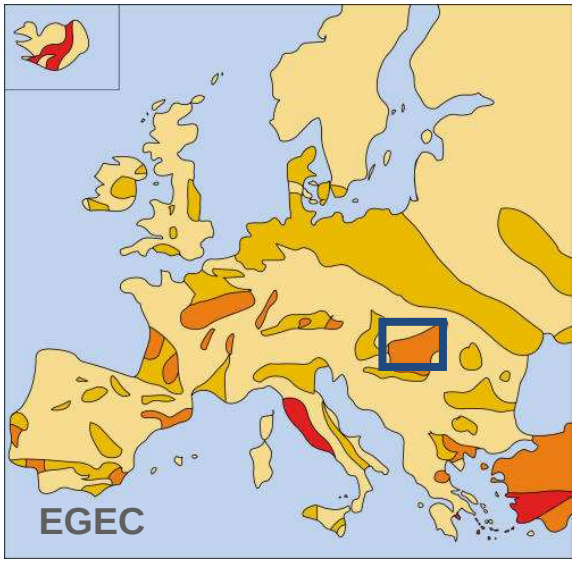
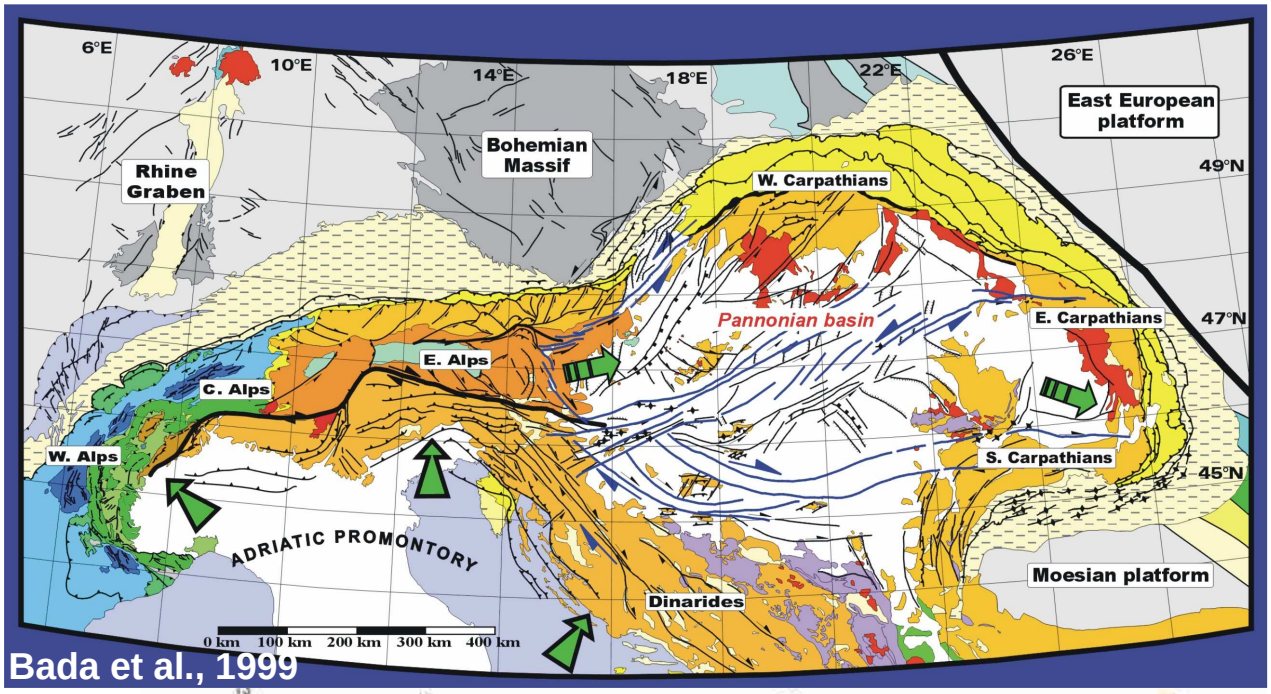
On-going transboundary geothermal exploration projects in the Pannonian Basin

