Deep thermal transboundary aquifers Transenergy project

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WORKSHOP ON TRANSBOUNDARY WATER RESOURCES MANAGEMENT IN WESTERN AND CENTRAL EUROPE, BUDAPEST, HUNGARY, 8-10 FEBRUARY, 2011

Outline of presentation

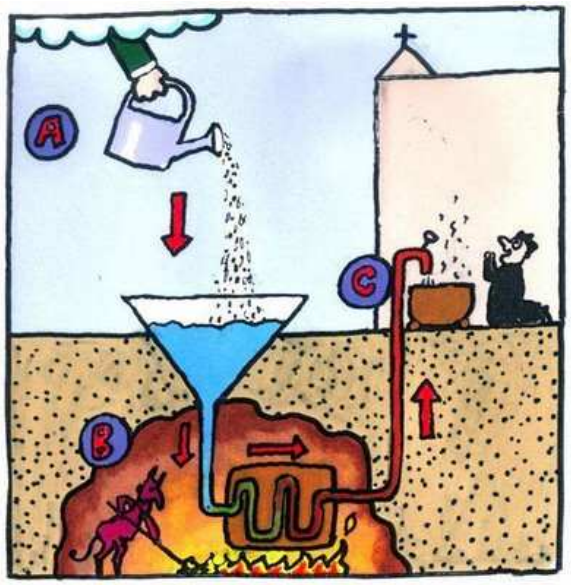
GROUNDWATER and ENERGY

Hydrogeothermal vs. geothermal energy utilization:

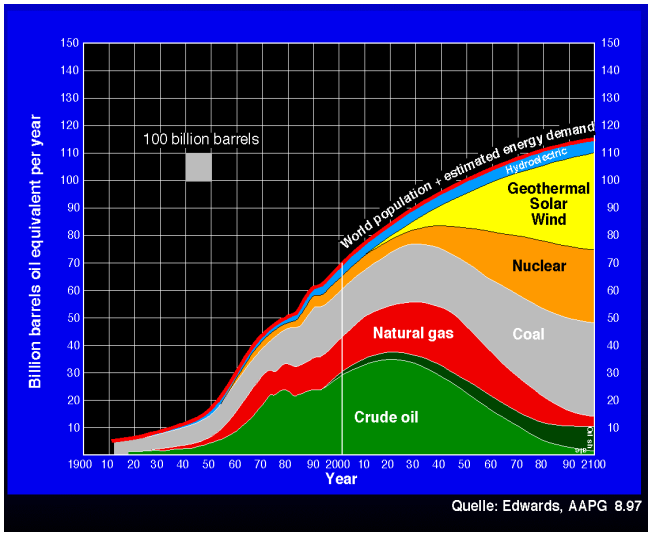
- **Driving forces on the enhanced use of renewables**
- **Goals vs. reality: share of renewables**
- **Hydrogeothermal systems and utilization concepts**

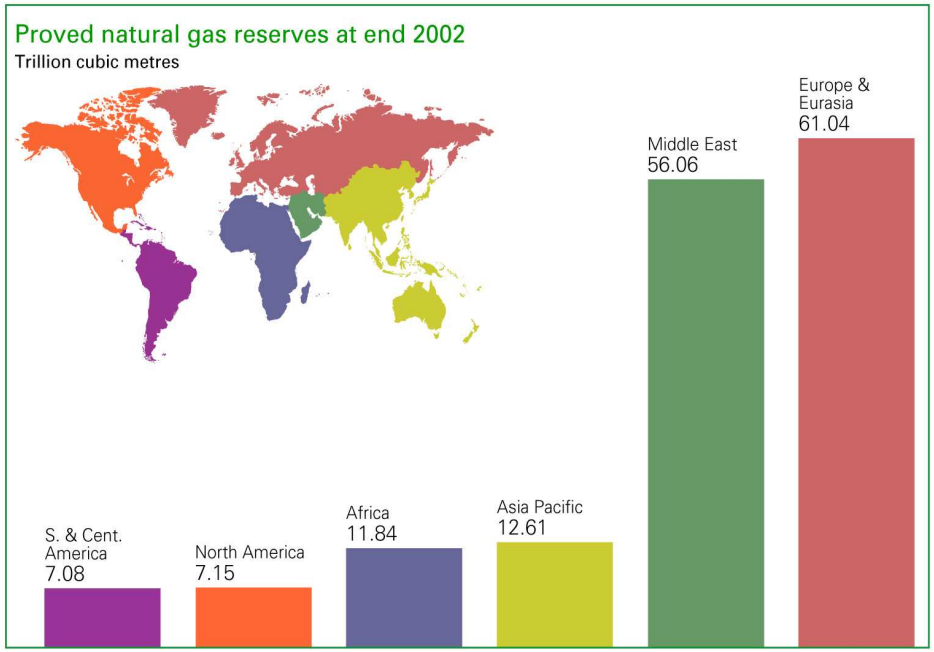
Joint geothermal resources – transboundary / bordering (thermal) groundwater bodies

Examples and some „messages to take home" from a Central Europe project: TRANSENERGY

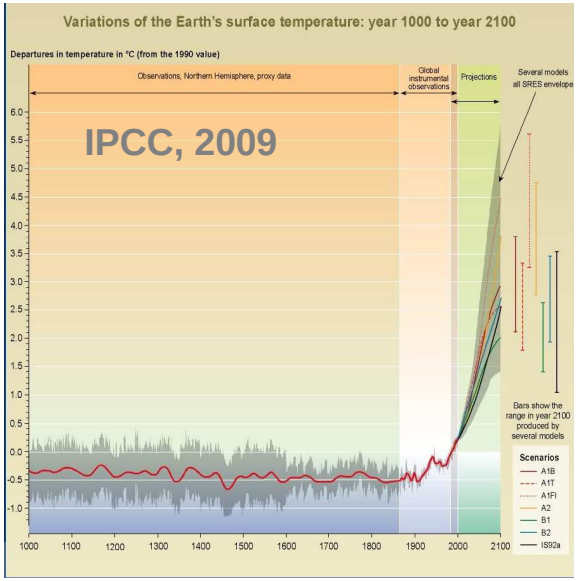


Why renewables?





BP statistical review of world energy 2003



Growing energy demand coupled with restricted and uneven distribution of fossil fuels

Climate change debate: Enhanced use of fossil fuels → increased atmospheric CO_2 concentration by 31 % since 1750 (280 → 379 ppm), highest values during the last 420 ky → global warming, extreme events

Ambitious goals…

Global targets - Kyoto Protocol: 8% drop of greengouse gases below 1999 level during 2008-2012

- **cut energy consumption (fossil fuels) and carbon-dioxide emisssions**
- **increase energy efficiency**
- **increase renewable energy sources (RES)**

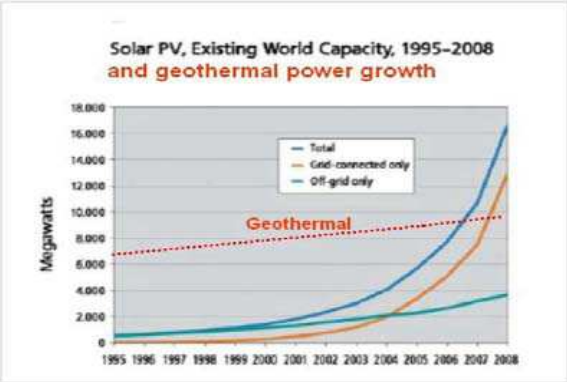
Europe: „20/20/20 by 2020" COM(2006)848, decision of the EU Spring Summit, 2007

- **20% cut of energy consumption**
- **20% cut of CO_2 emission**
- **20% of renewable energy consumption**

…and reality □ electricity generation

	Potential capacity (EJ/y) (WEA, 2000)	Installed capacity (GWe)	Produced electricity (TWh)
Geothermal	5000	10	65,7
Solar	1575	16	19,6
Wind	640	121	222,6

Rybach, 2010

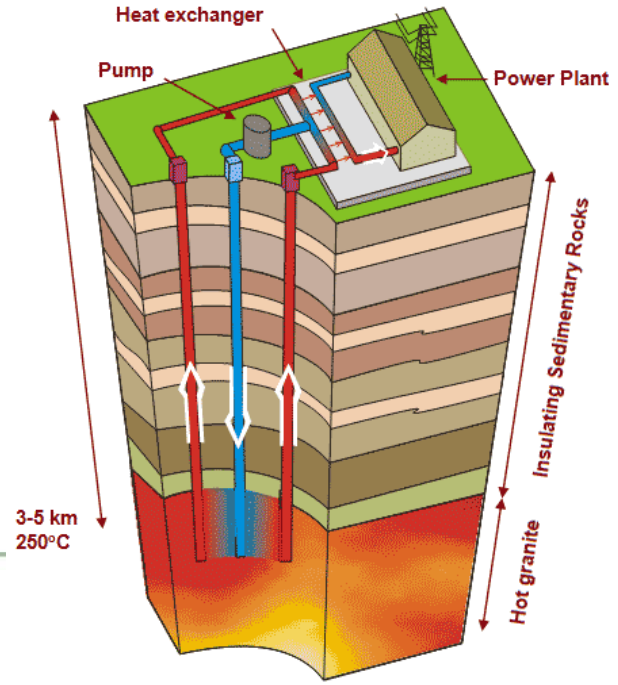


wind and solar PV: exponential growth

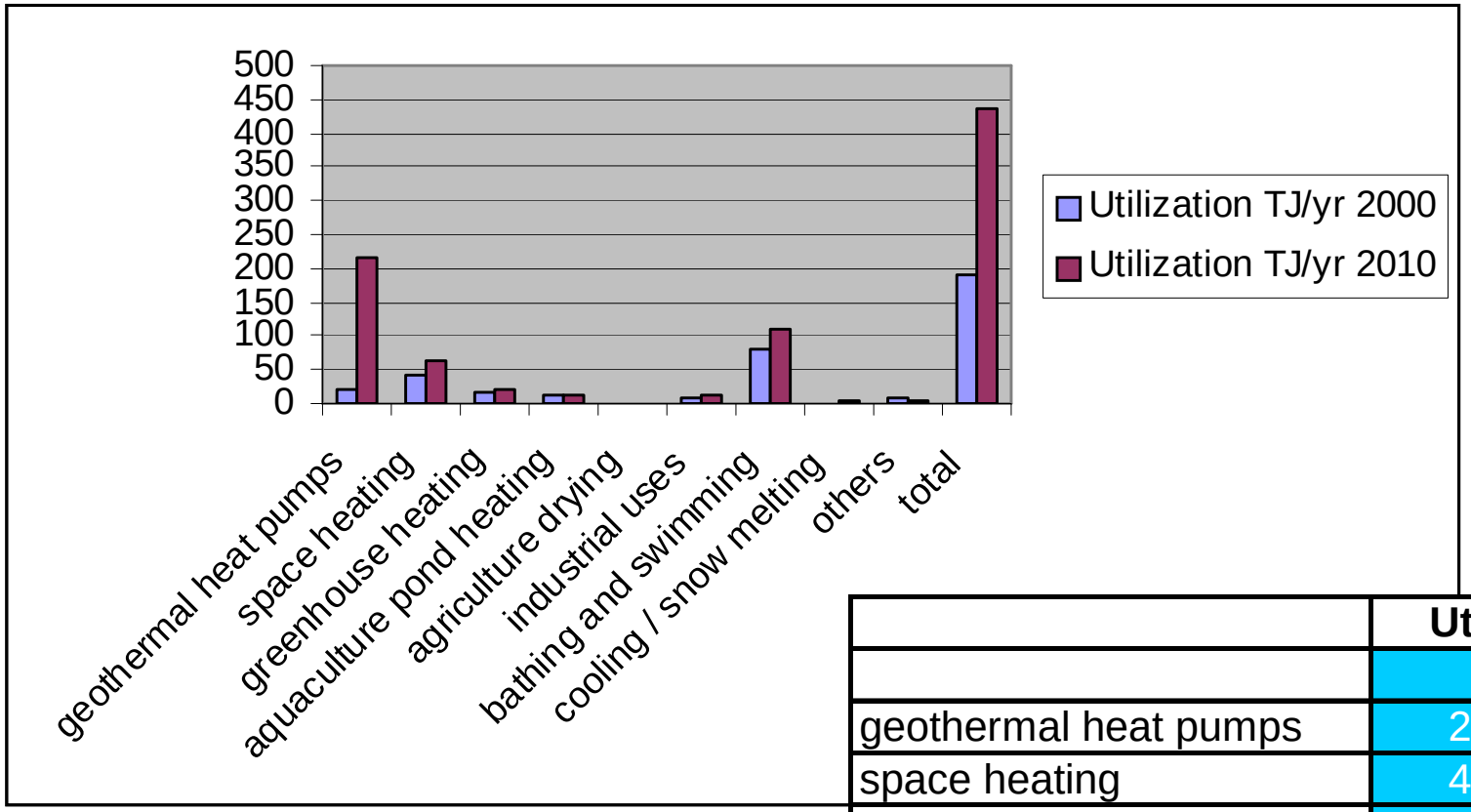
geothermal power develops „only" linearly

