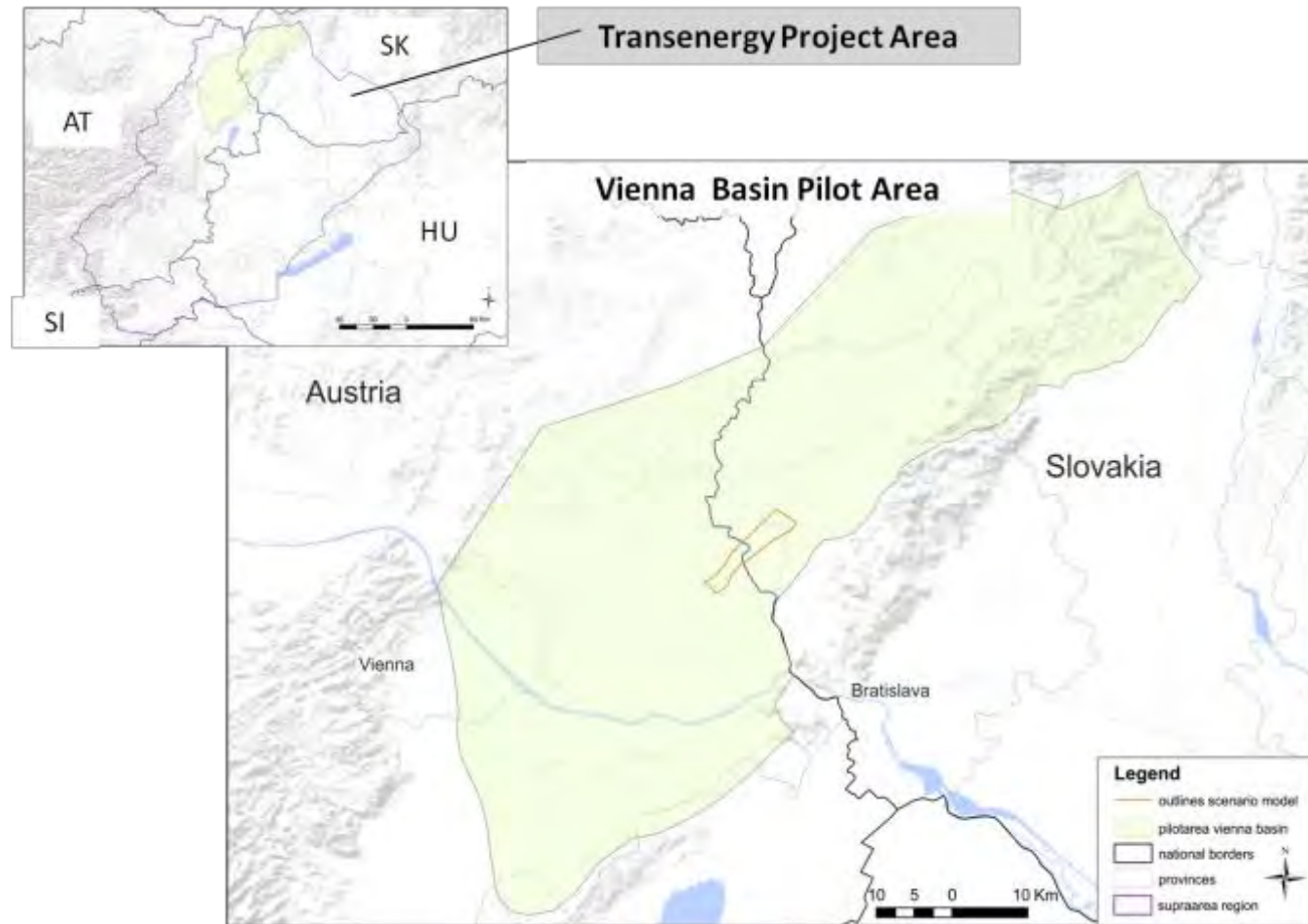


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