Annamária Nádor

Geological Institute of Hungray

Pannonian basin

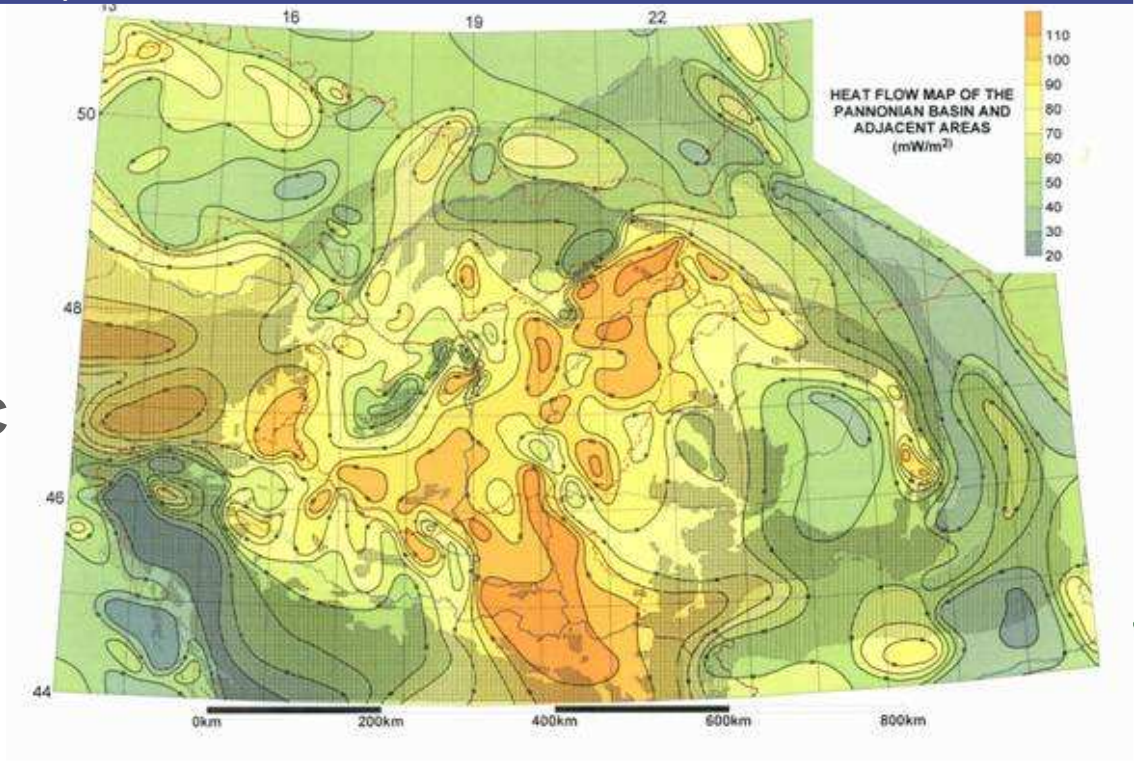




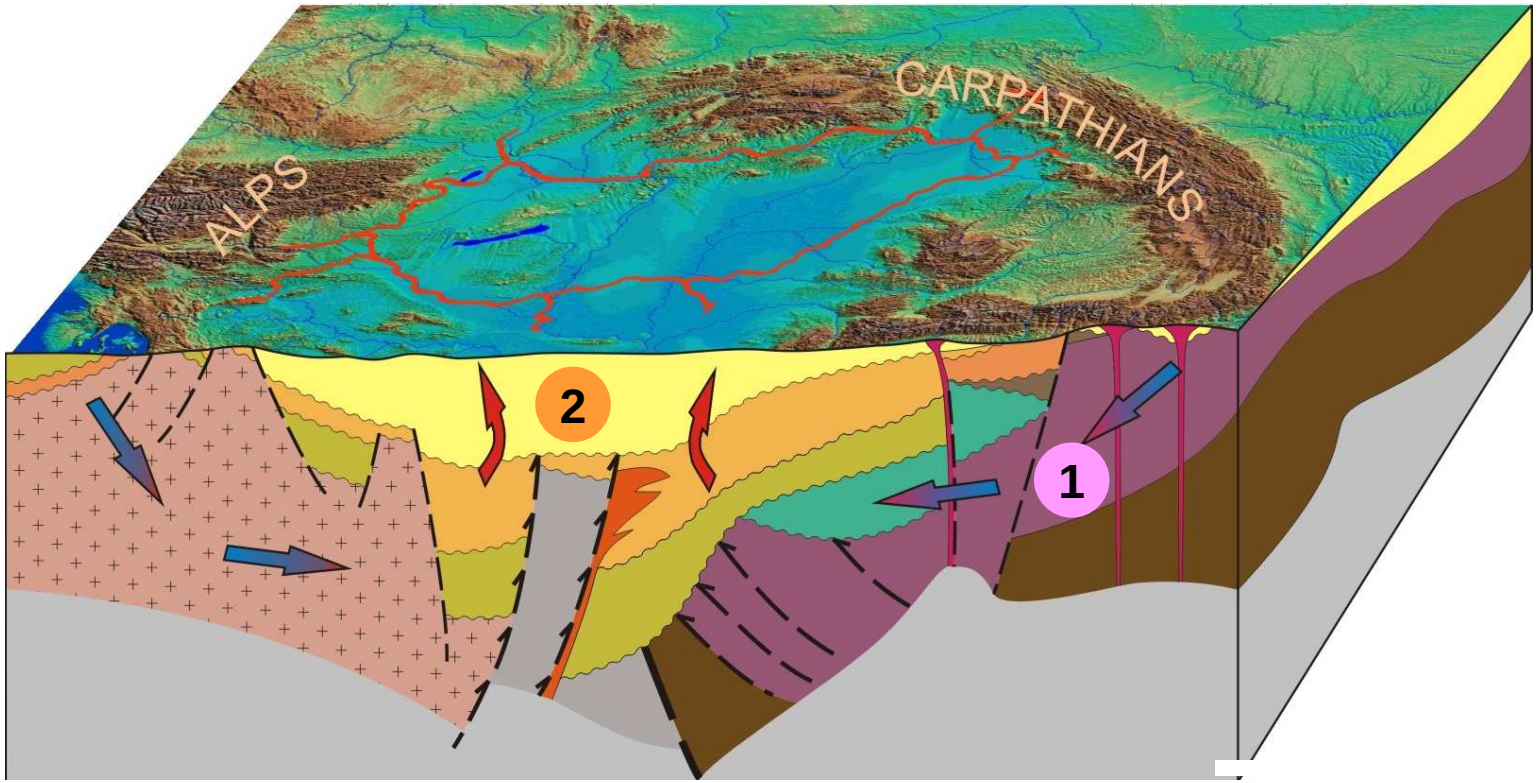
Bada et al., 1999

Average terrestrial heat flow: 100 mW/m²

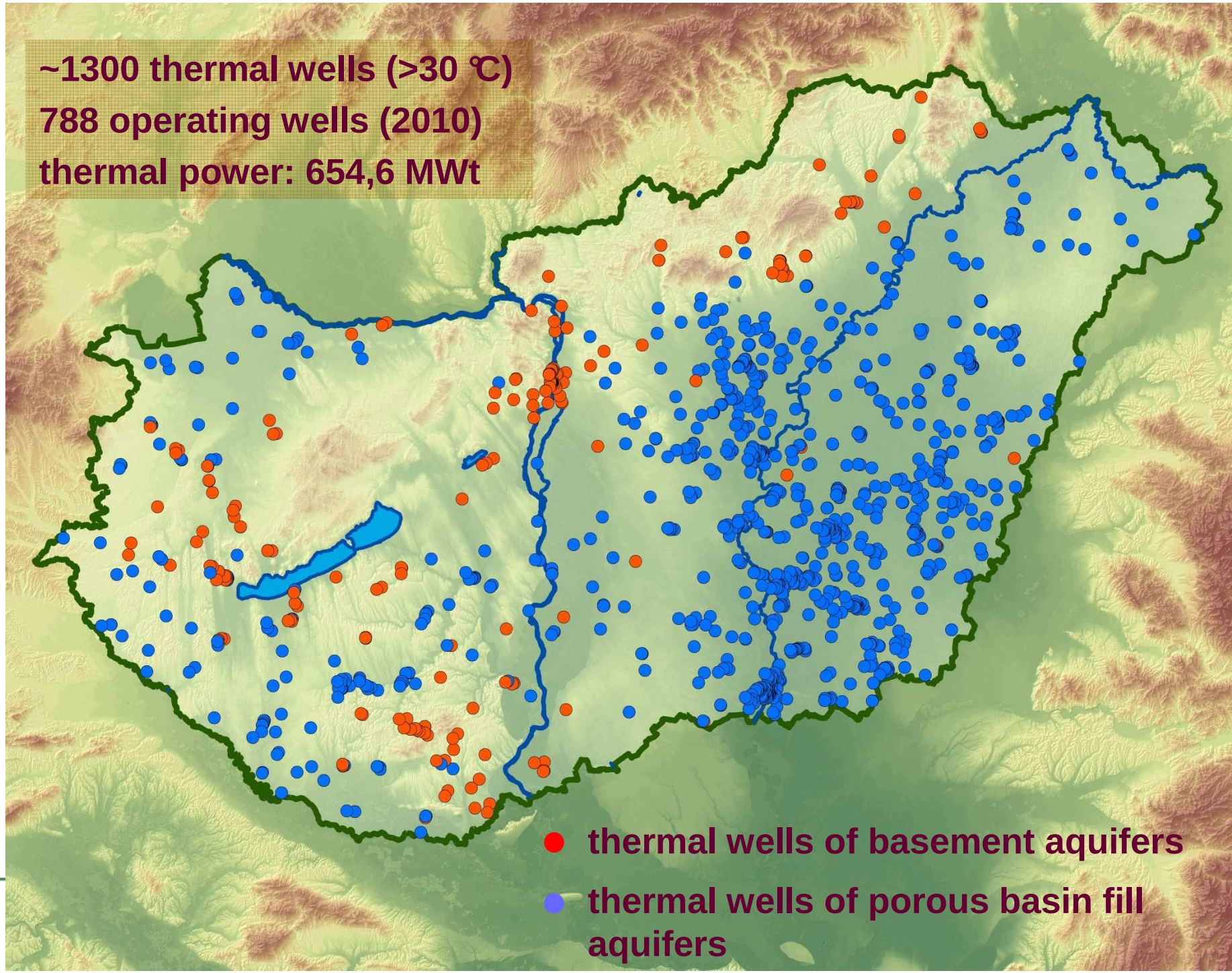
Geothermal gradient: 45 m/℃



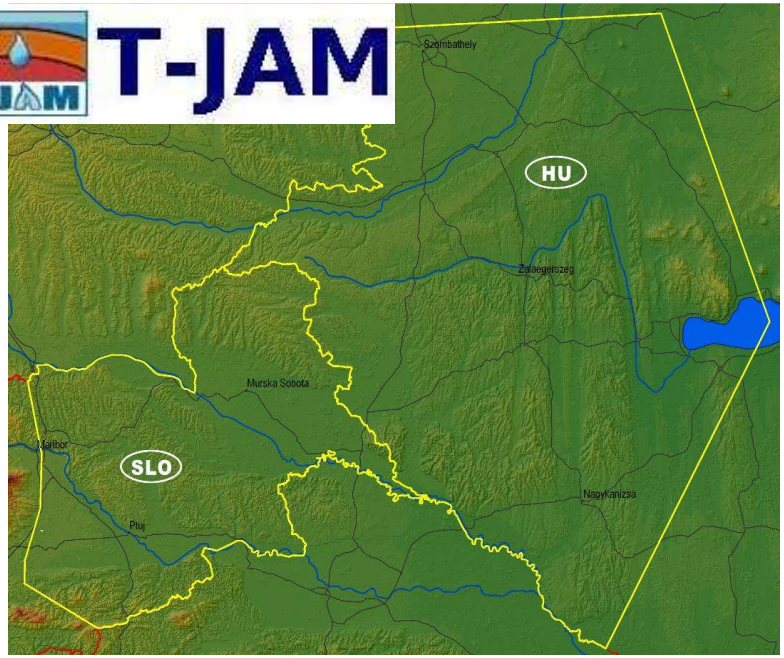
Lenkey et al., 1999



Main geothermal reservoirs	1. fractured, karstified basement rocks (Palaeozoic-Mesozoic)	2. porous multi-layered sandstones, shales (Upper Miocene-Pliocene basin fill)
thickness	80-100 m (upper part)	200-300 m
depth, temperature	>2500 m, >100-120 ℃	800-2000 m, ~60-70 ℃
porosity	< 5%	20-30%
permeability	500 -1500 mD	500 -1500 mD


~1300 thermal wells (>30 ℃)
788 operating wells (2010)
thermal power: 654,6 MWt
thermal wells of basement aquifers
thermal wells of porous basin fill aquifers

T-JAM



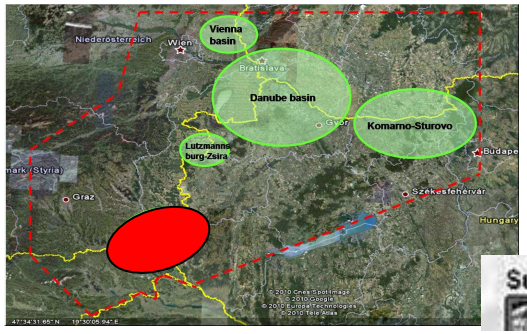
trans energy te

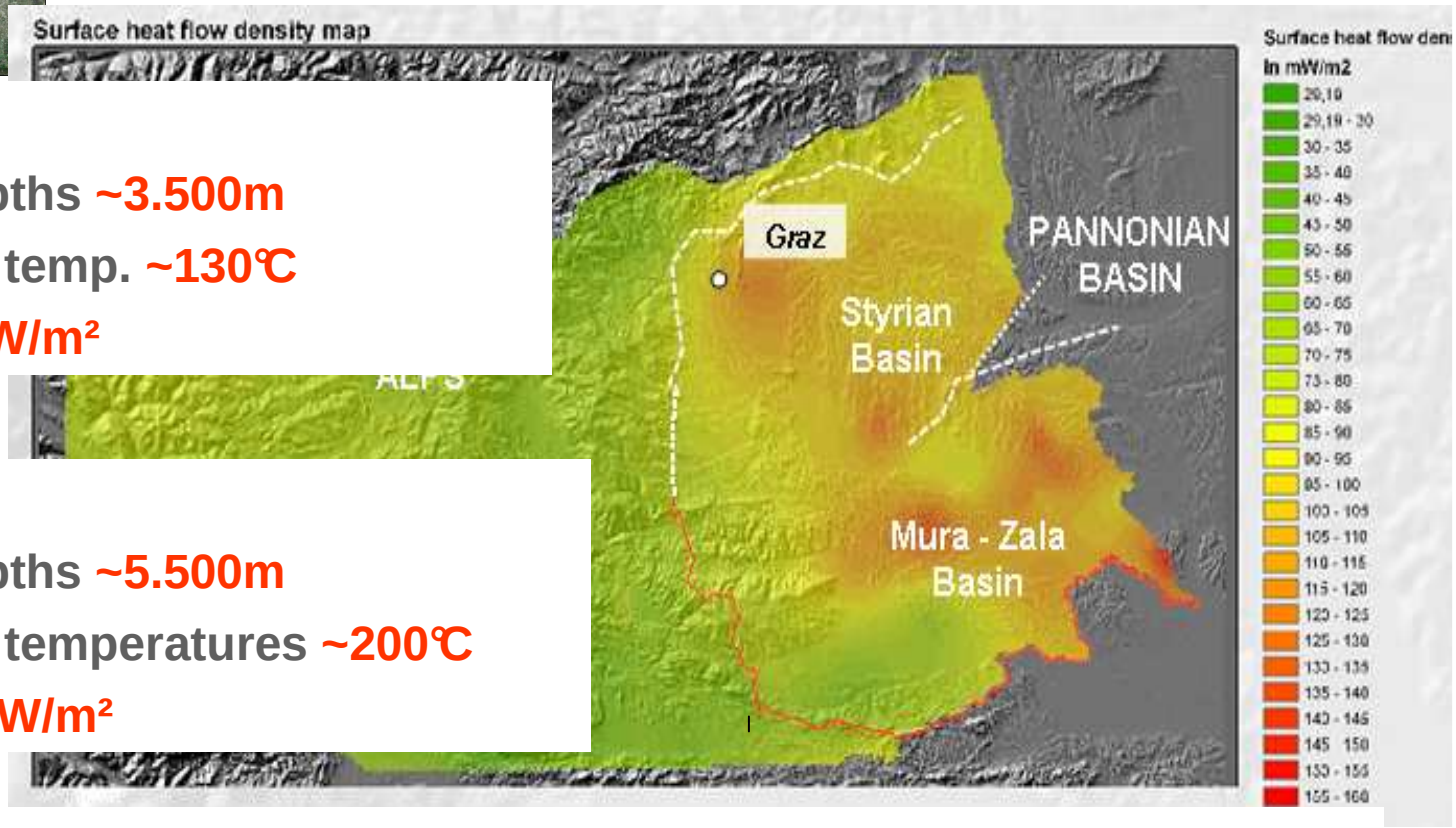
Joint evaluation of transboundary hydrogeothermal systems, recommendations for sustainable utilization and management