accelerated growth:

Enhanced Geothermal Systems (EGS)



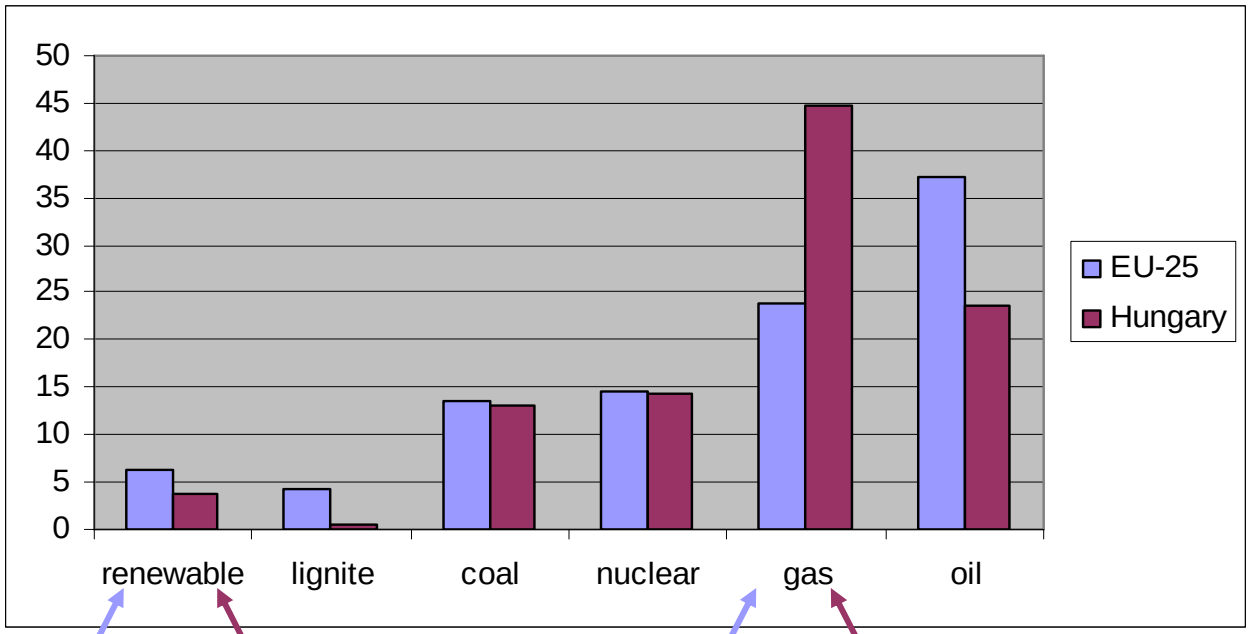
…and reality direct utilization



Lund et al., 2010

	Utilization TJ/yr	
	2000	2010
geothermal heat pumps	23,275	214,782
space heating	42,926	62,984
greenhouse heating	17,864	23,264
aquaculture pond heating	11,733	11,521
agriculture drying	1,038	1,662
industrial uses	10,22	11,746
bathing and swimming	79,546	109,032
cooling / snow melting	1,063	2,126
others	9,56	3,034
total	190,699	438,071

Composition of total energy use: EU vs. Hungary (2004)



6,2%
mostly biomass

3,7%

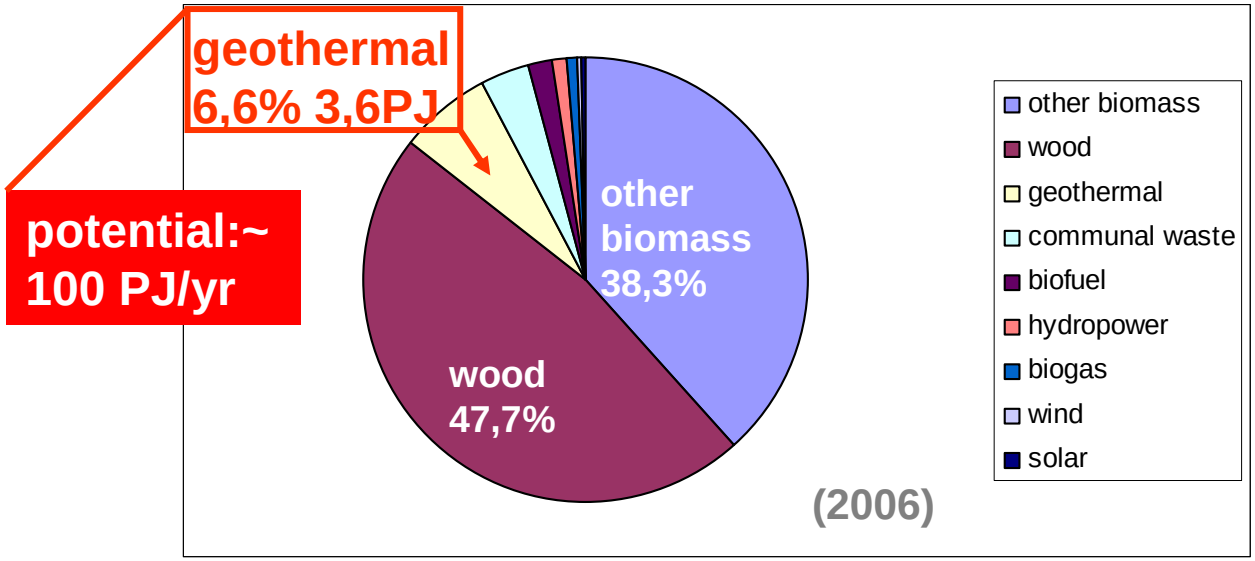
23,9%

44,8%

Hungary's import dependency (hydrocarbons and uranium) is 78,5%

Source: Energiaközpont Kht

Renewables and share of geothermal energy in Hungary



Total: 54,8 PJ (4,7% of primary energy use)

Source: Energiaközpont Kht

Proportion of geothermal energy	2005	2008	2010	2015	2020 total RES target 13% (186,4 PJ)
Renewable electricity production (GWh)	0	0	0	65	442
Renewable heat production (PJ)	3,63	4	4,5	7	9

Hydrogeothermal vs. geothermal energy utilization?

EU Directive on Promotion of Renewable Energy Sources 2009/28/EC

Art.5: The gros final consumption of energy from renewable sources shall be calculated as a sum of:

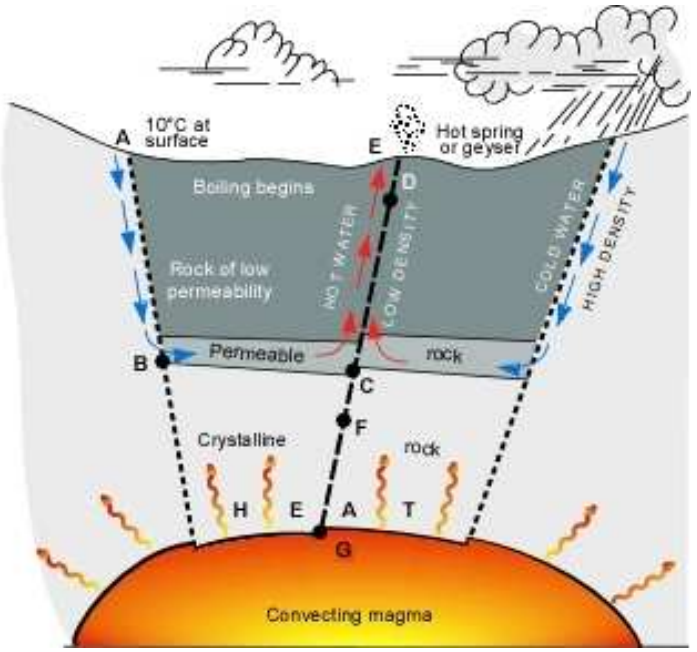
- **gros final consumption of electricity from renewable energy sources**
- **gros final consumption of energy from renewable sources for heating and cooling**
- **final consumption of energy from renewable sources in transport**

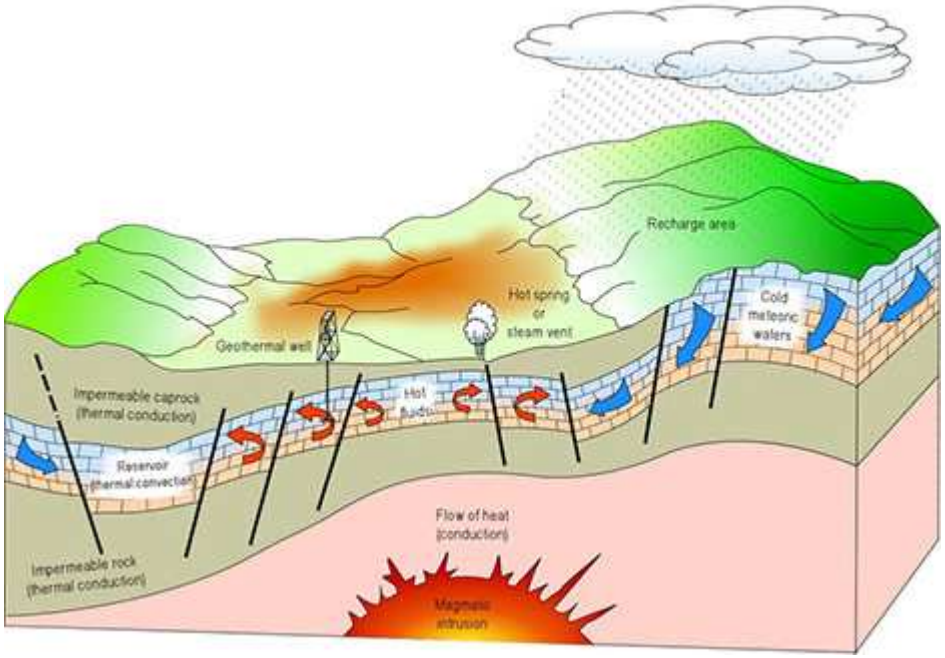
except for Ground-Source Heat Pumps and Enhanced Geothermal Systems the extraction of heat is possible only by the extraction of its carrying medium (thermal water)