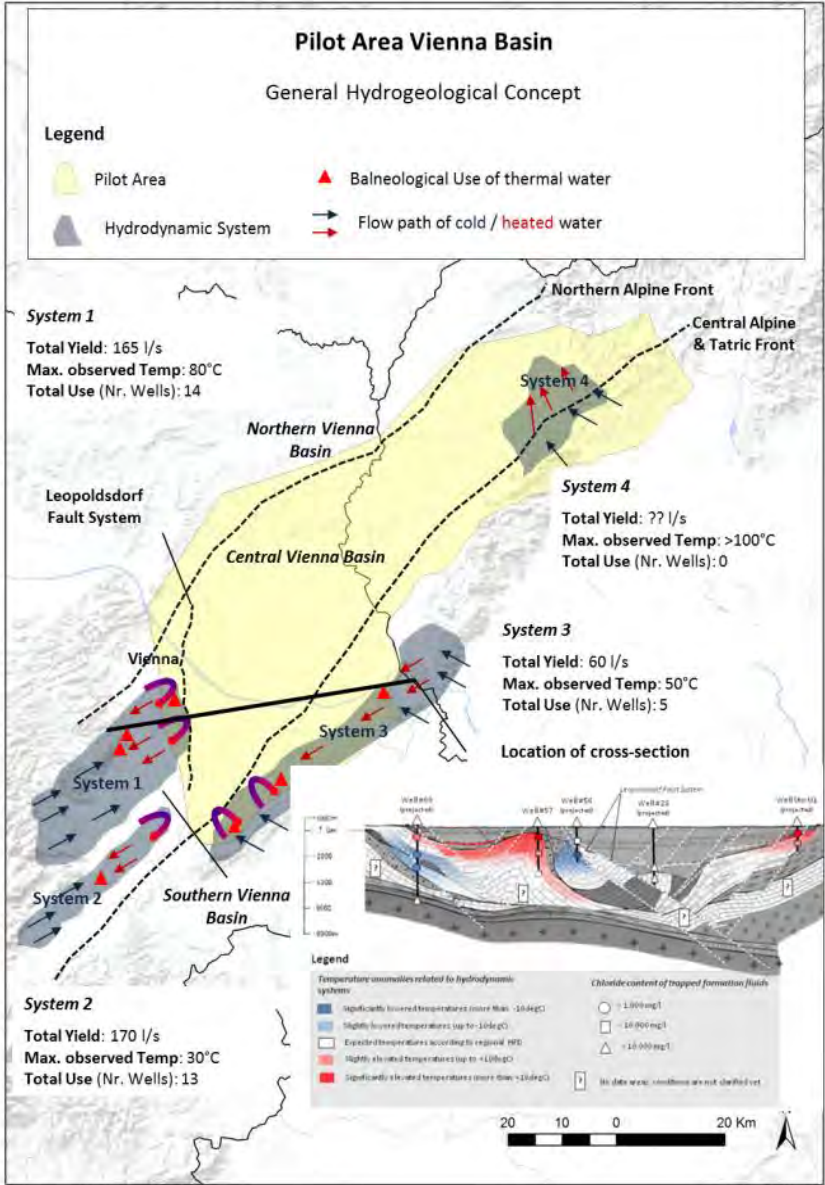
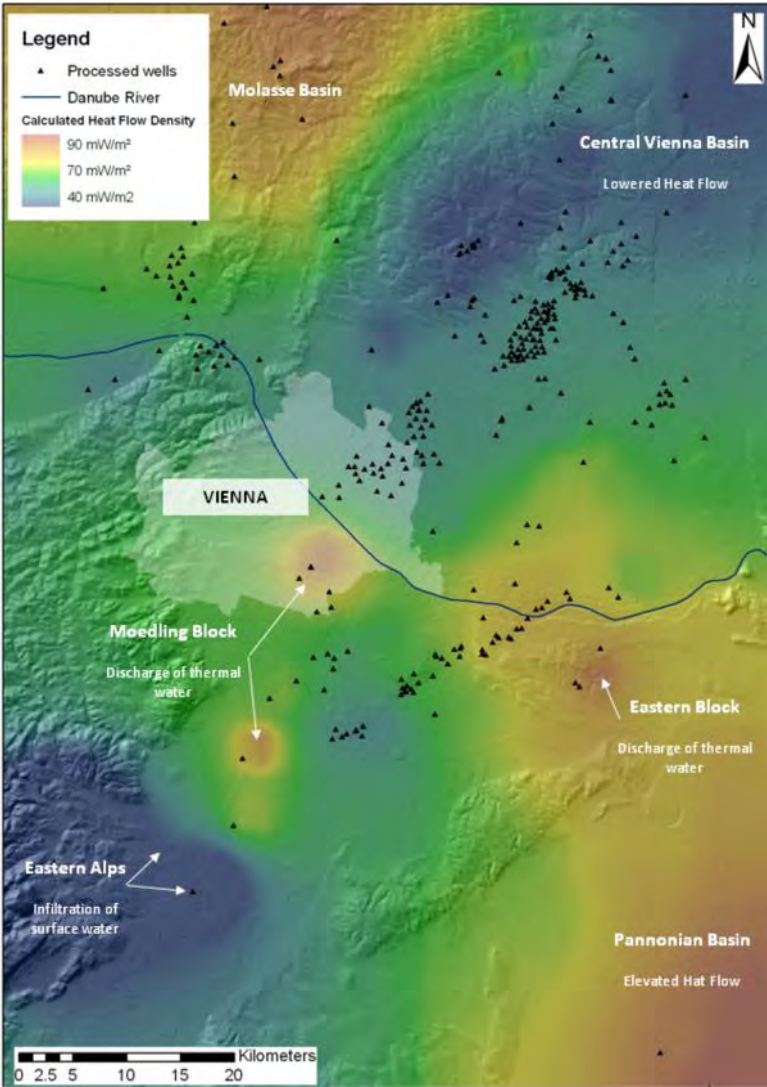
THE VIENNA BASIN PILOT AREA