- focus on Upper Pannonian hydrogeothermal reservoirs
- shallow geothermal (heat pumps) also included
- single-well concept: to determine amount of extractable thermal water
- delineate joint SI-HU porous thermal groundwater body

- focus on porous basin AND basement reservoirs
- no shallow geothermal
- single AND double-well concept: focus on energetic utilization
- steady state and scenario models for cross-border pilot areas
- web-based decision support tool

SLO-A-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**

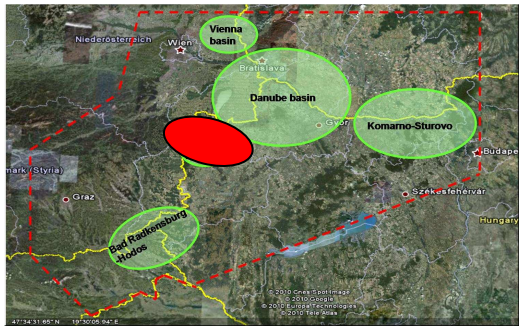
Maximum reservoir temperatures **~200℃**

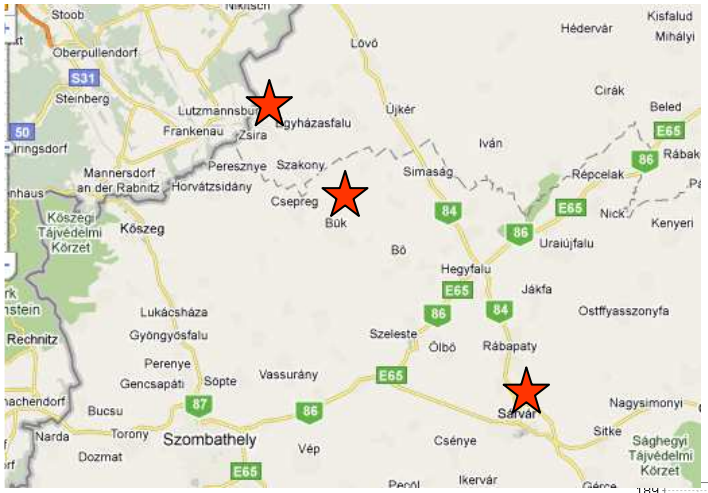
Heat flow **60 -150 mW/m²**

Questions addressed:

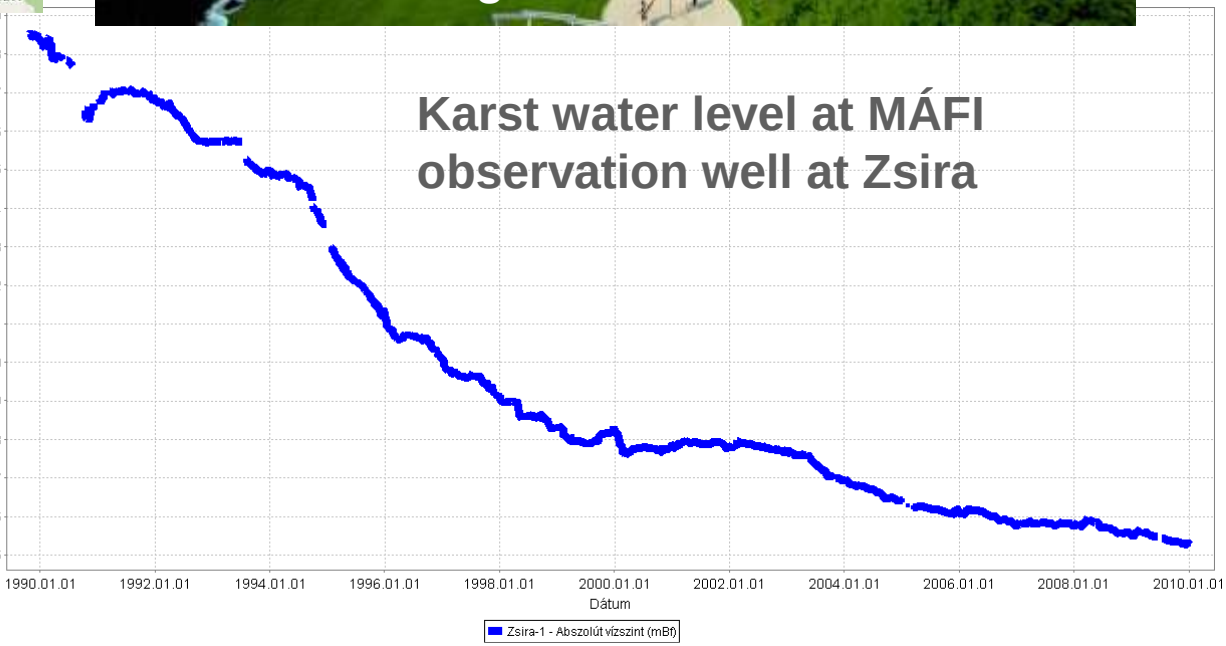
- preneogene carbonate reservoir of the Radgona-Hodos area – role of hydraulic barriers on possible recharge
- modelling of a narrow fissured aquifer (Rába fault zone)
- cross-border utilization problems (Bad Radkensburg and vicinity)

A-HU cross-border region: Lutzmannsburg Zsira





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



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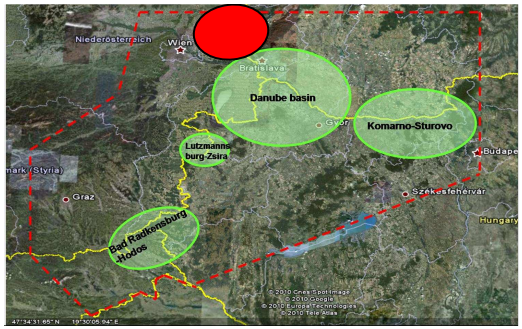
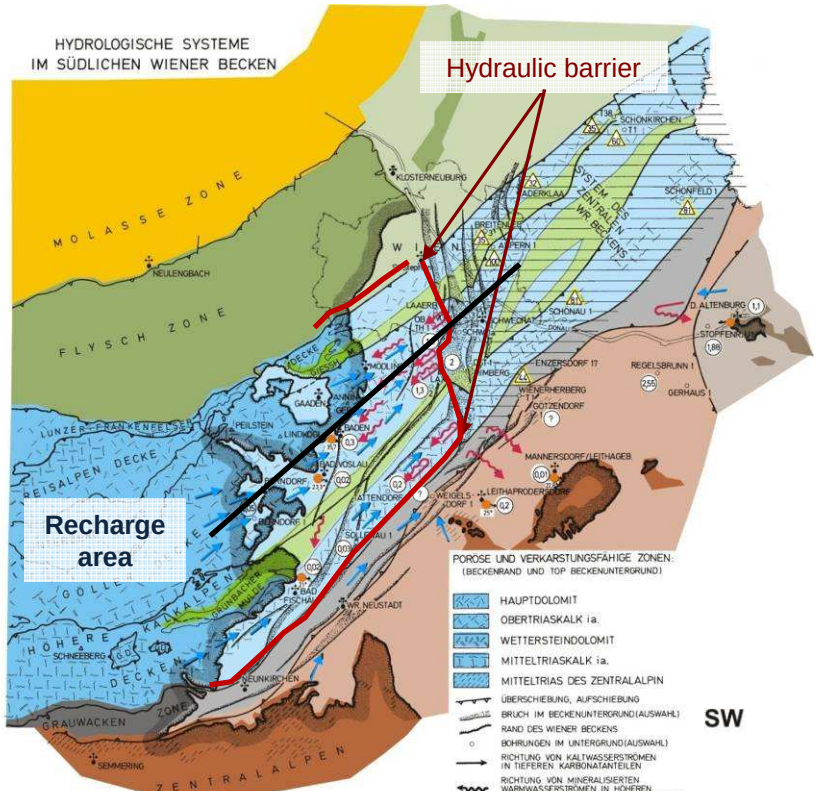
A-SK cross-border region: Vienna basin





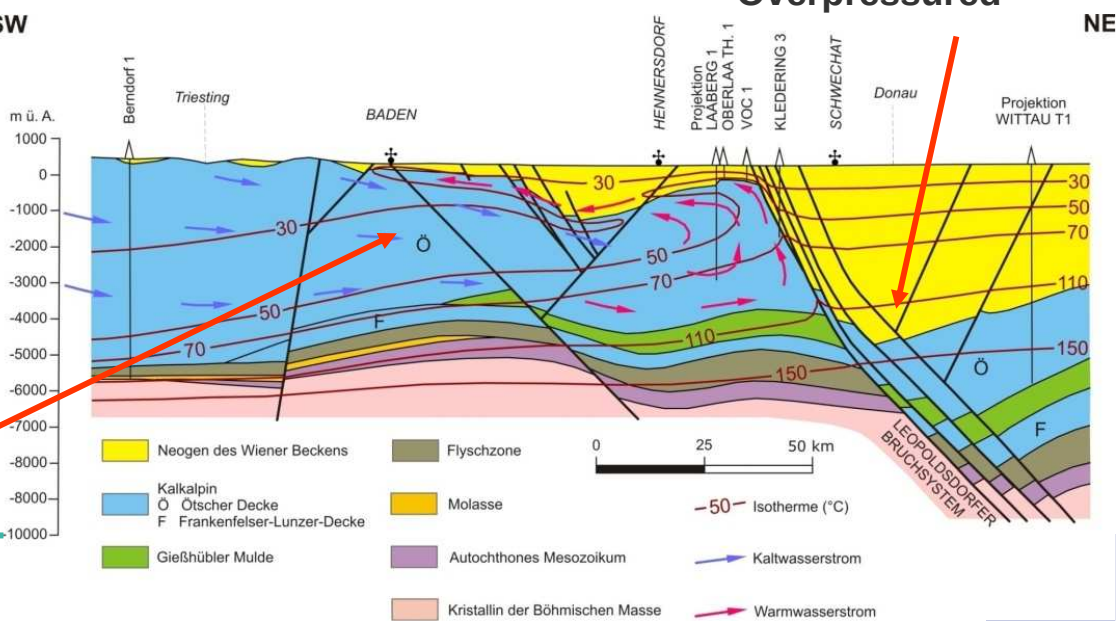
Questions addressed:

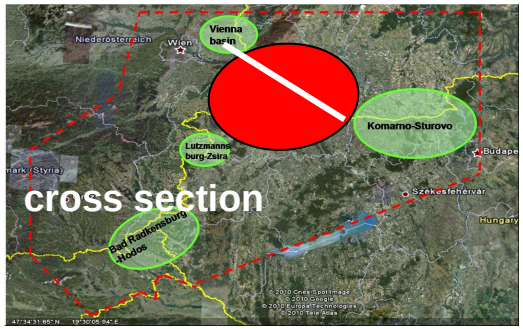
- ➢conflicts with hydrocarbon exploration
- ➢promote hydrogeothermal utilization in the central depression