WATER MANAGEMENT ISSUE

Hydrogeothermal systems

Fluid convection: heating → thermal expansion → heated fluids of lower density rise and are replaced by colder fluids of high density recharging from the margins of the system





Balanced fluid/heat production: not producing more than the natural recharge re-supplies (heat and fluid)

Utilization concepts

single well thermal water extraction – balneology (re-injection is not possible du to contamination)

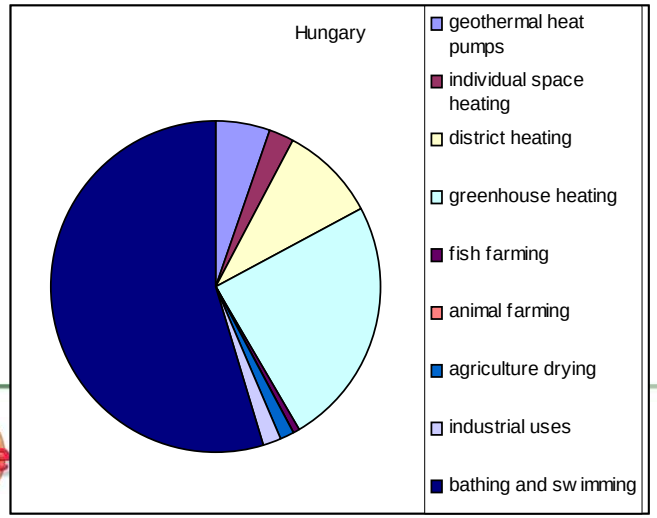
geothermal doublets: production - reinjection wells (energetic purposes)

Benefits

- increased flow rates
- optimum heat recovery
- maintenance of pressure
- land subsidence control
- disposal of the cooled brine

Drawbacks

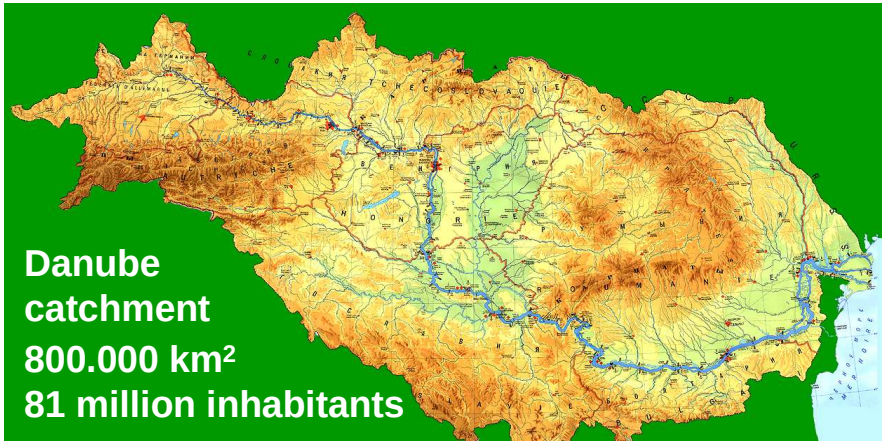
- „waste water" contamination of the aquifer (e.g. bacteria, gas, chemicals)
- premature cooling (thermal breakthrough) of production wells
- permeability impairment induced by particles



TJ/year	Hungary
geothermal heat pumps	518
individual space heating	232
district heating	930
greenhouse heating	2388
fish farming	44
animal farming	17
agriculture drying	123
industrial uses	159
bathing and swimming	5356
cooling / snow melting	0
total annual use	9767

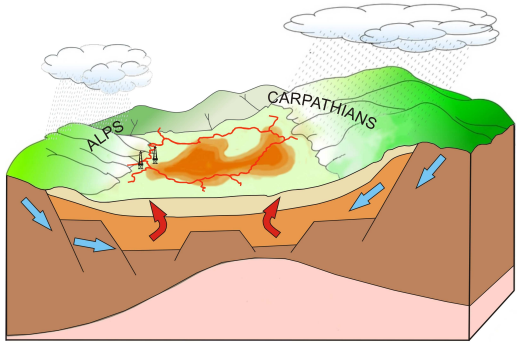
Water Framework Directive (2000/60/EC)

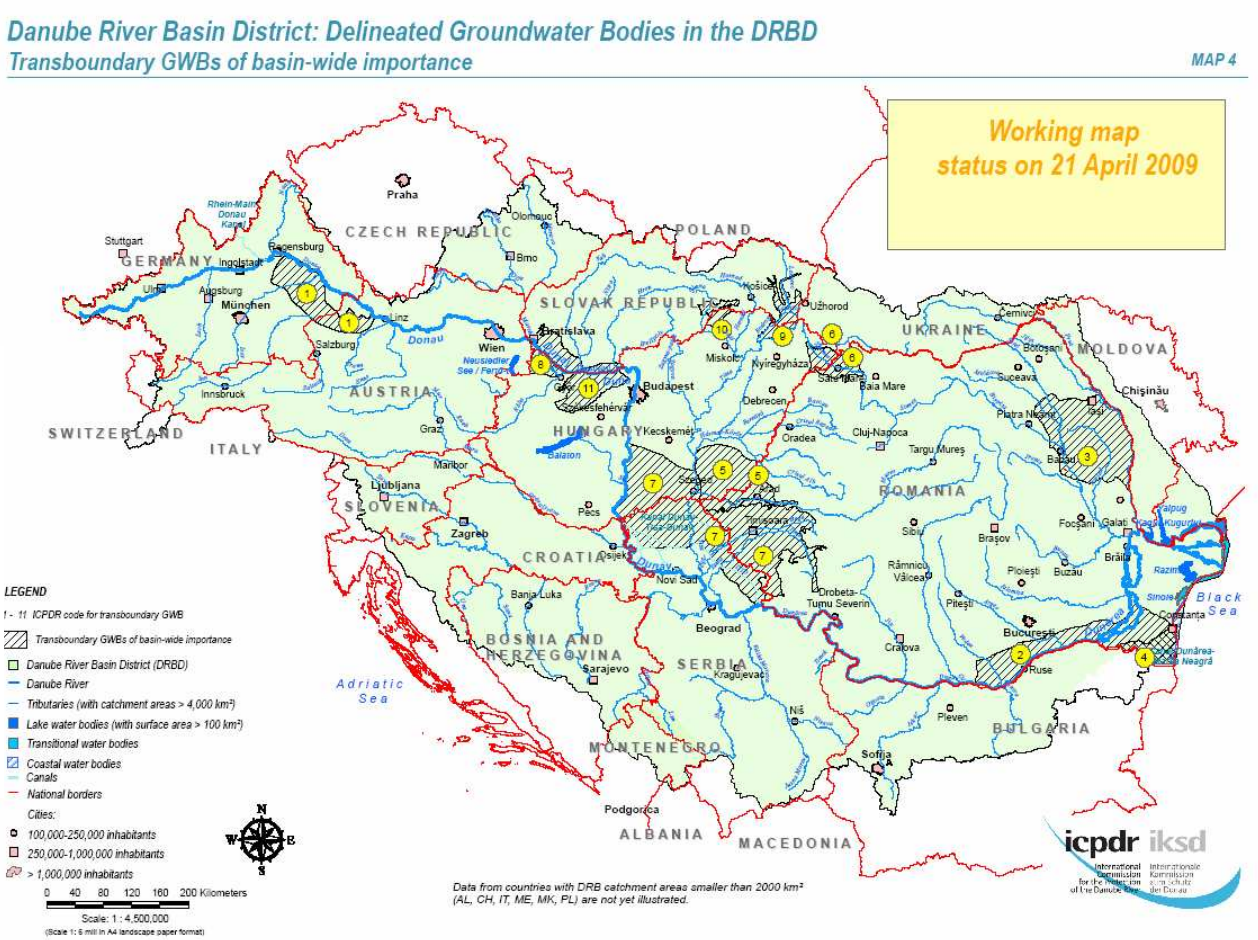
Shared between 10 EU member states and 9 non-member states