Geographical Settings



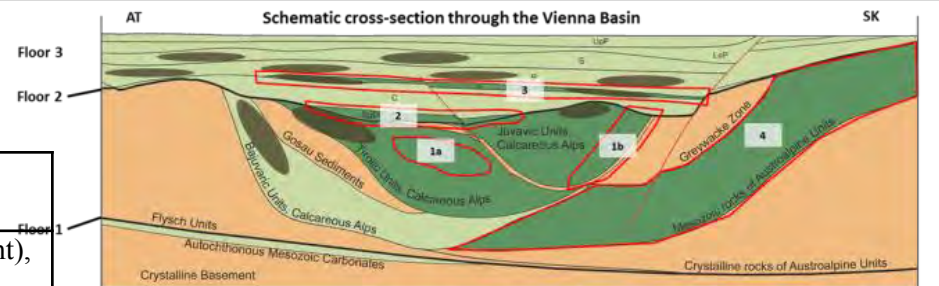
Vienna Basin Pilot Area

Hydrogeological & Geothermal Settings

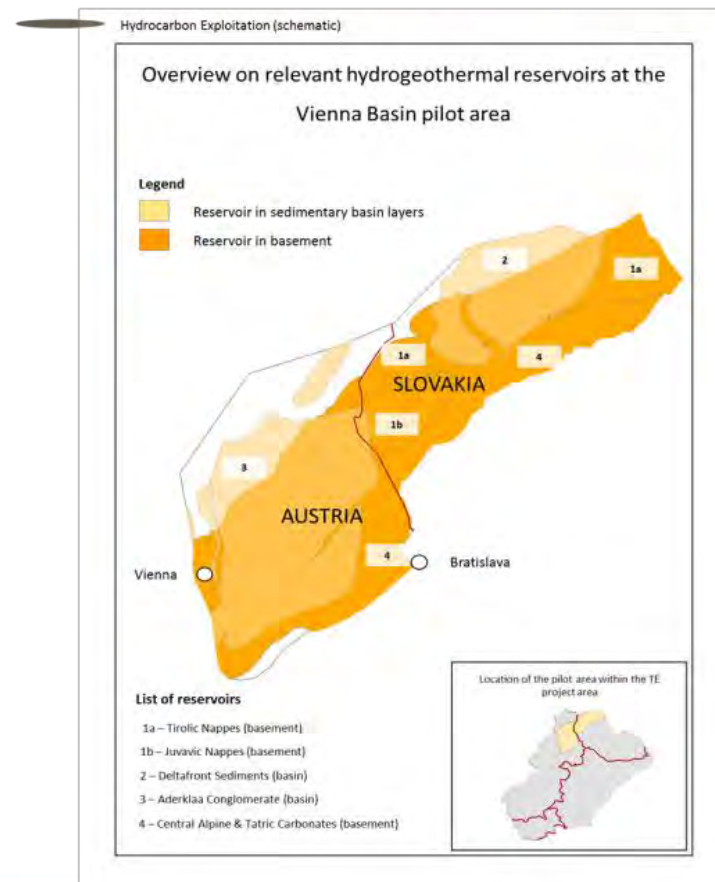


Identified Hydrogeothermal Plays

ID	Name	Description
1a	<i>Tiroler Nappes</i>	Upper Austroalpine Units (basement), fractured reservoir (Dolomite & Limestone), connate water, slightly overpressured
1b	<i>Juvavic Nappes</i>	Upper Austroalpine Units (basement), fractured reservoir (dolomite & limestone), connate water, hydrostatic pressure
2	<i>Deltafront Sediments</i>	Neogene basin fillings, porous reservoir (sandstone), connate water, hydrostatic pressure