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

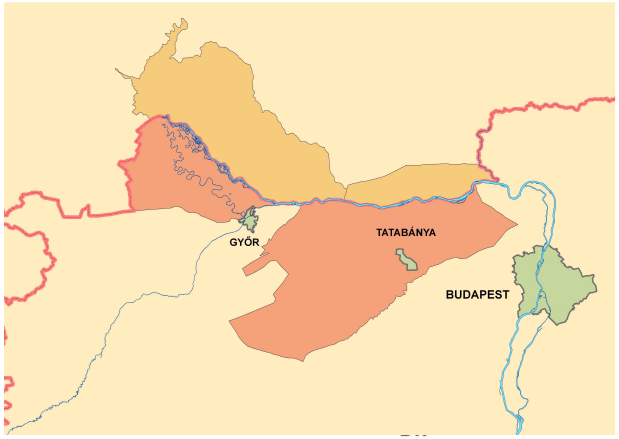
High mineralization
Connate
Overpressured

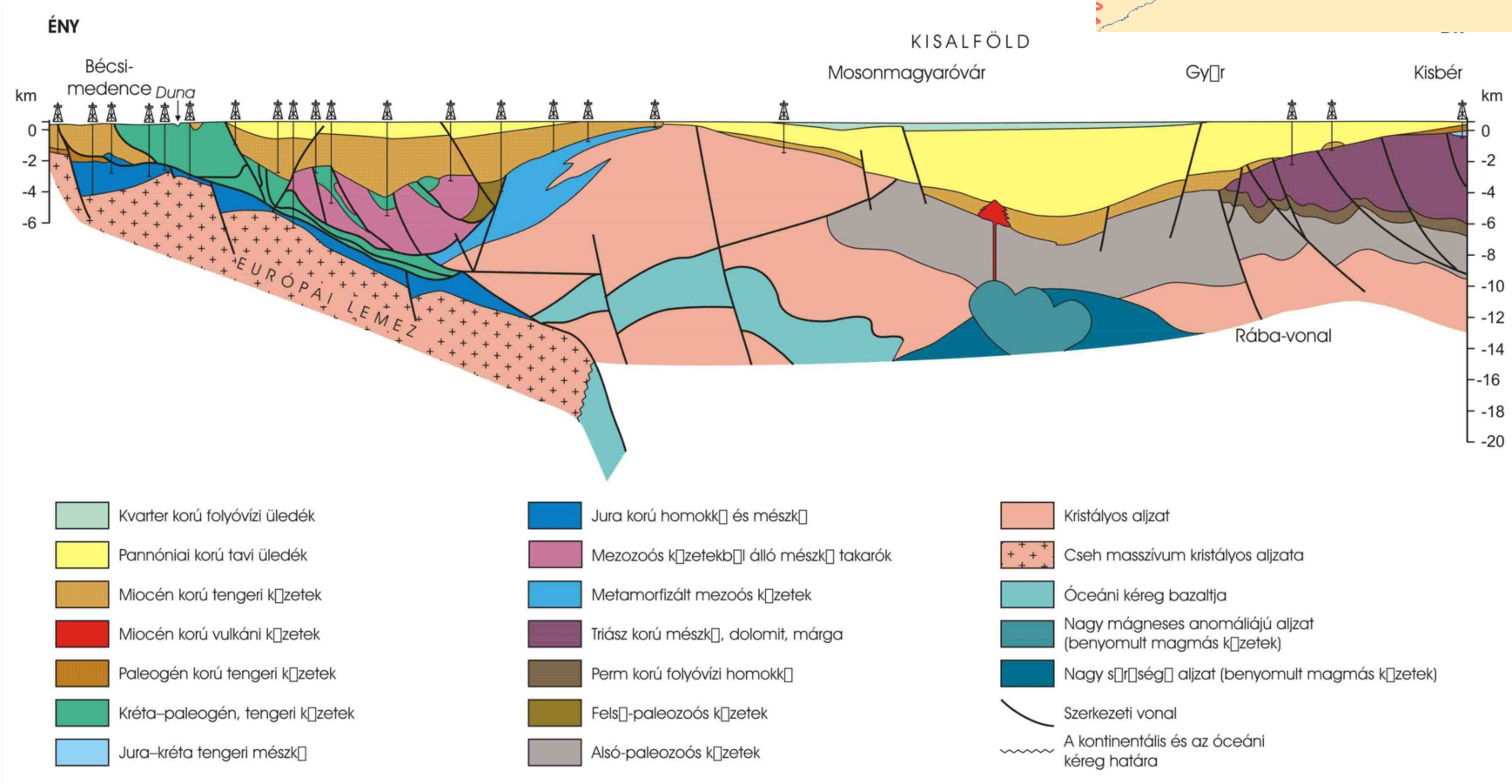
Low mineralization
Active recharge
Temperature anomalies

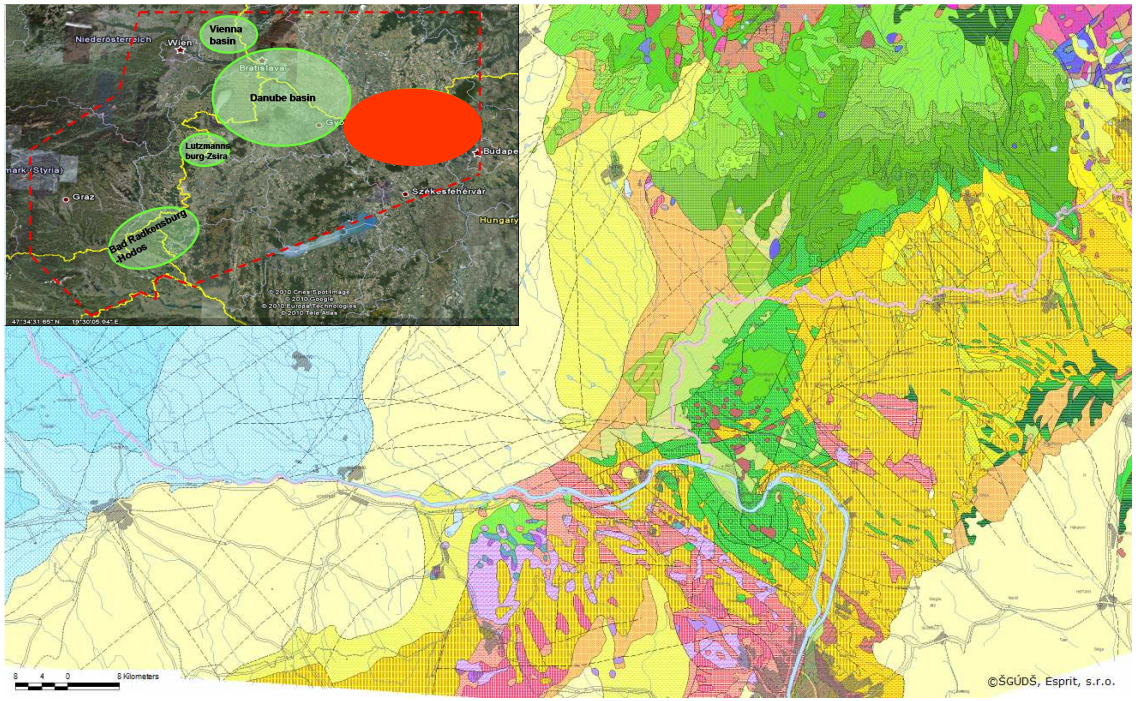




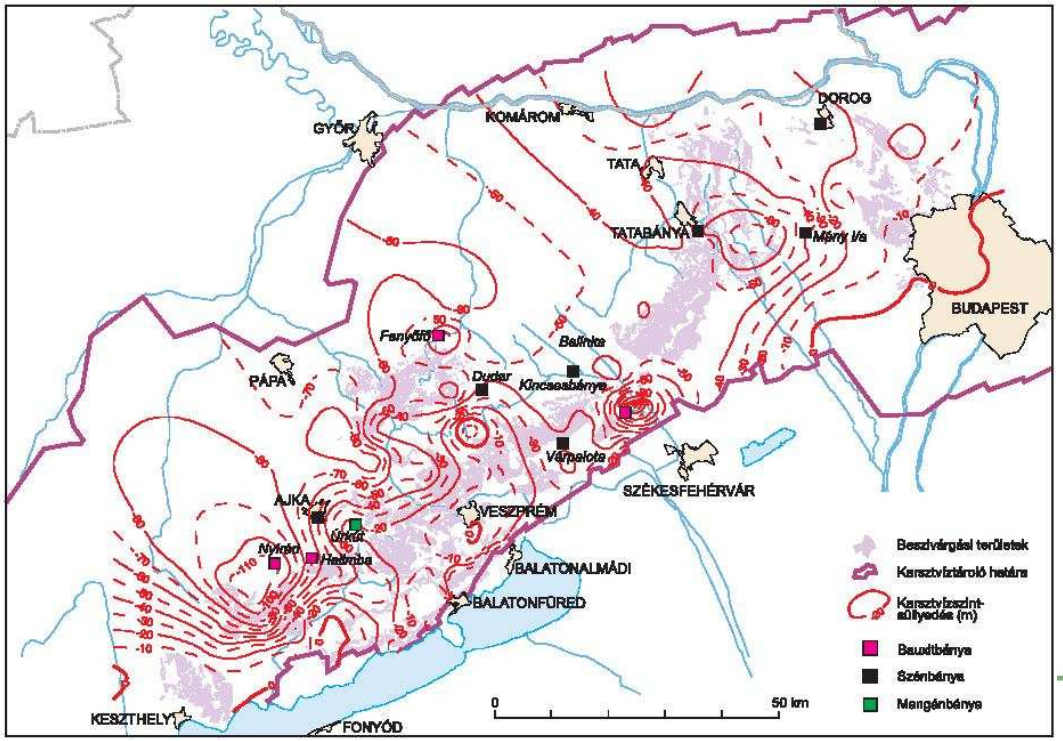
A-HU-SK cross-border region: Danube basin