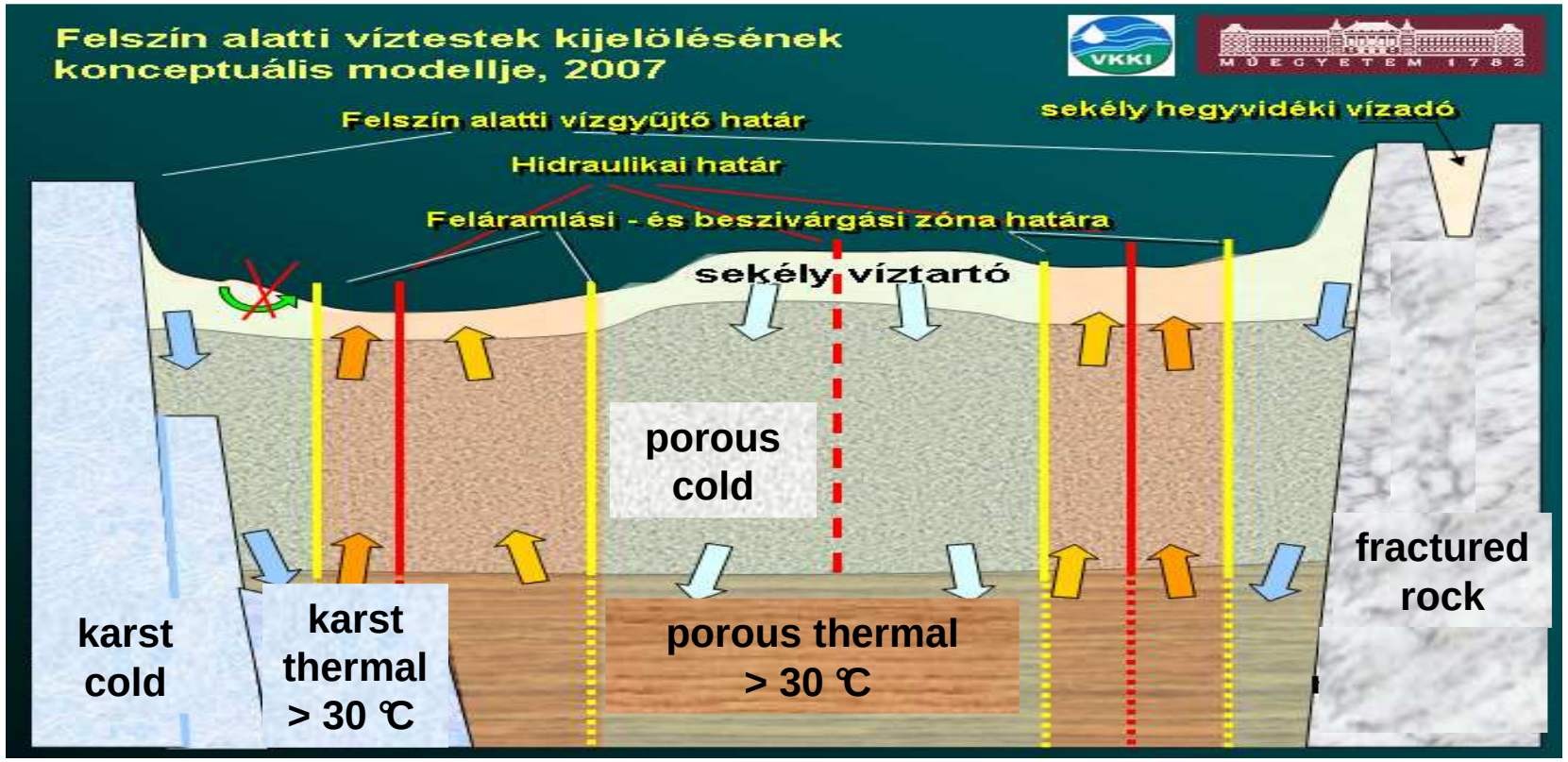


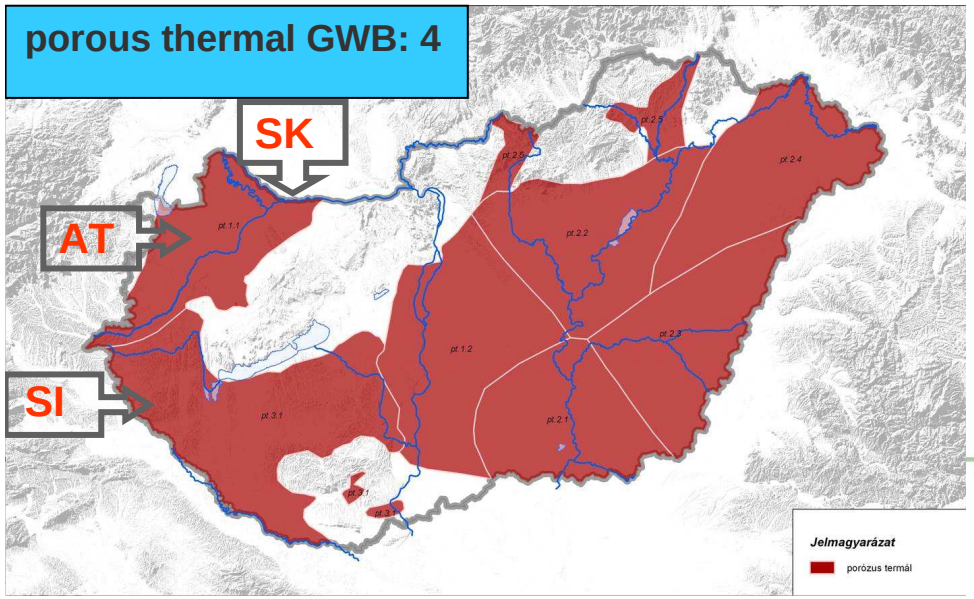
Hungary shares transboundary aquifers with:

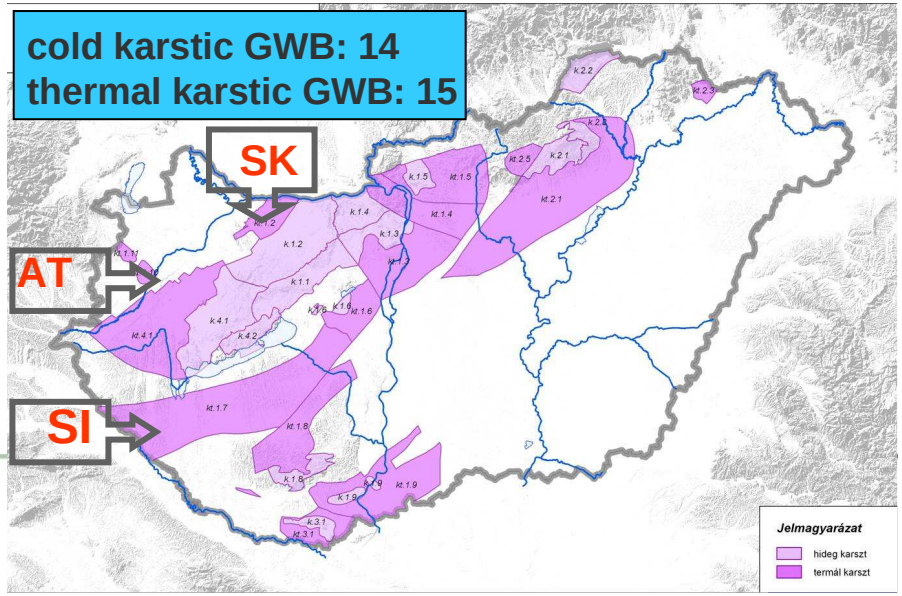
Austria
Slovakia
Slovenia
Croatia
Romania
Serbia
Ukraine





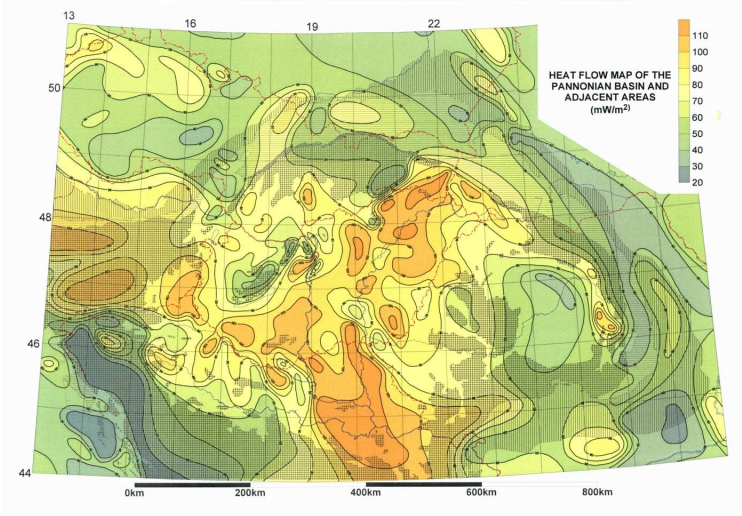

Felszín alatti víztestek kijelölésének konceptuális modellje, 2007
VKKI
MŰEGYETEM 1782
Felszín alatti vízgyűjtő határ
Hidraulikai határ
Feláramlási - és beszivárgási zóna határa
sekély hegyvidéki vízadó
sekély víztartó
porous cold
fractured rock
karst cold
karst thermal > 30 ℃
porous thermal > 30 ℃

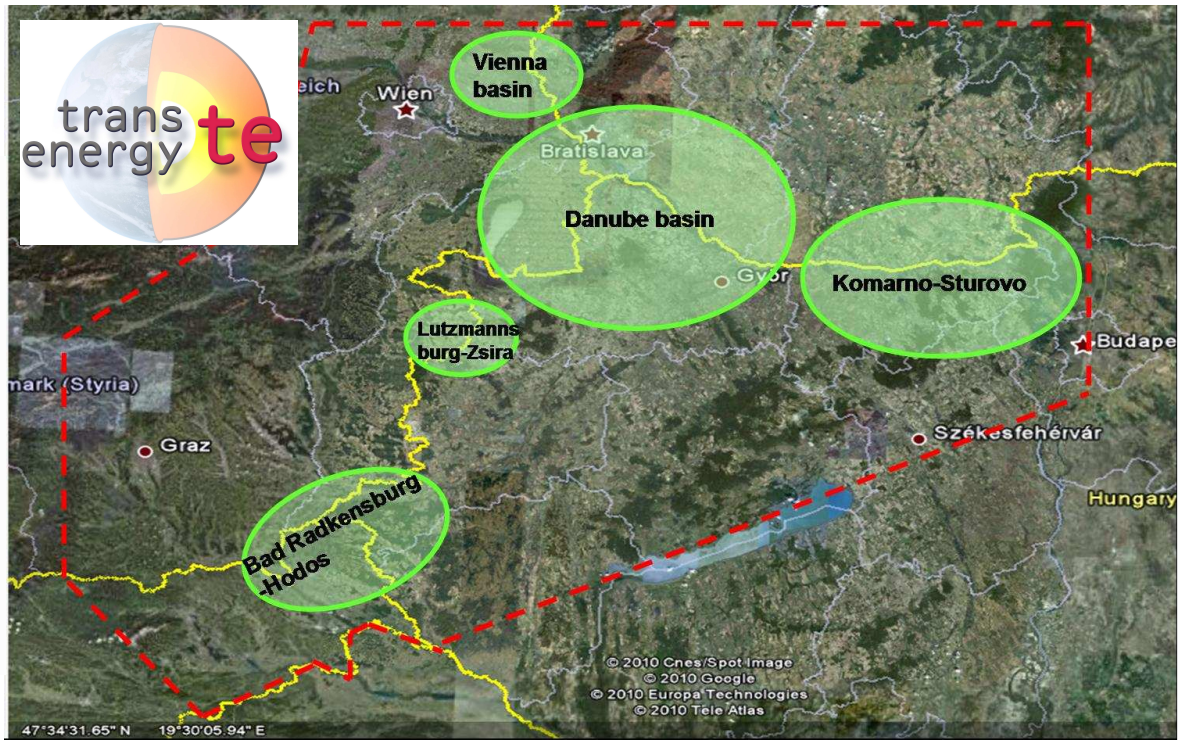

porous thermal GWB: 4
SK
AT
SI
Jelmagyarázat
porózus termál


cold karstic GWB: 14
thermal karstic GWB: 15
SK
AT
SI
Jelmagyarázat
hideg karszt
termál karszt

This project is implemented through the CENTRAL EUROPE Programme co-financed by the ERDF.