3	<i>Aderklaa Conglomerate</i>	Neogene basin fillings, porous reservoir (conglomerates), connate water, underpressured due to hydrocarbon exploitation
4	<i>Central Alpine & Tatric Carbonates</i>	Fractured basement rocks (dolomites and sandstones), partly active recharge, existing utilizations (balneology)



UpP - Upper Pannonian, LoP - Lower Pannonian, S - Sarmatian, B - Badenian, A - Aderklaa Conglomerate C - Carpathian, EgOt - Eggenburgian, Ottangian



OBJECTIVES & APPROACH

Main Objective

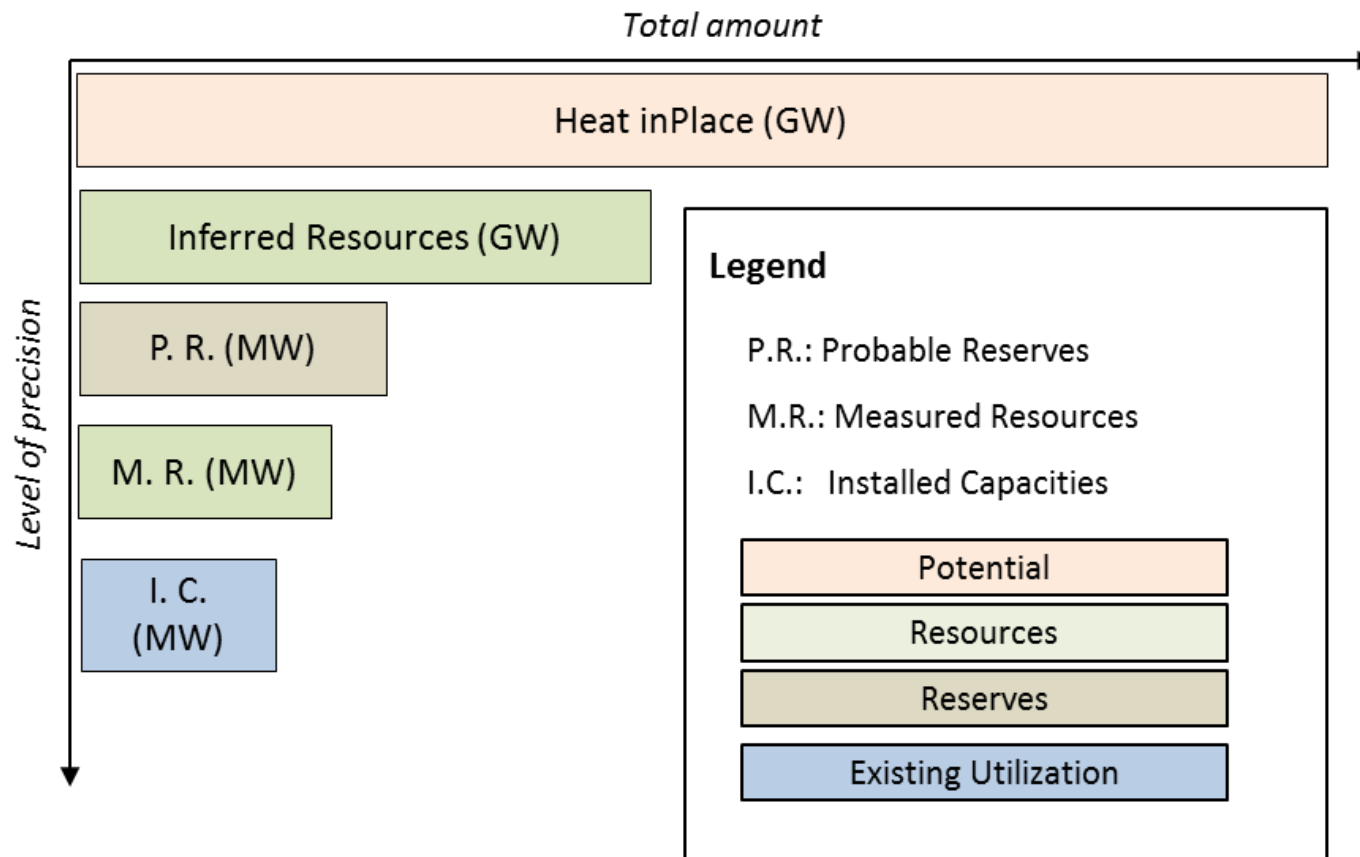
Providing the necessary data fundament (models) for future resource management and monitoring (baseline estimation)