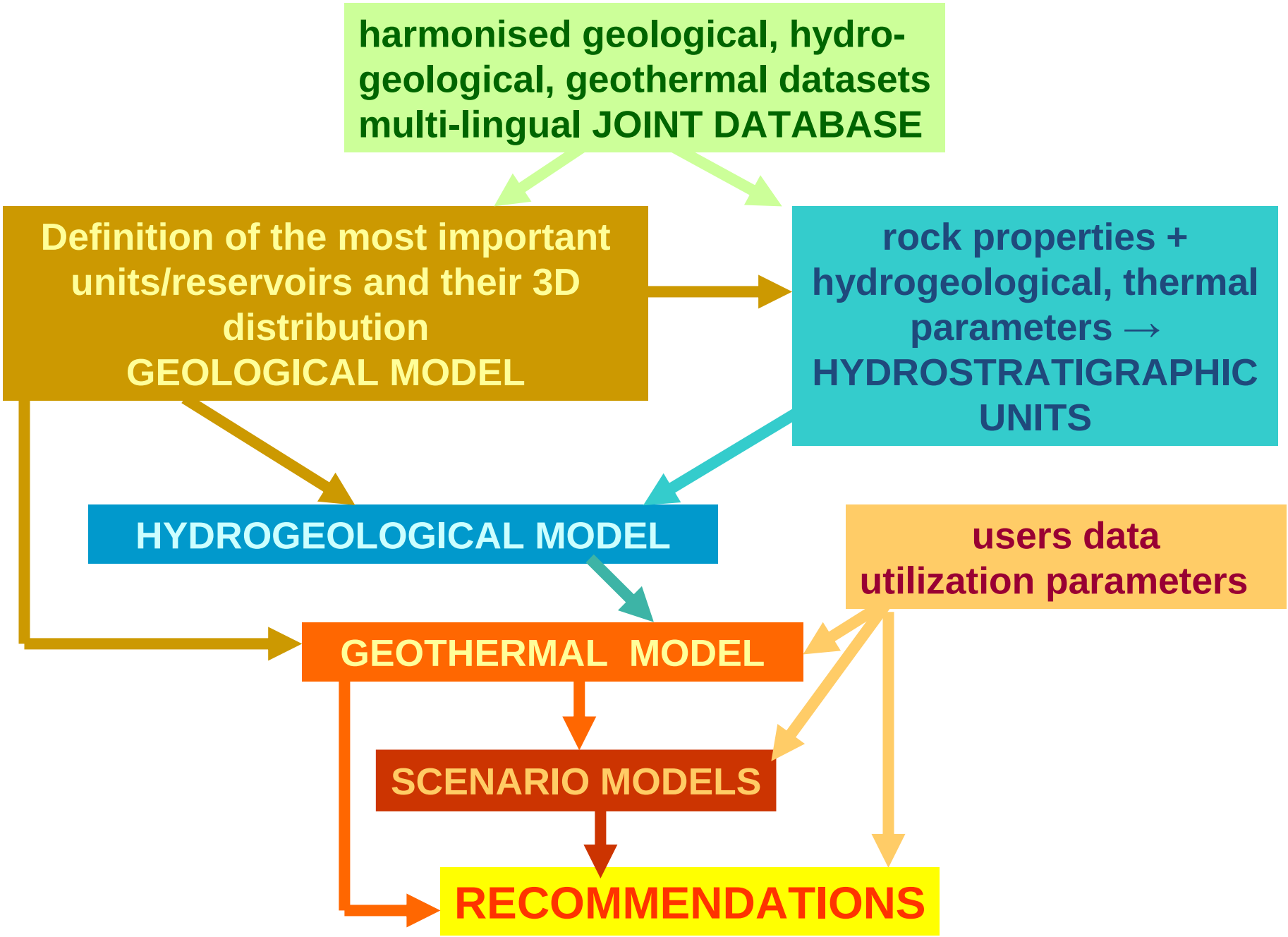
SK-HU cross-border region: Komarno-Sturovo



Questions addressed:

- mining related karstwater withdrawal vs. hydrogeothermal systems
- possible utilization according to different withdrawal scenarios

depression in karst water level 1990's


harmonised geological, hydro-geological, geothermal datasets multi-lingual JOINT DATABASE
Definition of the most important units/reservoirs and their 3D distribution GEOLOGICAL MODEL
rock properties + hydrogeological, thermal parameters → HYDROSTRATIGRAPHIC UNITS
HYDROGEOLOGICAL MODEL
users data utilization parameters
GEOTHERMAL MODEL
SCENARIO MODELS
RECOMMENDATIONS

Multi-lingual joint database (MS-Access)

basic data (name, coordinates, depth, screened intervals, etc.)

purpose of drill (hydrogeological, geothermal, oil prospection, reinjection)

utilization (heating, balneology, agriculture, reinjection, no, etc.)

geology (lithology from-to, facies, etc.)

hydrogeology (permeability, porosity, pressure logs, etc.)

geothermics (BHT, T-outflow, thermal conductivity, etc.)

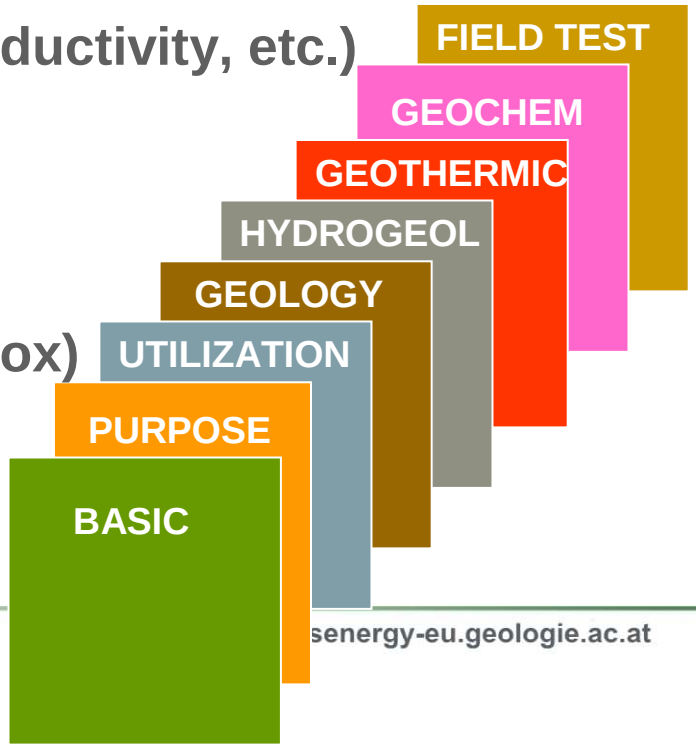
isotopes (O, C, Rn, Ra, noble gases)

organic components

trace elements

field measurements (pH, conductivity, redox)

pumping test (yield, level)



Hungary		Slovenia	
Expert	Public	Expert	Public
792	158	404	99

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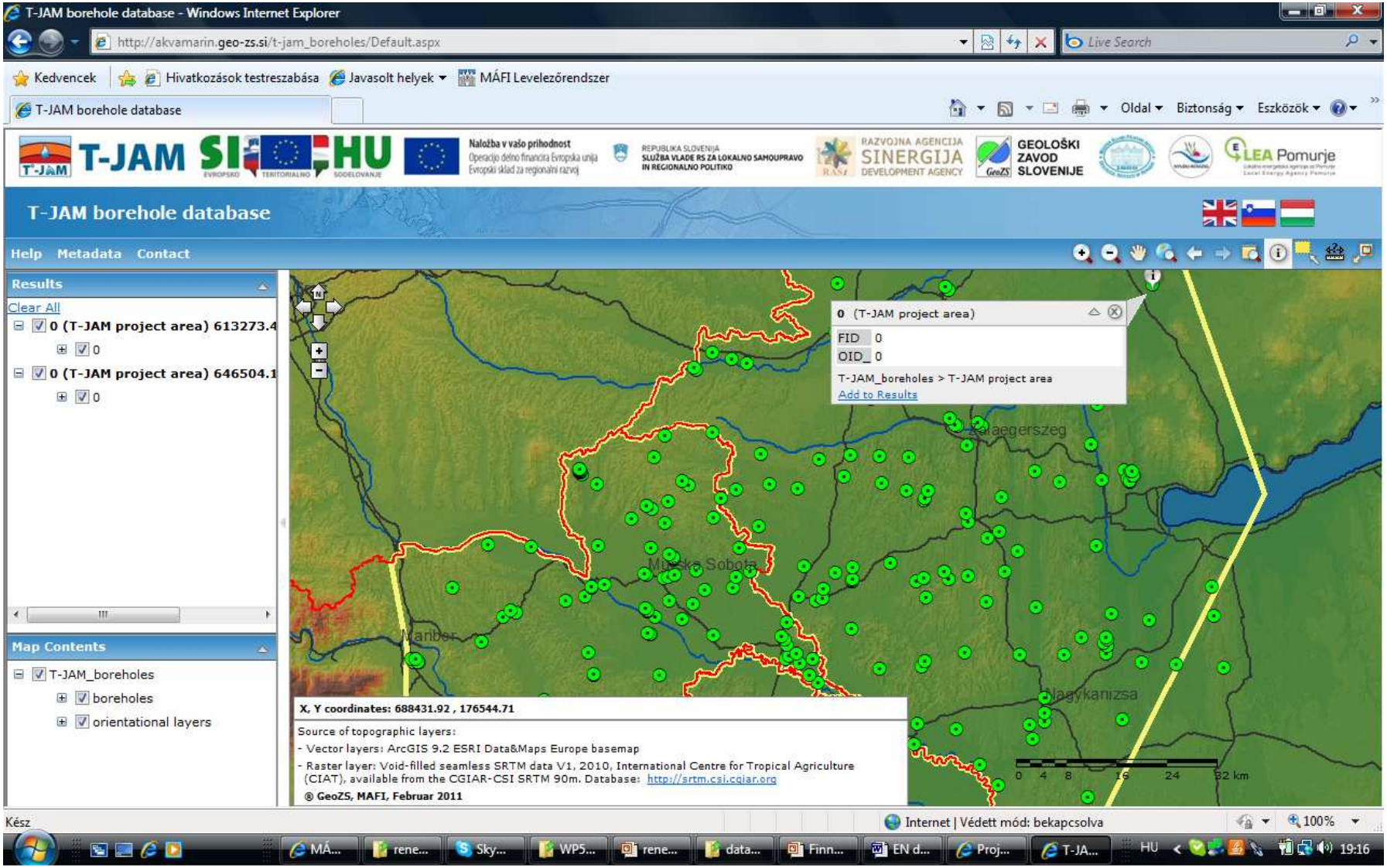
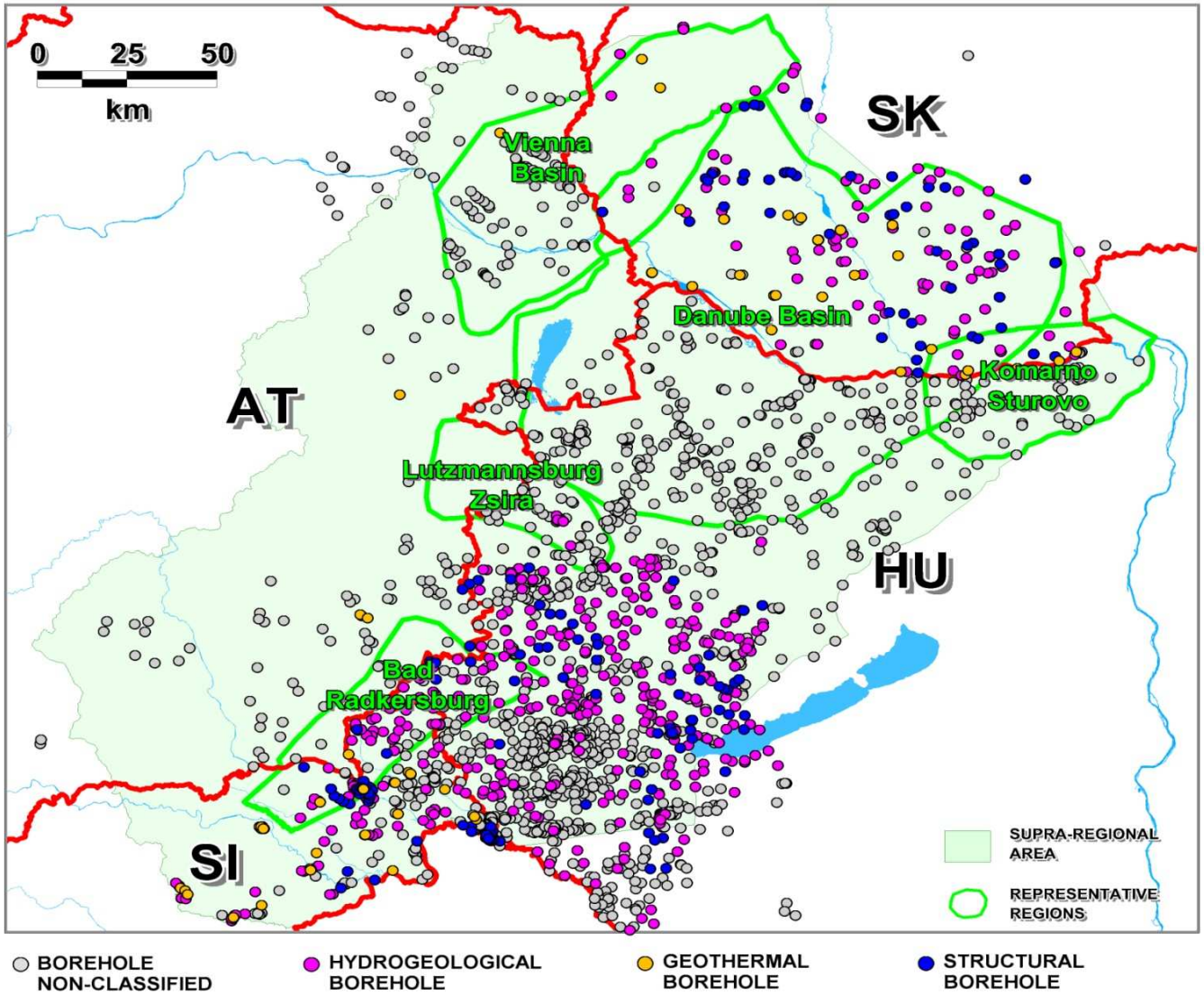