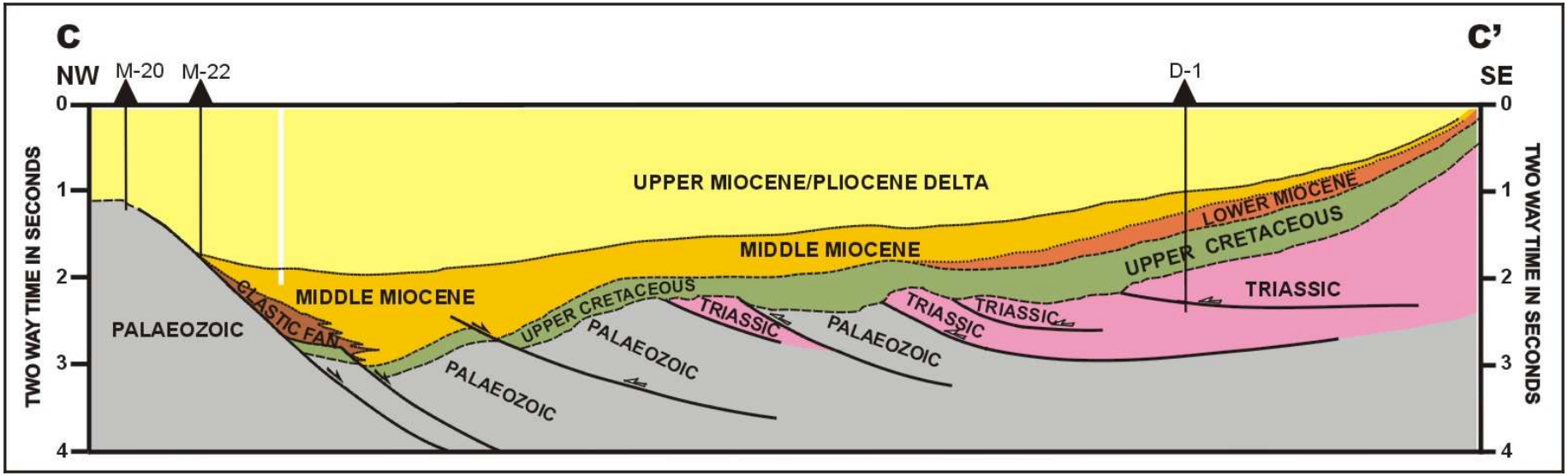
http://transenergy-eu.geologie.ac.at



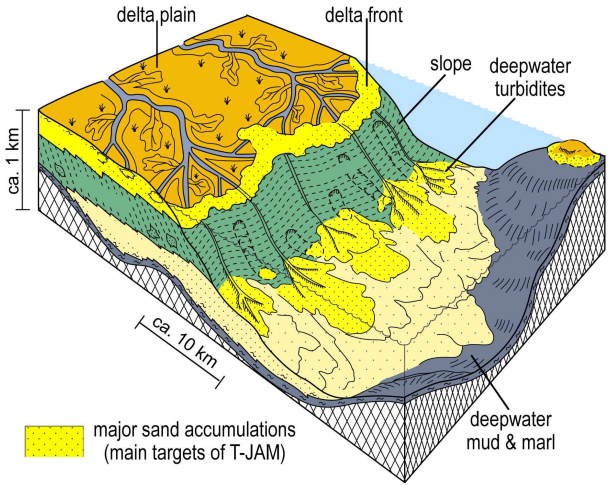


TRANSENERGY: Transboundary Geothermal Energy Resources of Slovenia, Austria, Hungary and Slovakia

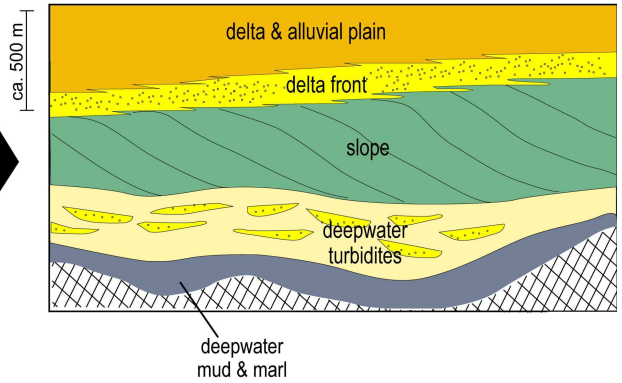
Most important reservoirs in the Pannonian basin



Late Miocene palaeoenvironment

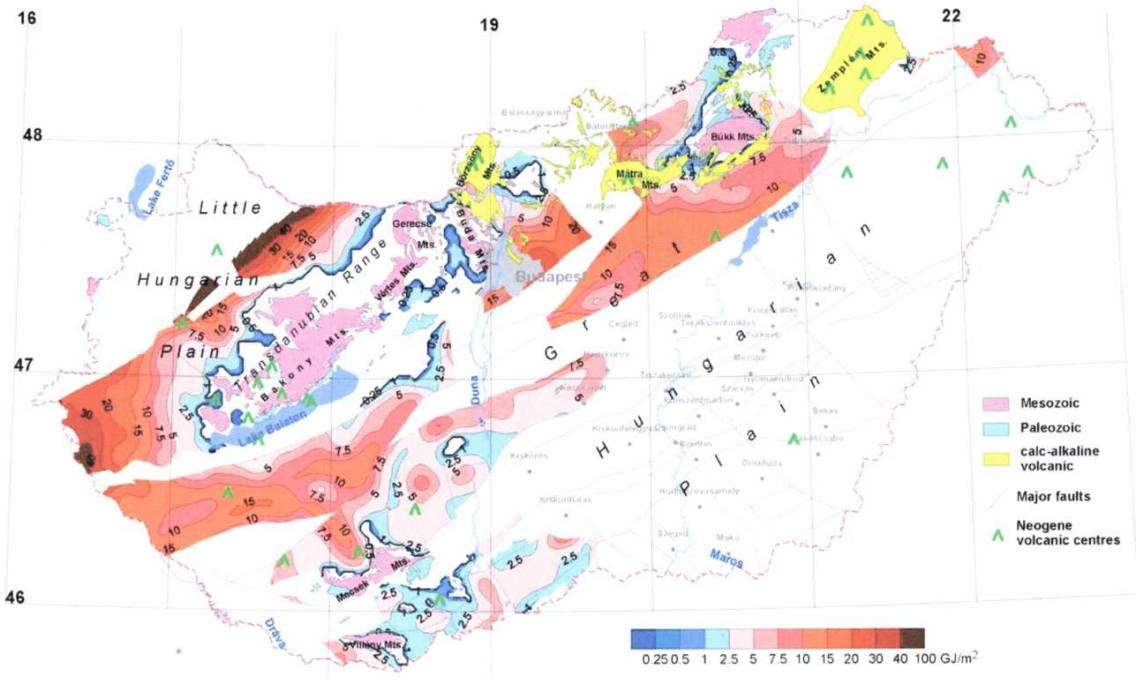


present-day pattern of Late Miocene strata

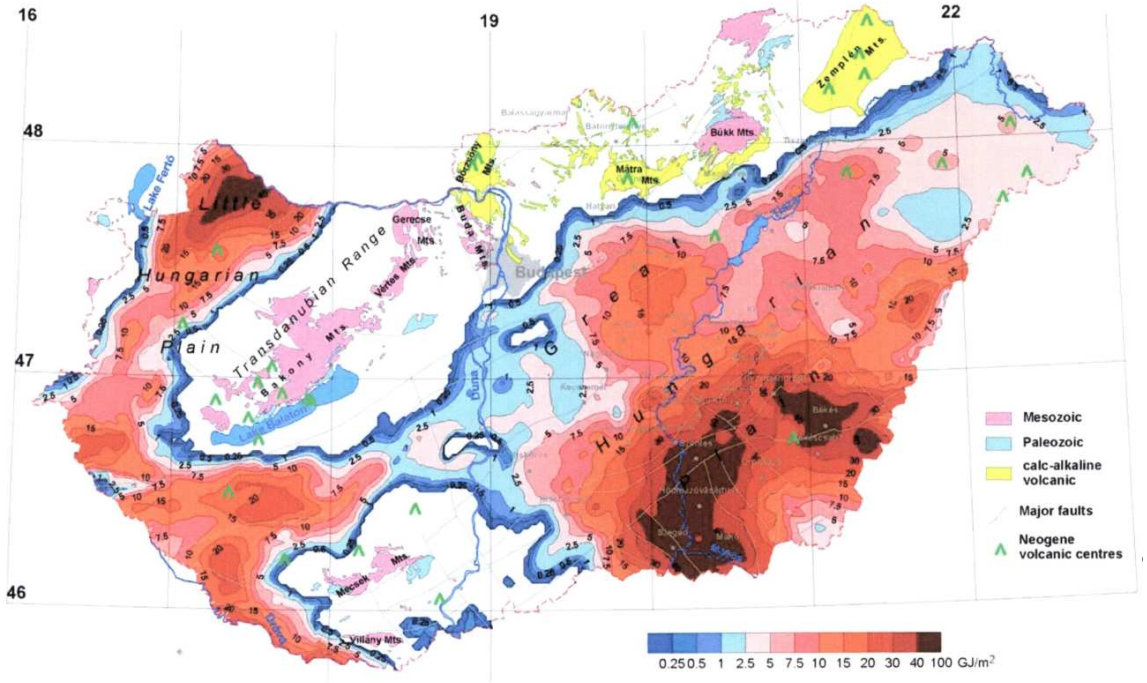


(1) Fractured, karstified basement rocks

(2) Neogene clastic basin fill sediments



Energy content of the fractured-karstified basement reservoirs



Energy content of the porous basin fill reservoirs

trans energy te

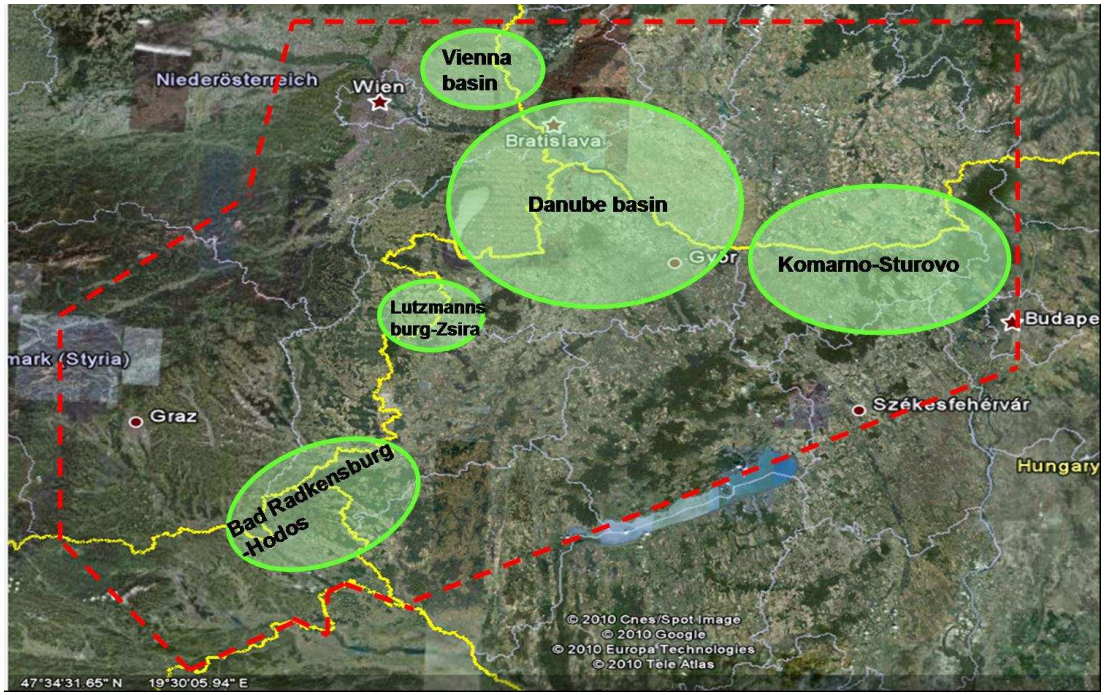
Main goals of Transenergy

A user friendly **web-based decision supporting tool** (interactive web portal), which transfers expert know-how about hydrogeothermal utilization (single-well - balneology and doublets - geothermal energy) and sustainable reservoir management to stakeholders (decision makers, water- and mining authorities, present and potential investors, scientific associations and wider public interested), such as:

- assessment of heat in place, limited technical and economic potentials
- complex assessment of thermal groundwater bodies
- scenario models for different water extractions: predictable quality and quantitiy changes
- experiences of present (cross-border!) interactions, best practice recommendations
- sustainable utilization

Shallow geothermal potential (Ground-Source Heat Pumps) are not part of assessment