Workflow & approach

3D regional scale geological & thermal model	<i>GOCAD, Comsol & FEFLOW (pure conductive)</i>
Resource evaluation (regional scale)	<i>2D raster based analyses based on analytical and numerical studies (e.g. Gringarten 1978)</i>
Evaluation of Measured Resources	<i>Existing hydrocarbon wells & existing balneological use</i>
Estimation of Reserves	<i>Economical analyses & available surface space</i>

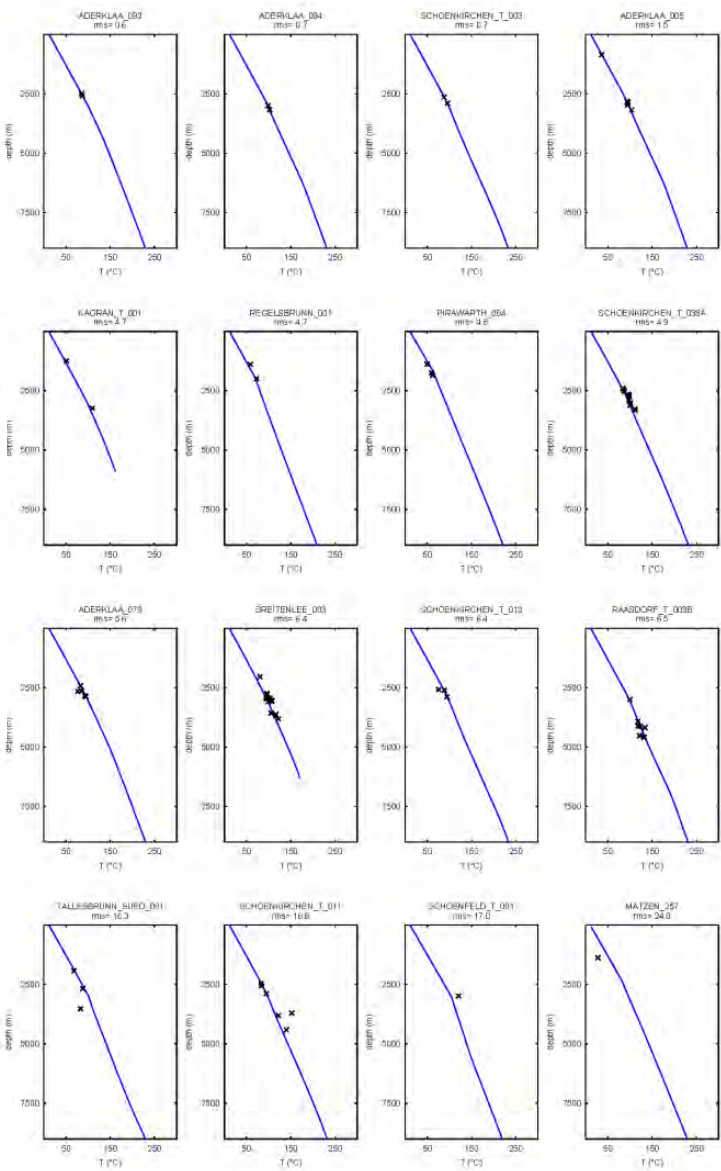
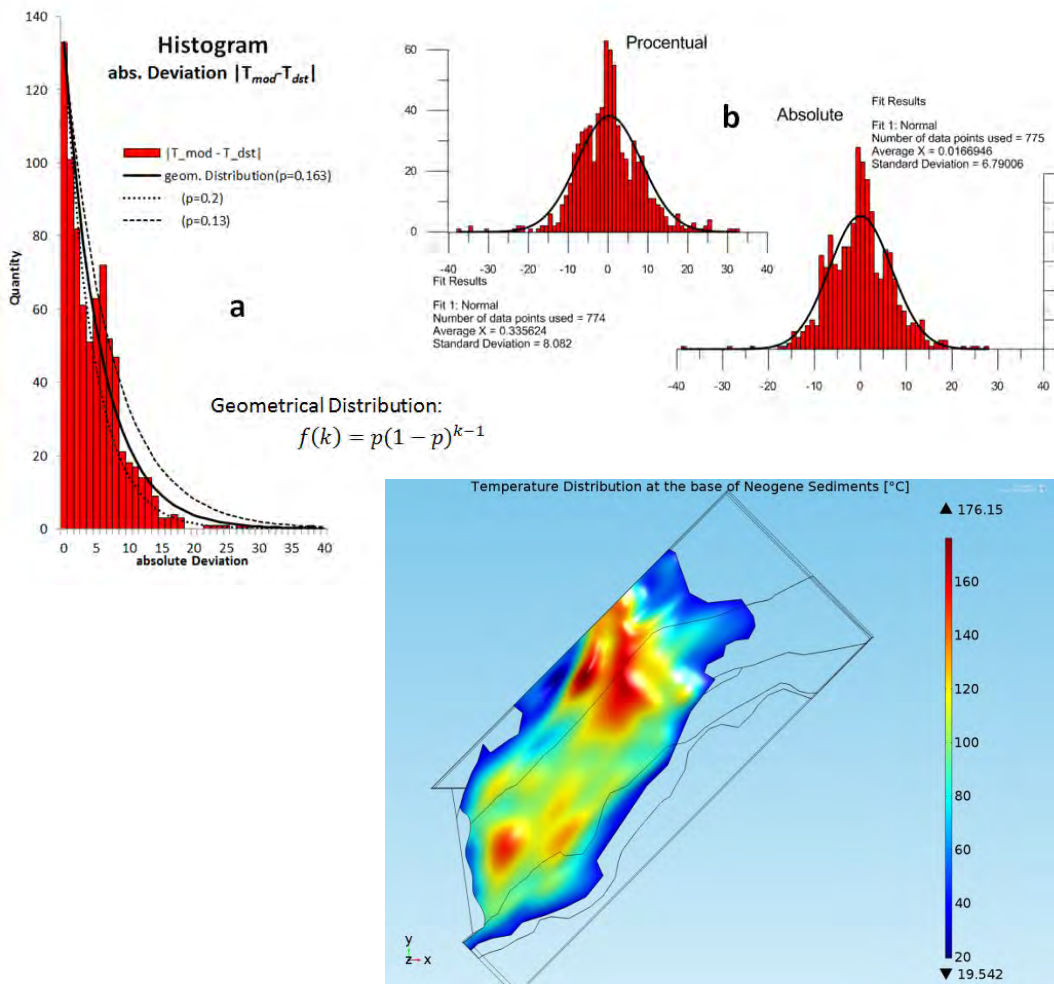
Objectives & Approach