Number of boreholes *(March 31, 2011)*

SK: 284

SLO: 455

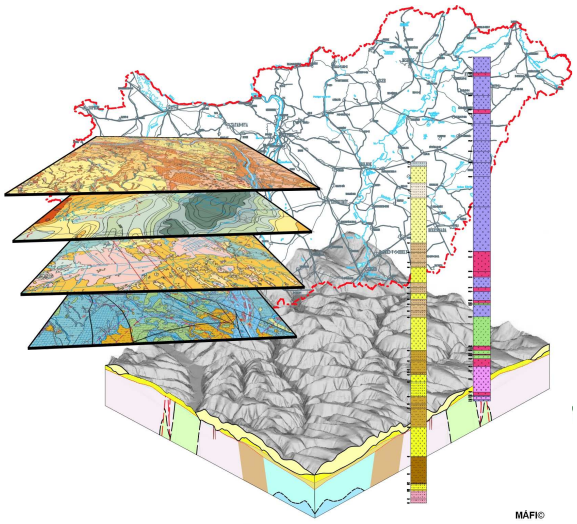
AT: 223*

HU:1797

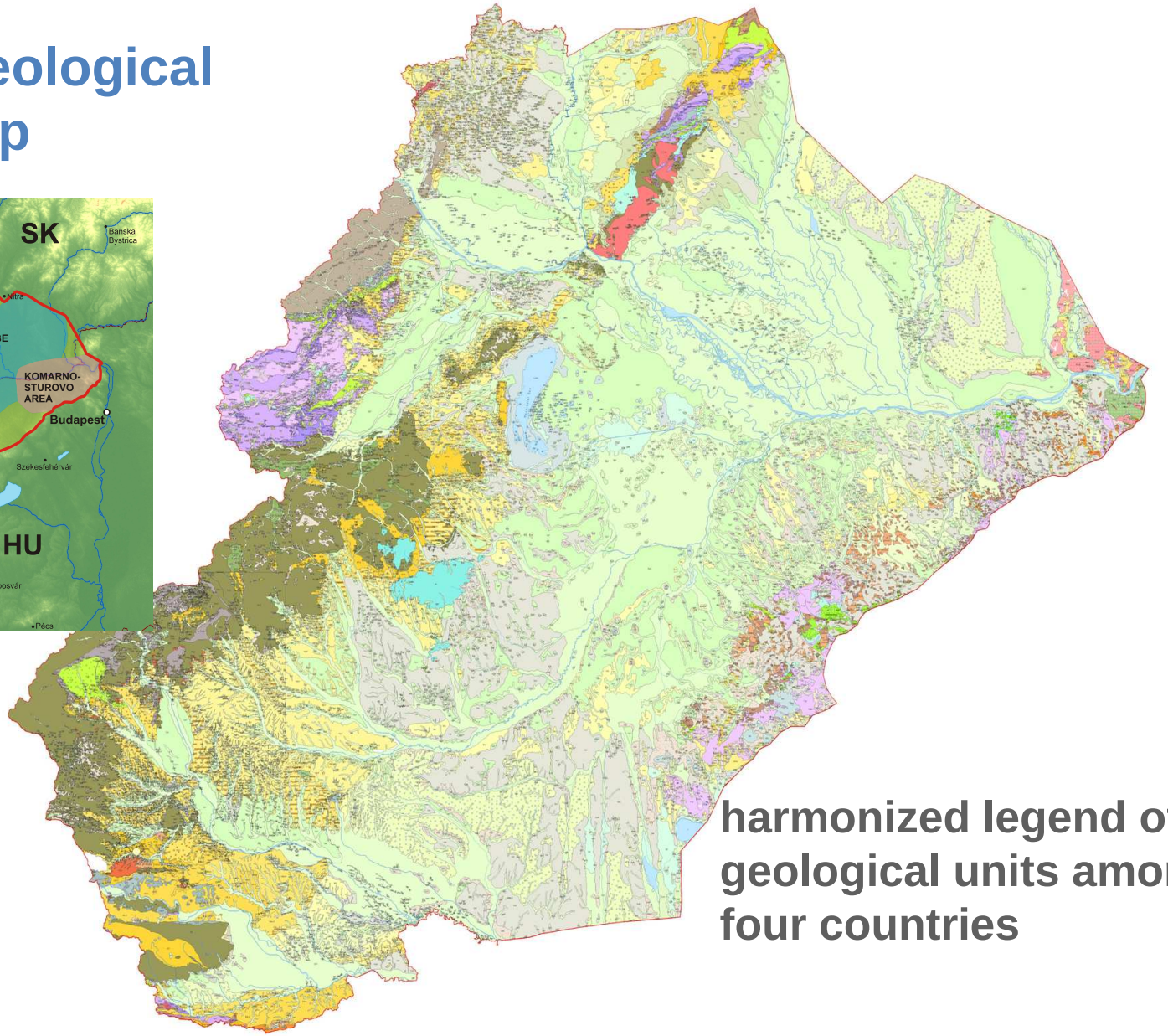
SUM: 2759

Geological model: bounding surfaces of hydrostratigraphic units

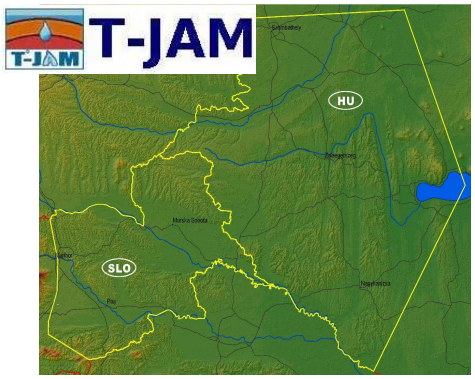
- Quaternary covered (surface) geological map
- Base of the Quaternary formations (Pre-Quaternary)
- Base of the Upper Pannonian formations (base of delta front sands)
- Base of the Lower Pannonian formations (Pre-Pannonian)
- Base of the Sarmatian formations (Pre-Sarmatian)
- Base of the Badenian formations (Pre-Badenian)
- Base of the Neogene formations (Pre-Neogene)
- Base of the Cenozoic formations (Pre-Cenozoic)
- Base of Cretaceous formations (Pre-Creatceous)
- Surface of basement formations