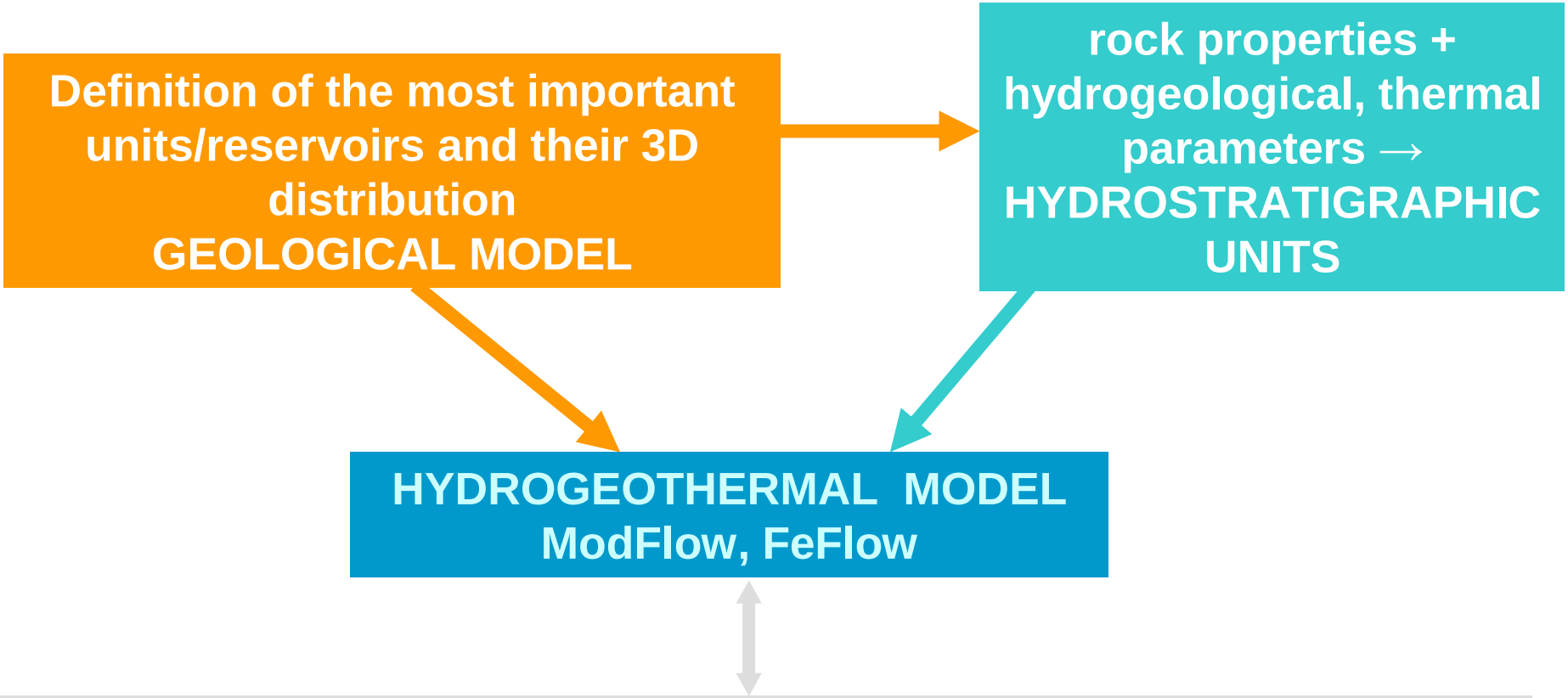
Cross-border geoscientific models



- geological models
- hydrogeological models
- geothermal models
- scenario modelling

supra-regional area
1:500 000

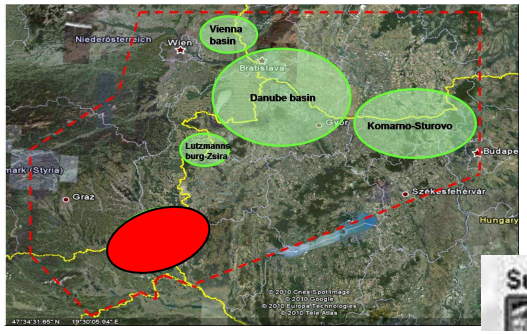
- thermal karst of Komarno-Sturovo area (HU-SK) 1:200 000
- central depression of the Danube basin (A-SK-HU) 1:200 000
- Lutzmannsburg – Zsira area (A-HU) 1:100 000
- Vienna basin (SK-A) 1:100 000
- Bad Radkersburg – Hodoš area (A-SLO-HU) 1:200 000



MODEL CALIBRATION

- hydrogeochemical data (rock-water interaction, flow paths)
- time series data from the National Groundwater Monitoring System (160 wells) → spatial and temporal changes of hydraulic heads
- production parameters