Estimation of resources and reserves follows the “Canadian Geothermal Code for Public Reporting”



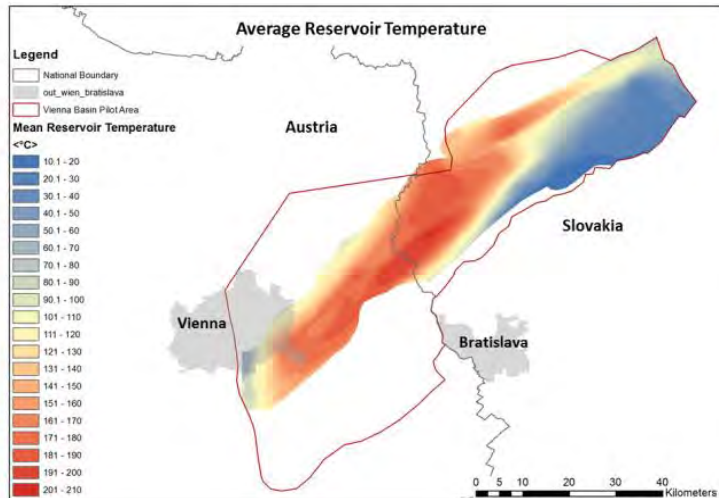
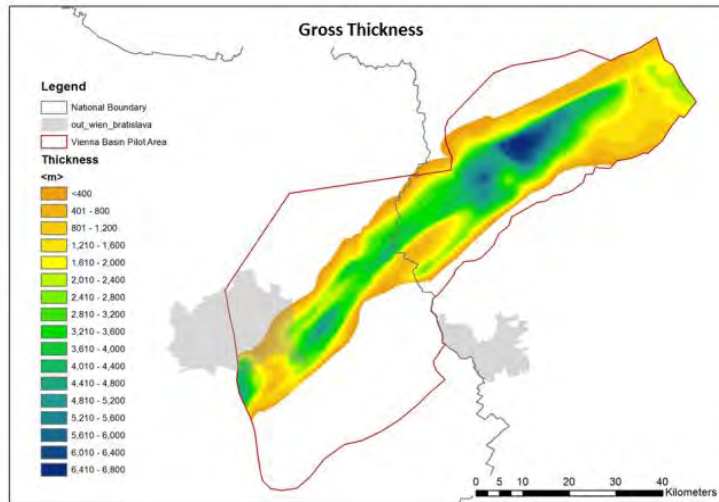
RESULTS