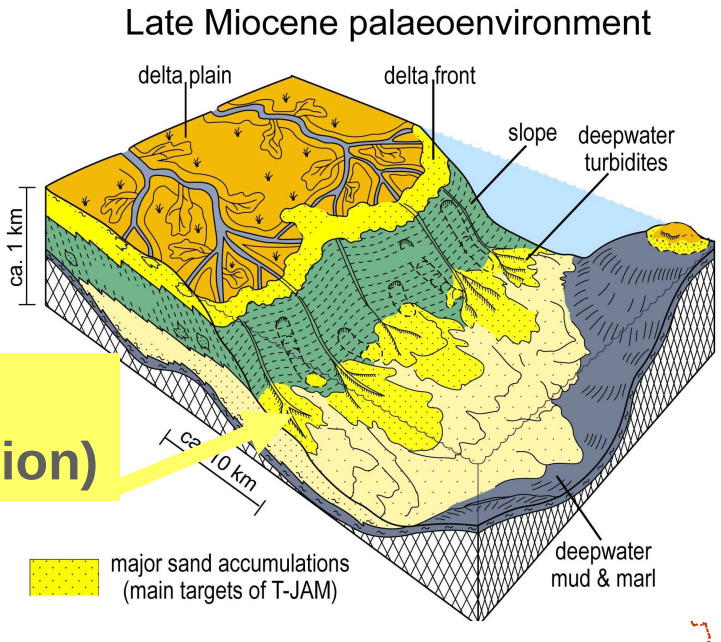


Surface geological map

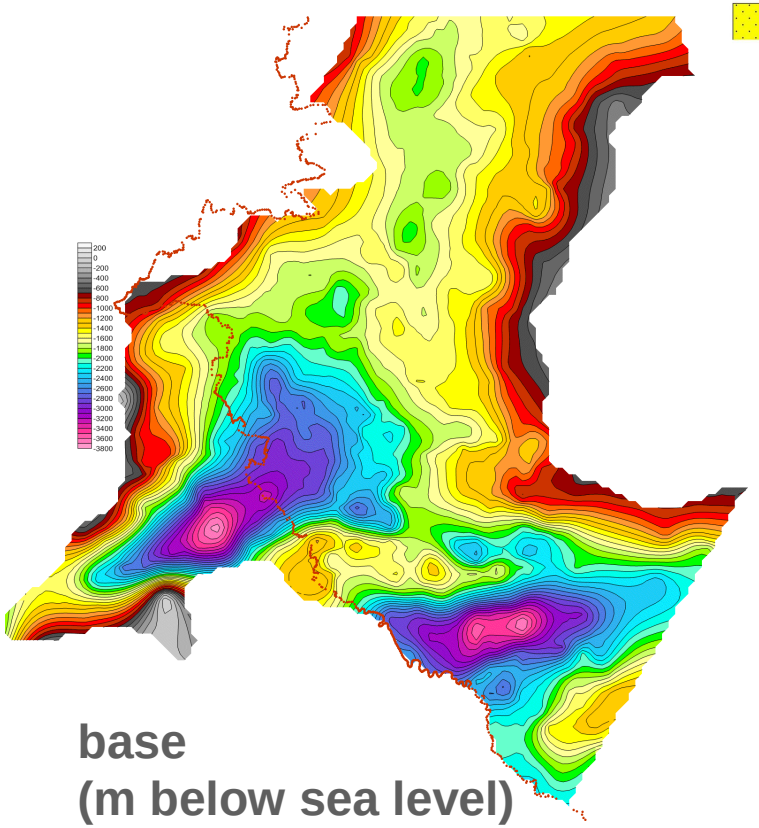


harmonized legend of geological units among four countries

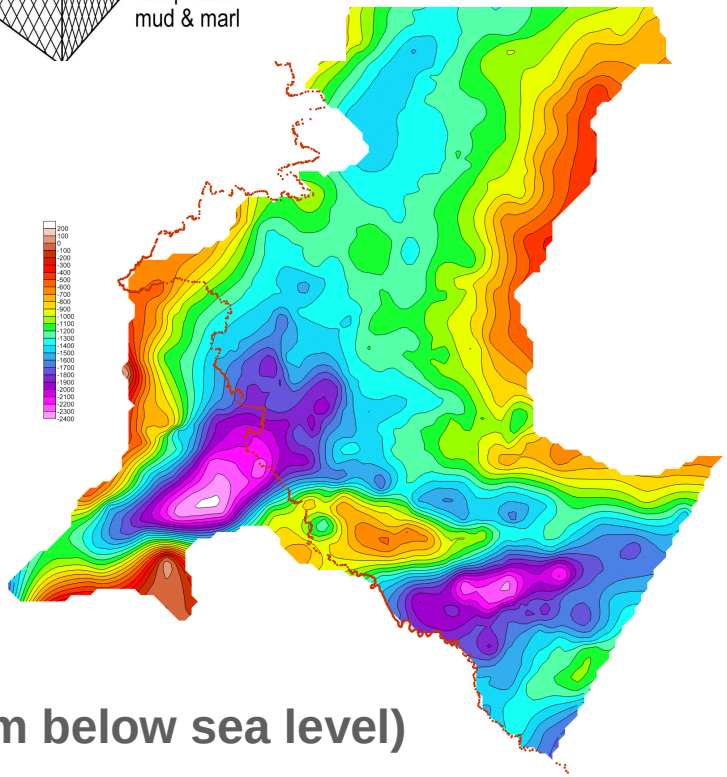




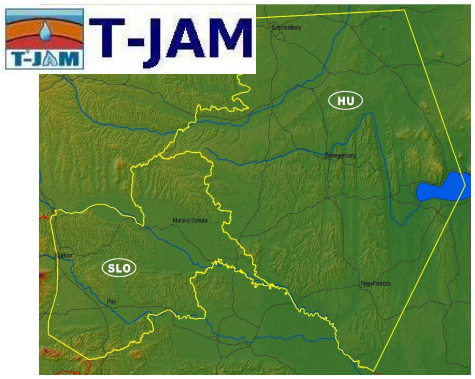
Pannonian turbidites (Szolnok / Lendava Formation)

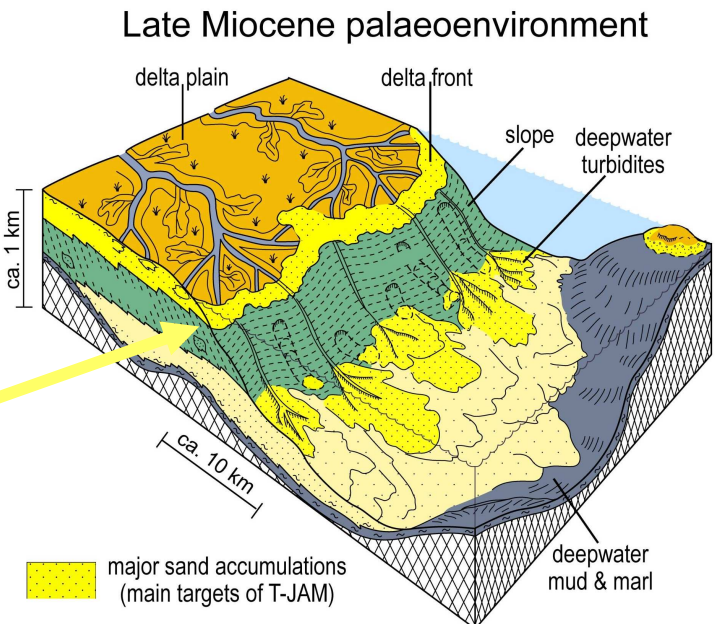


base (m below sea level)

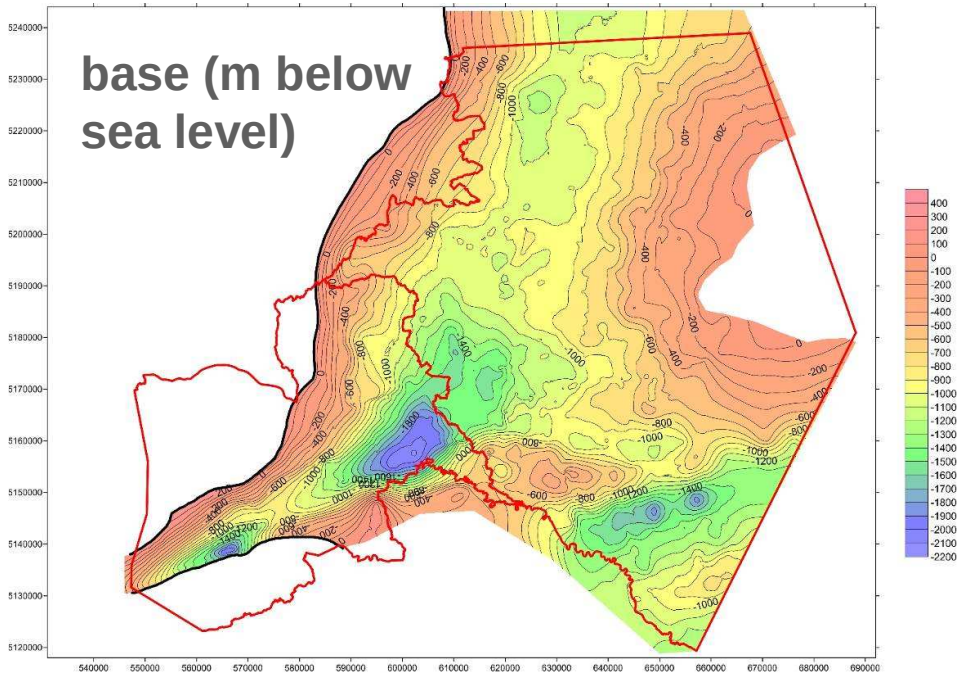


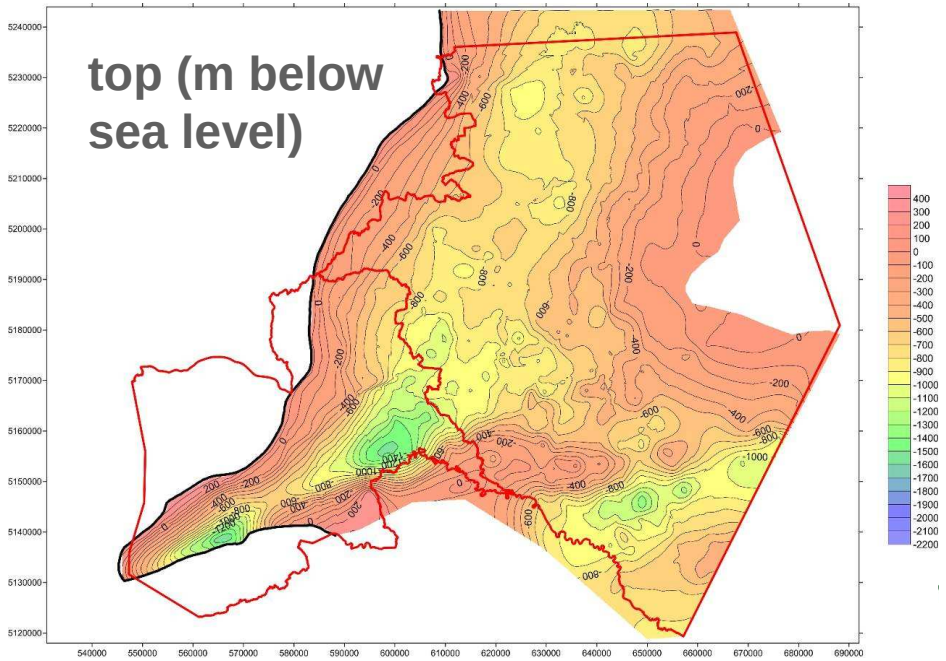
top (m below sea level)