SLO-AT-HU cross border region

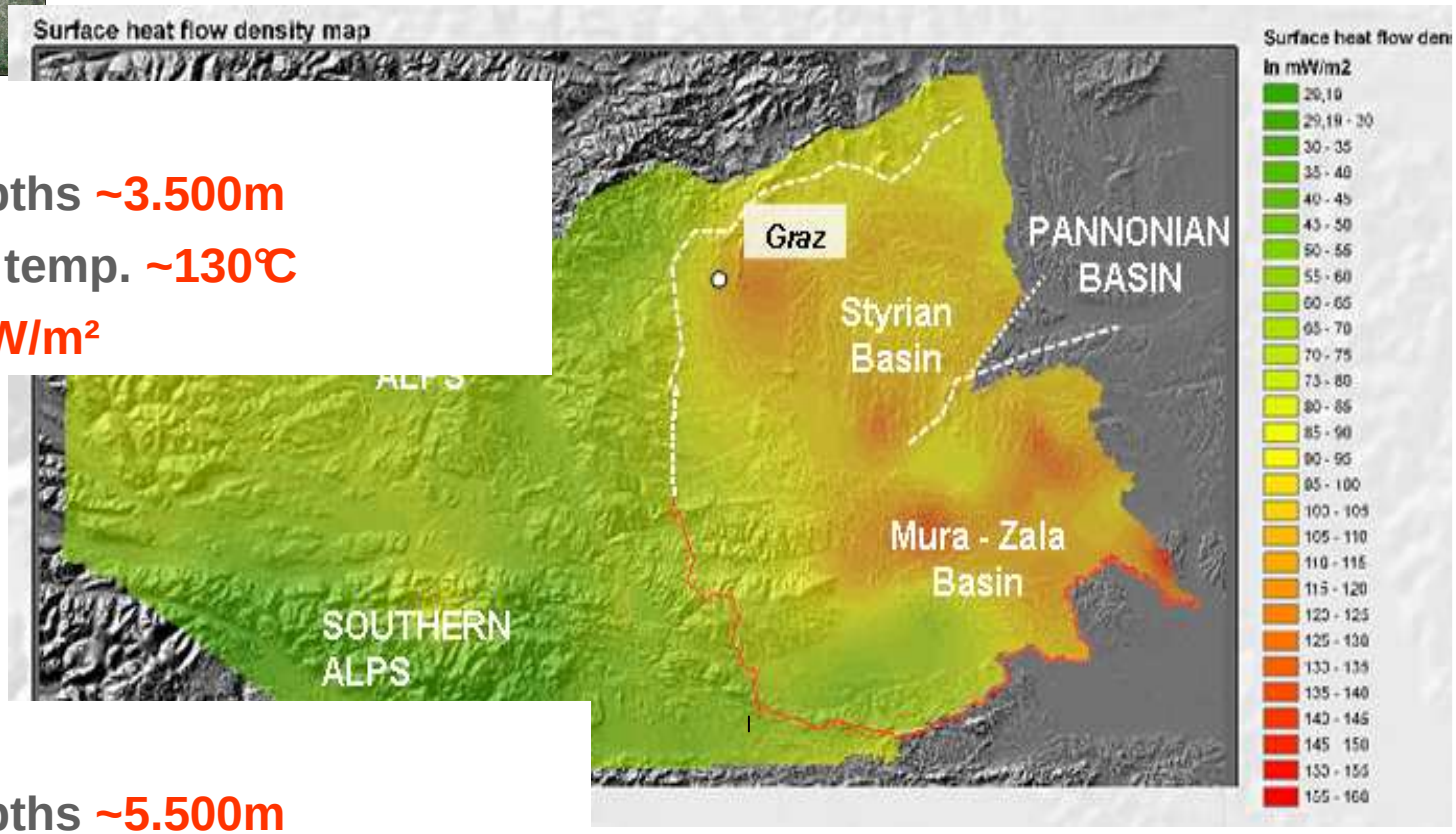


Styrian Basin

Maximum basin depths **~3.500m**

Maximum reservoir temp. **~130℃**

Heat flow **70-130 mW/m²**

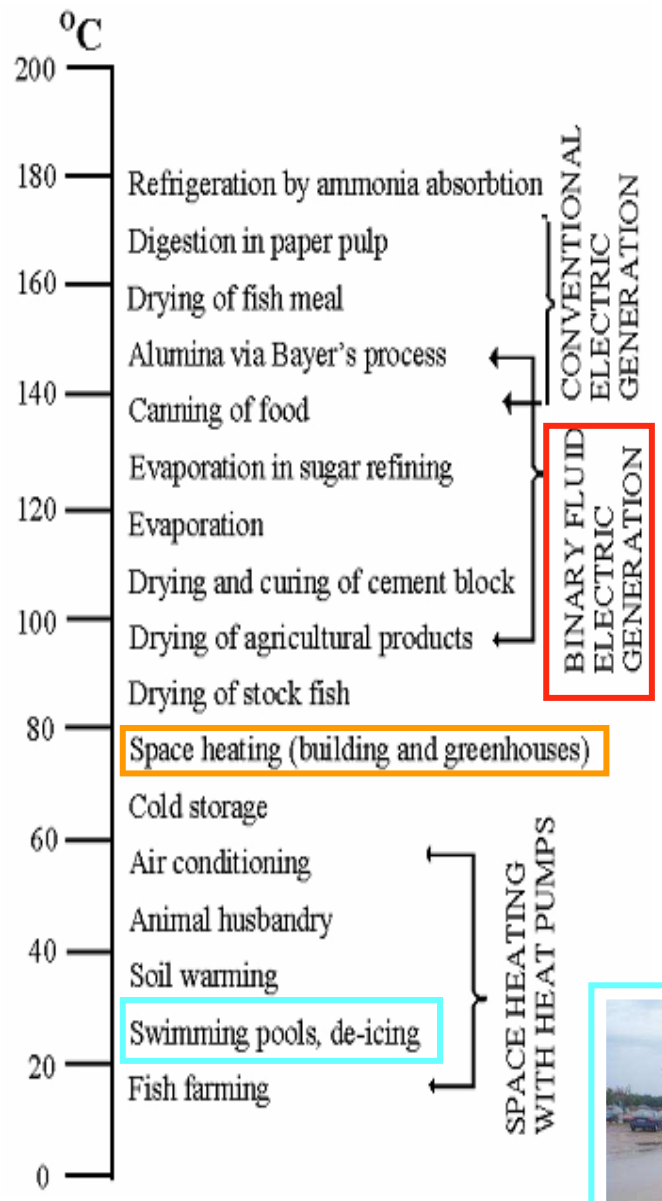


Mura-Zala basin

Maximum basin depths **~5.500m**

Maximum reservoir temperatures **~200℃**

Heat flow **60 -150 mW/m²**



Blumau - ORC electricity facility

Murska Sobota – district heating

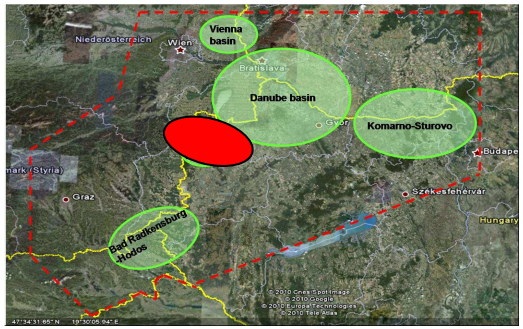
Dobrovnik – orchids greenhouse

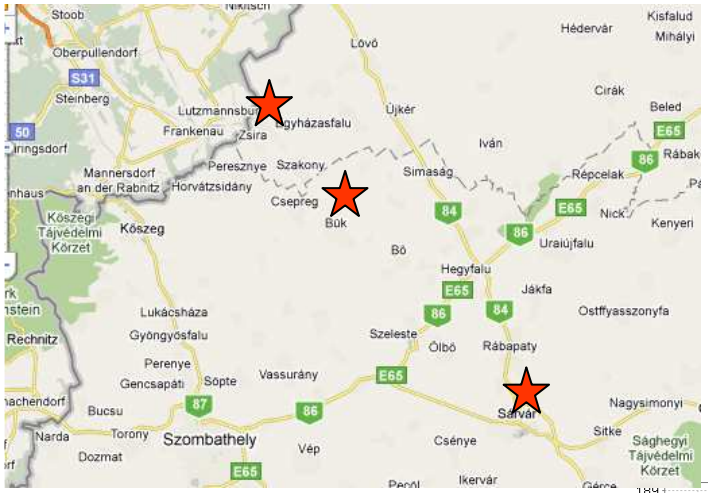
Lendava – de-icing

Moravske Toplice – spa

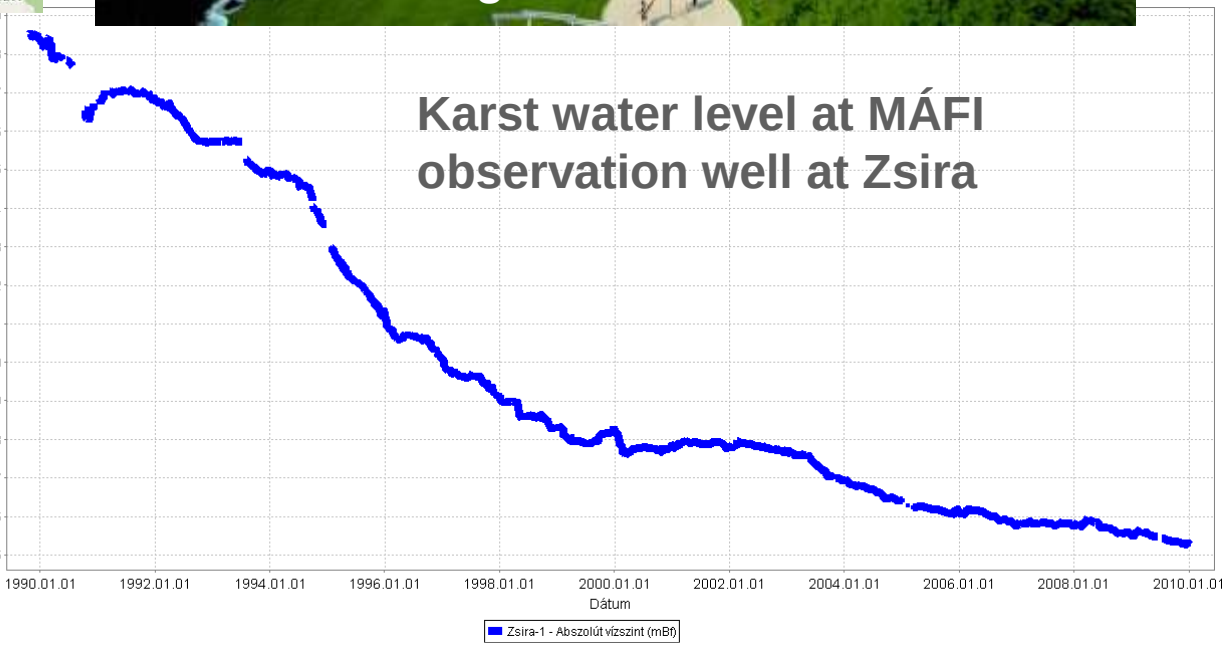
trans energy te

AT-HU cross-border region: Lutzmannsburg Zsira

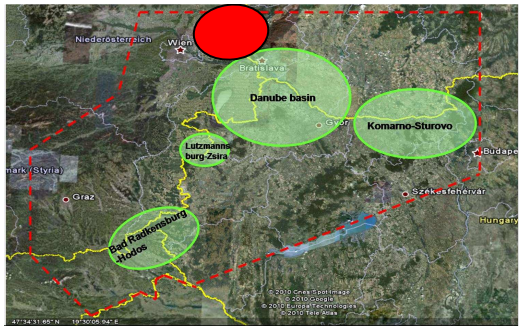


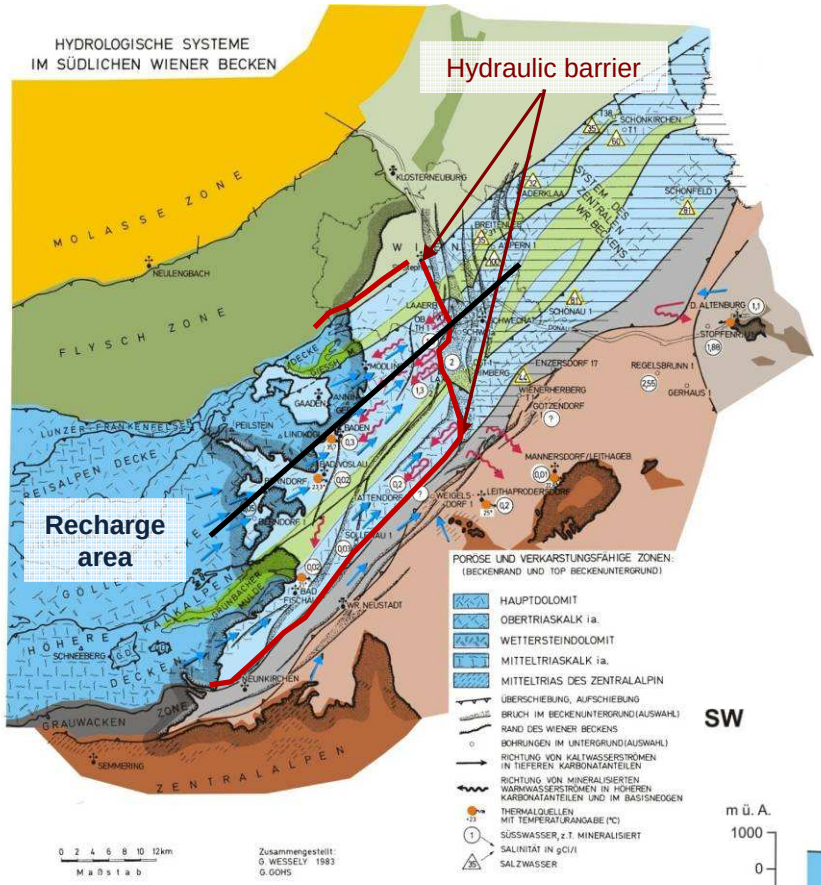


Maximum basin depths **~2.000m**
Maximum reservoir temp. **~70℃**
Heat flow **70-110 mW/m²**



AT-SK cross-border region: Vienna basin

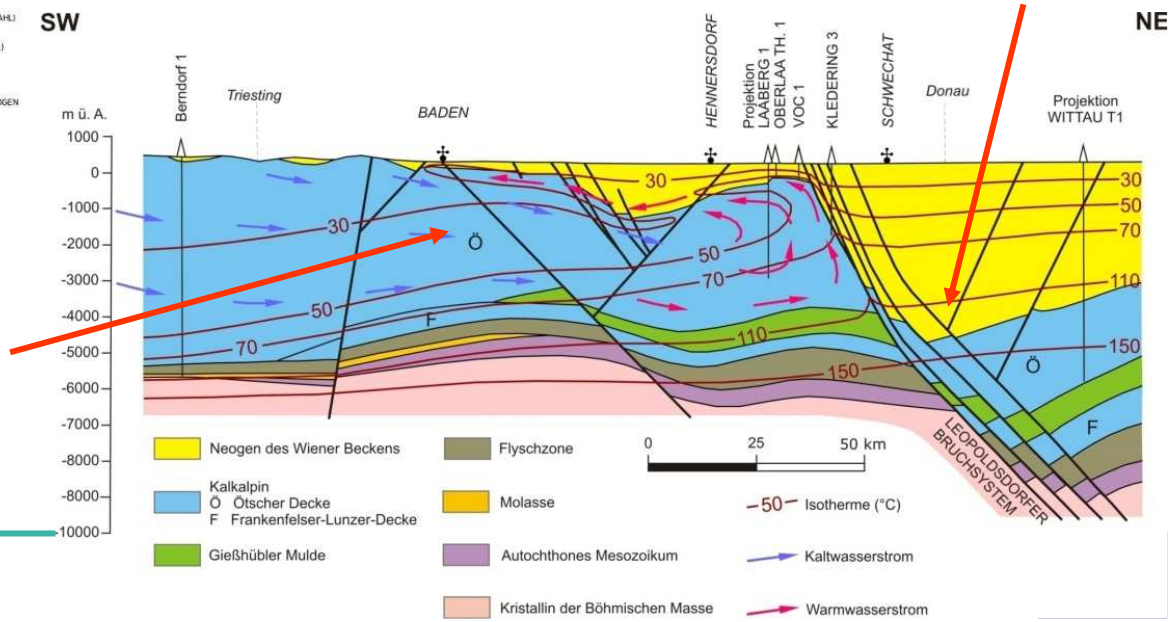


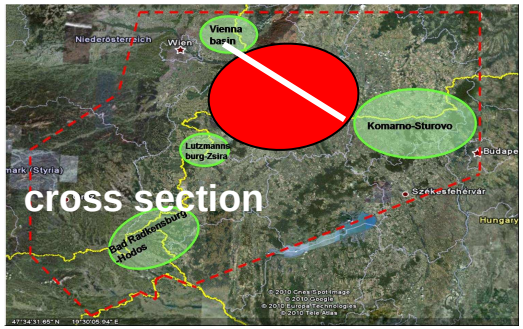


Maximum basin depths ~7.000m
Maximum reservoir temp. ~200℃
Heat flow 40-90 mW/m²

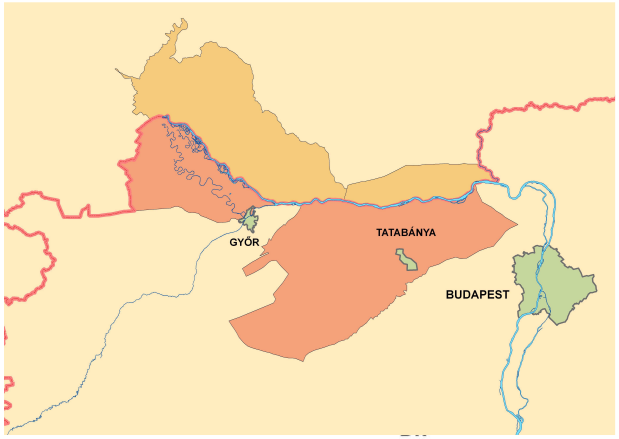
High mineralization
Connate
Overpressured