Regional scale pure conductive thermal model



Evaluation of hydrogeothermal potential and resources (inferred)

Geothermal Play 1a – Tirolic Nappes



Hydrogeothermal Play	Gross-volume (km ³)	θ _{T_{Res}} (°C)	θ _{Trans-missivities} (m ² /s)
1-a Tirolic Nappes	4426	117.8	1.48·10 ⁻³
1-b Juvavic Nappes	901	128.6	3.766·10 ⁻⁴
2 – Deltafront Sediments	124	58.2	1.413·10 ⁻²
3 – Aderklaa Conglomerates	249	79.8	3.338·10 ⁻⁴
4 – Central Alpine & Tatric Carbonates	3220	134.4	5.537·10 ⁻²

Hydrogeothermal Play	HIP ¹ (GW _{th})	HF ² (%)	Inferred Resources (GW _{th})
1-a Tirolic Nappes	532	33.17	176
1-b Juvavic Nappes	118	33.14	39
2 – Deltafront Sediments	0.693	32.94	0.228
3 – Aderklaa Conglomerates	12.3	33.05	4.1
4 – Central Alpine & Tatric Carbonates	416	33.17	134

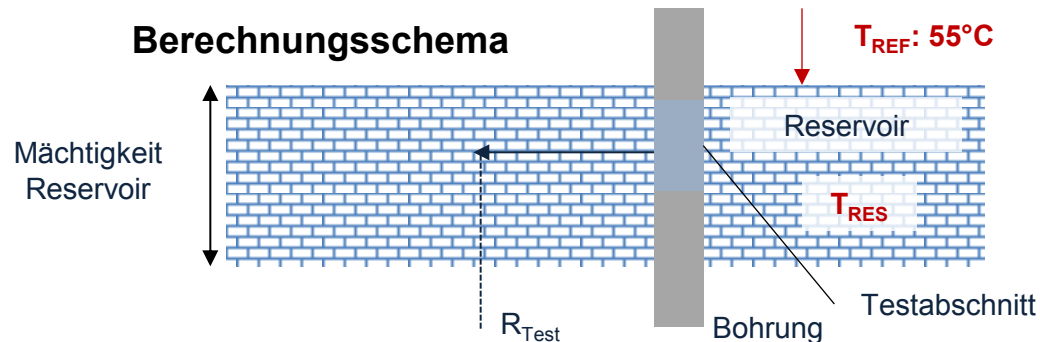
Assessment of Measured Resources

- Assessment of hydraulic tests of pred. Hydrocarbon wells
- Pessimistic approach (volumterical approach based on short term tests)

Hydrogeothermal Play	Measured Resources ³ (MW _{th})	Number of Wells ⁴	Installed Capacities (MW _{th})
1-a Tirollic Nappes	180.711	134	0
1-b Juvavic Nappes	34.595	28	0
2 – Deltafront Sediments	5.846	251	0
3 – Aderklaa Conglomerates	11.699	271	0
4 – Central Alpine & Tatric Carbonates	5.189	6	4.9 ⁵