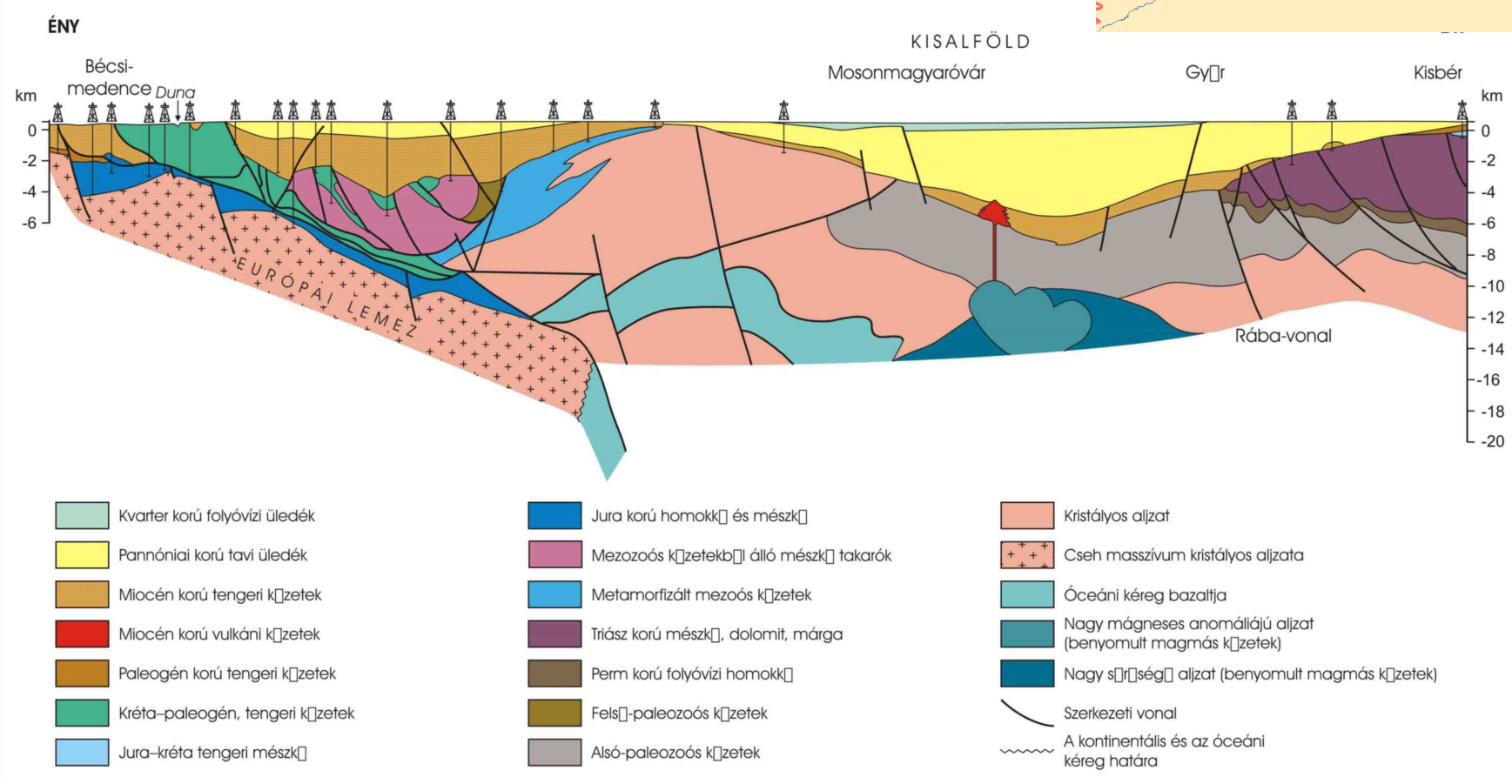
Low mineralization
Active recharge
Temperature anomalies



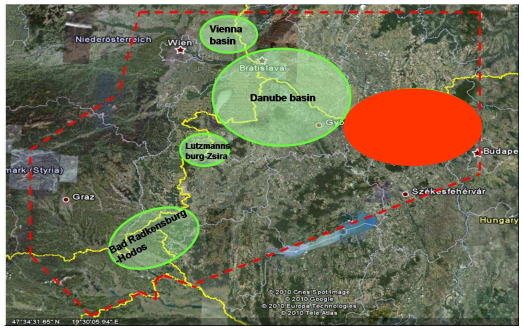


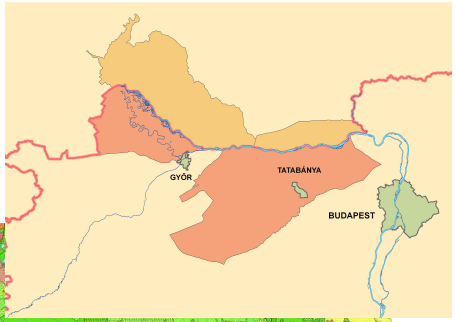
AT-HU-SK cross-border region: Danube basin

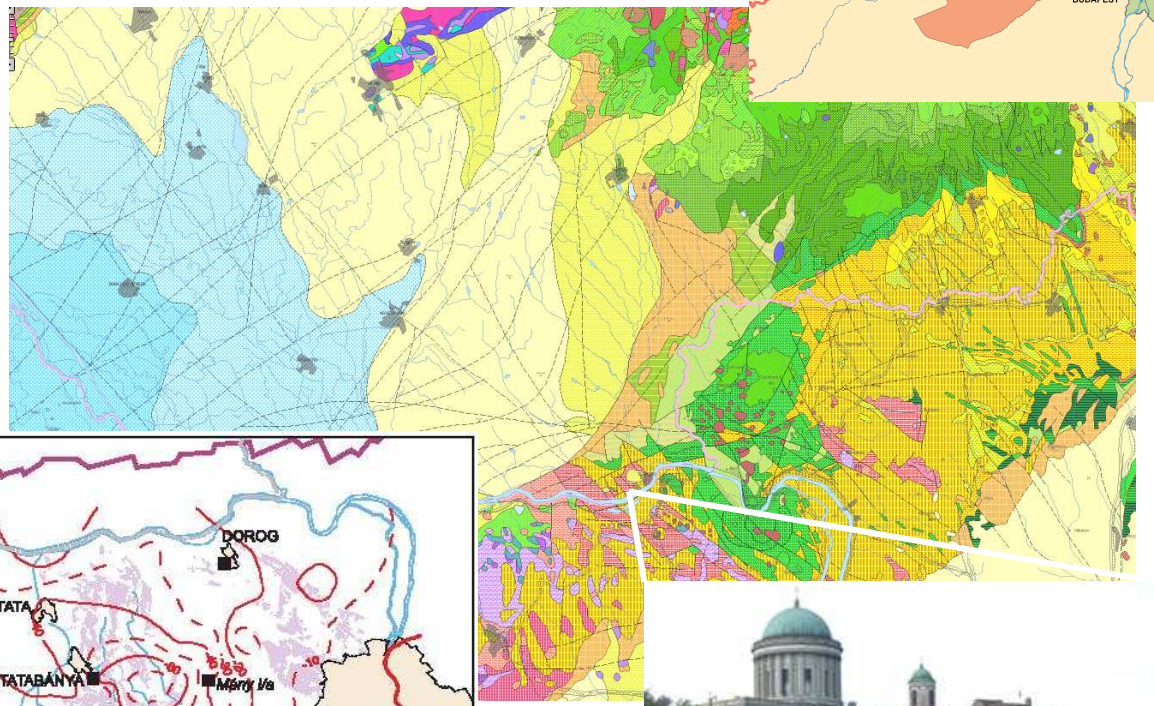


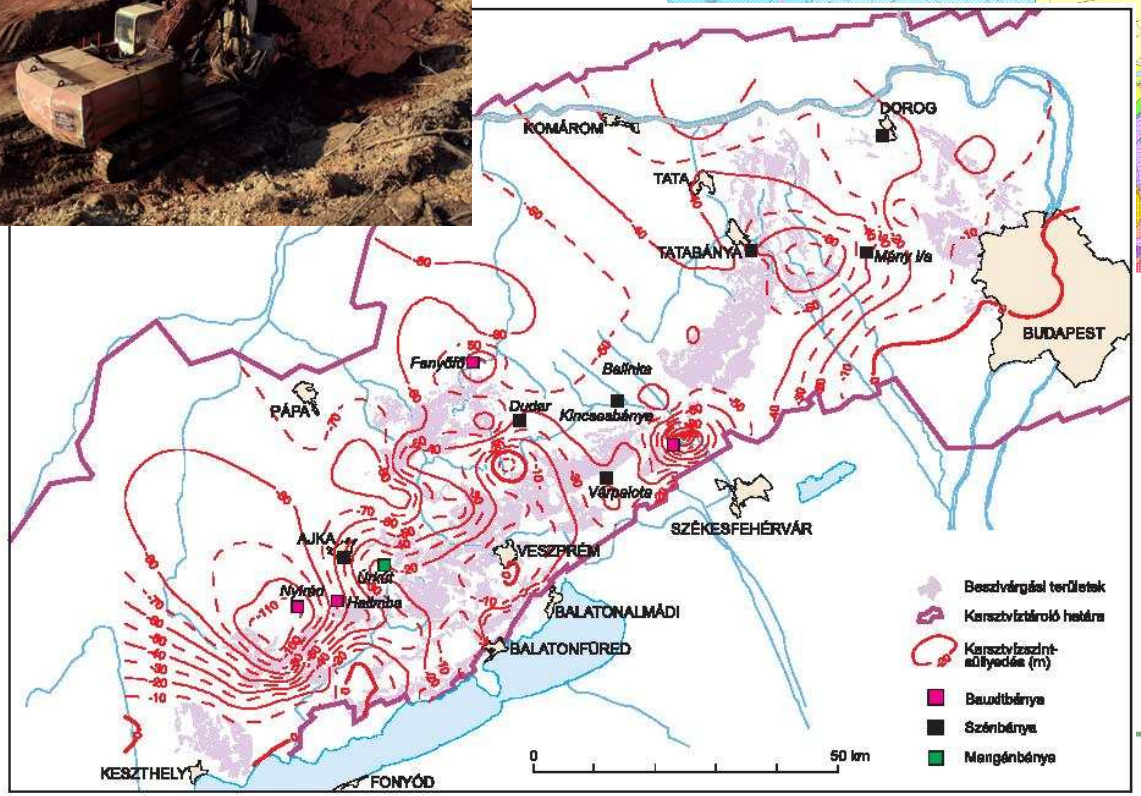


SK-HU cross-border region: Komarno-Sturovo









depression in karst water level 1990's

http://transenergy-eu.geologie.ac.at

Concluding remarks

- Present utilization of geothermal energy is still far below its potential, synergies with water management should be in focus
- Utilization of conventional hydrogeothermal systems require sound reservoir management strategies: production at sustainable levels
- Only harmonized, multi-national management strategies can lead to sustainable utilization of transboundary (geothermal) resources

Transenergy project

assessment of 5 transboundary pilot areas in the W-ern Pannonian basin (SLO, AT, HU, SK) various settings and utilization conflicts

http://transenergy-eu.geologie.ac.at

THANK YOU FOR YOUR ATTENTION!

Japanese macaques hanging out at the hot springs in Macaca Yamanouchi