Total measured resources ~ 230 MW_{th}

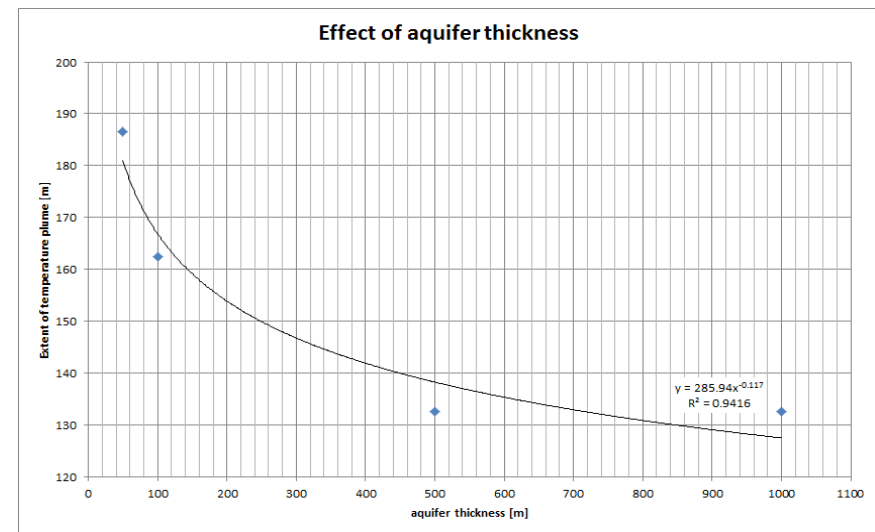
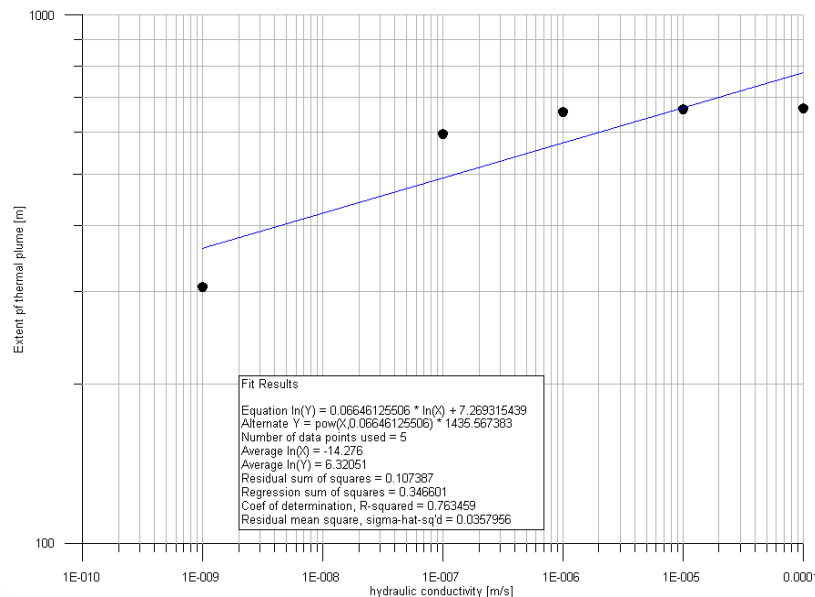


CONCLUSIONS & OUTLOOK

Conclusions (1)

- Simple conductive 3D model led to sufficient approach (stdev $\pm 6K$)
- Inferred Resources in the range of $350 \text{ GW}_{\text{th}}$, whilst Measured Resources in the range of $250 \text{ MW}_{\text{th}}$ (0.06%).

➔ Overestimation due to chosen approach (multiplet scheme following Gringarten, 1978) neglecting economical restrictions (HF is not depending on transmissivity)



- Inferred Resources in the range of 350 GW_{th}, whilst Measured Resources in the range of 250 MW_{th} (0.06%).

➔ Measured Resources underestimate due to (a) scattered wells, (b) main target set by hydrocarbon reservoirs and (c) chosen approach for estimation

- Further restrictions (Probable Reserves) by considering economic restrictions (max. depth, pumping effort) and land use
- Future Goal: Joint Management of Resources between AT and SK!

Level of Utilization	Data Acquisition (Surveys & Monitoring)	Data Management
<i>1 - No Utilization</i>	Closed aquifer: Interpretation of available exploration data (baseline assessment) Open aquifers: Baseline monitoring	Bilateral regional scale numerical models at regional scale; reporting of resources and reserves based on bilateral databases and rasters
<i>2 - Moderate Utilization</i>	Interpretation of exploration data and operational monitoring	Bilateral database of baseline and production data; validated numerical models at local to regional scale applied for permission procedures
<i>3 - Intense Utilization, interferences and changed in quantity and quality evident</i>	Operative monitoring Passive monitoring at observation wells Periodical evaluation of existing permissions	Bilateral database of data from passive monitoring; local scale numerical models validated by history matching

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Thank you for your attention!

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