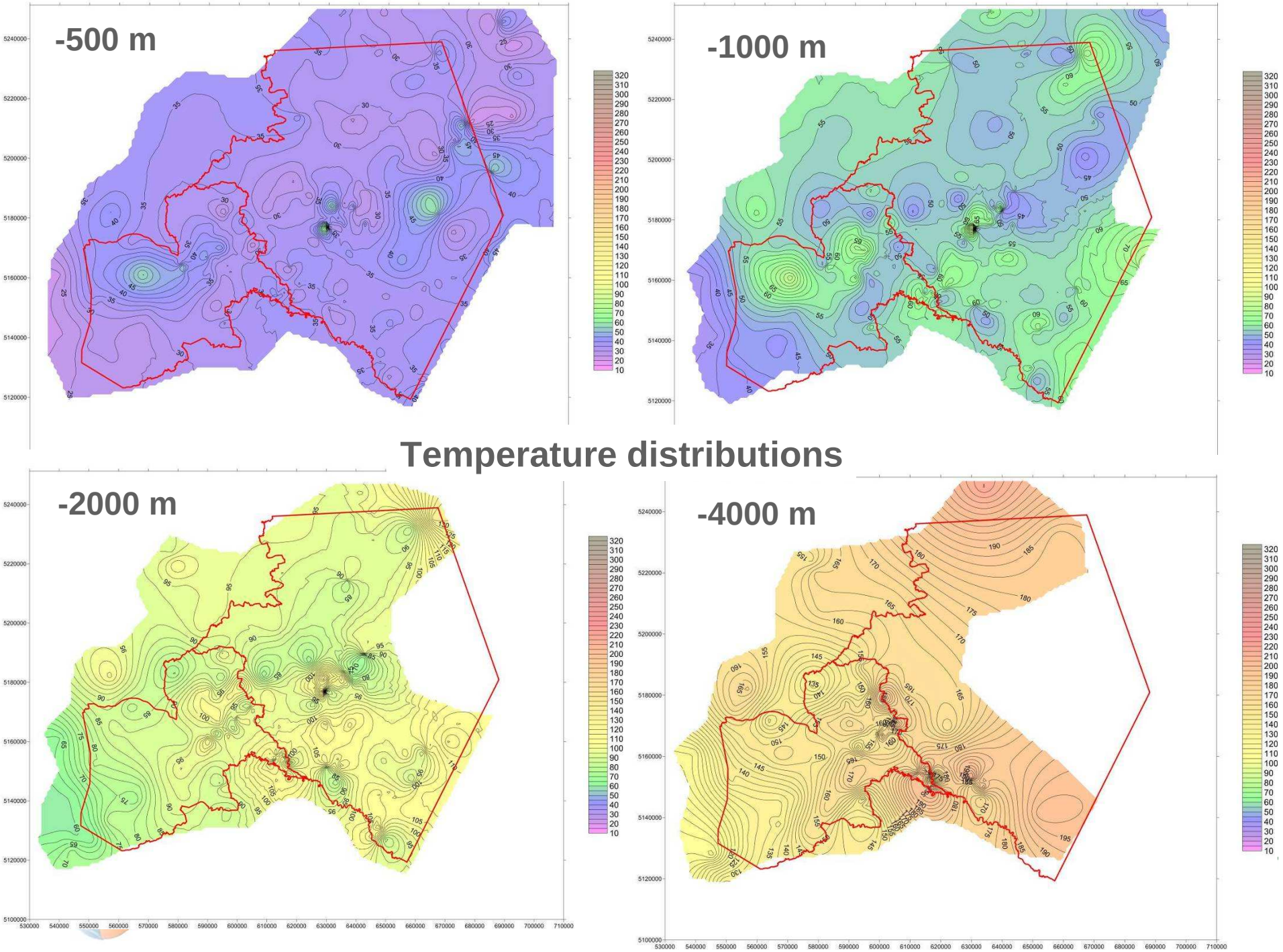




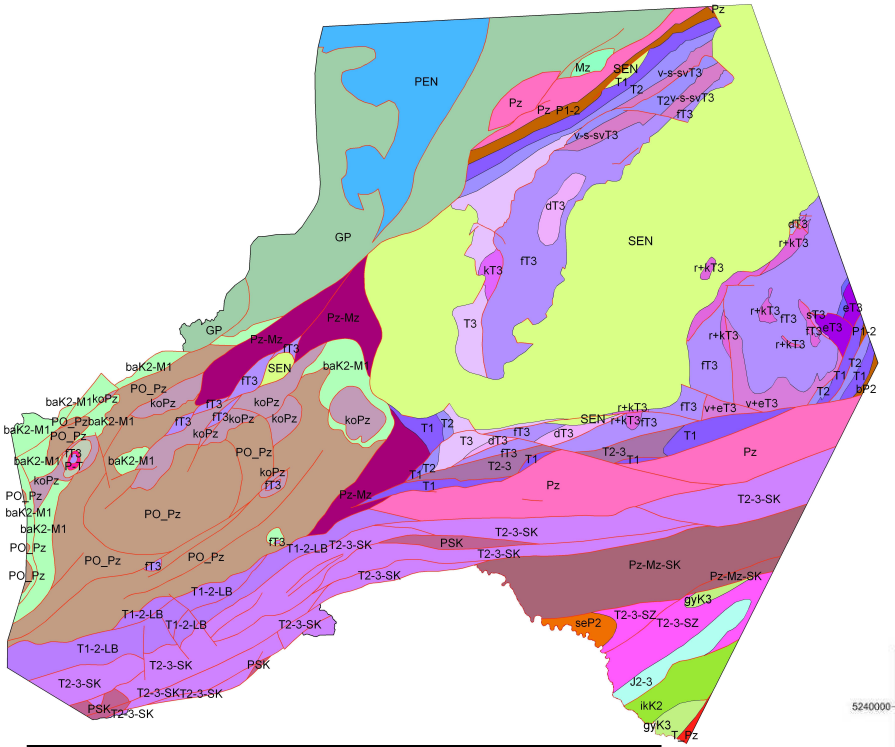
Pannonian delta-front sands Újfalu / Lower Mura Formations

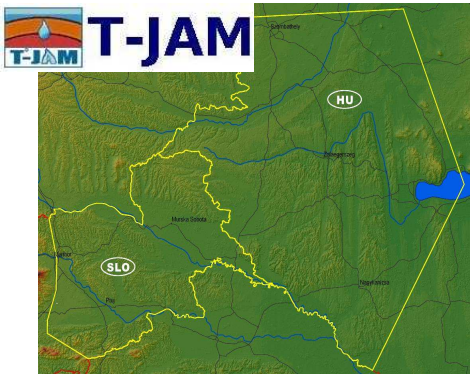




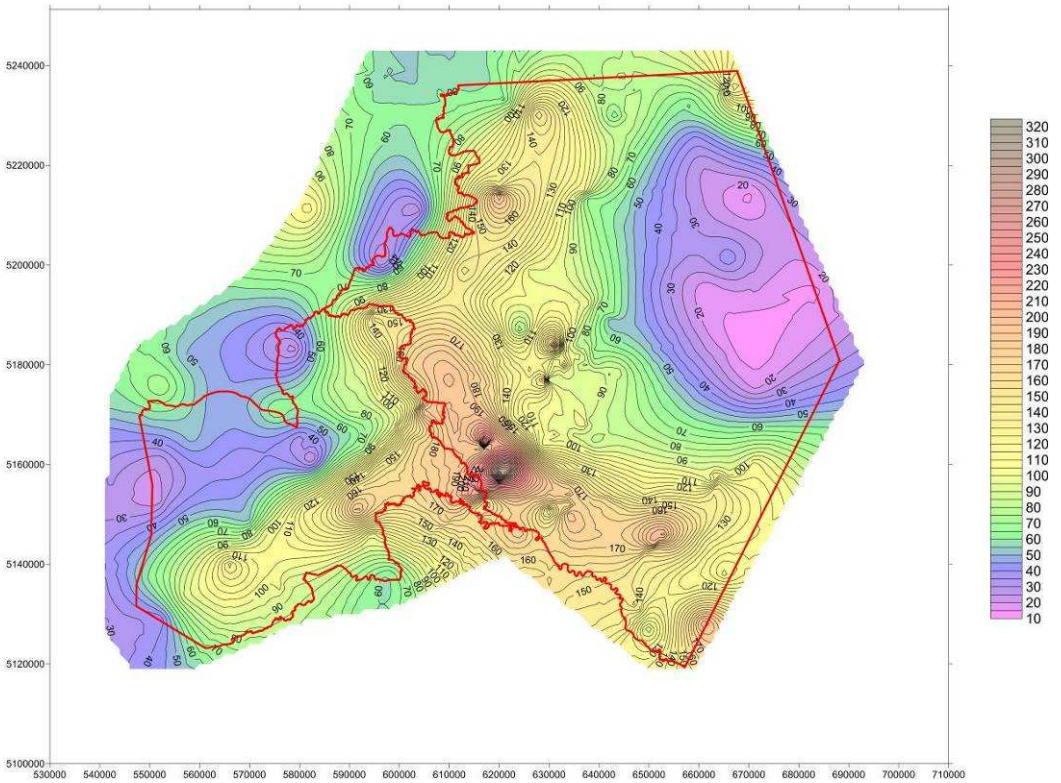

-500 m
-1000 m
Temperature distributions
-2000 m
-4000 m

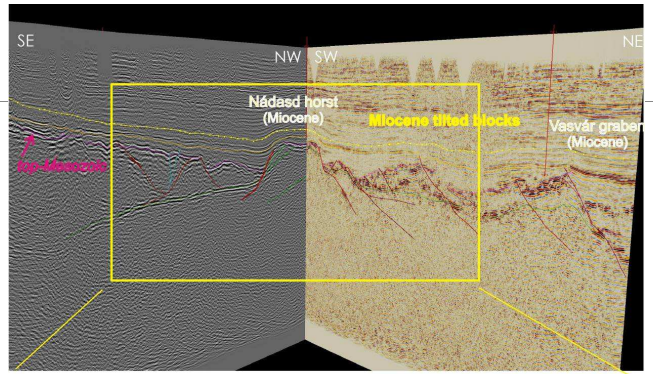
Pre-tertiary basement map

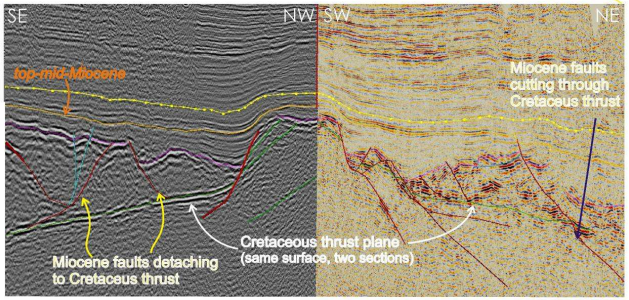




Temperature distribution at the pre-tertiary basement

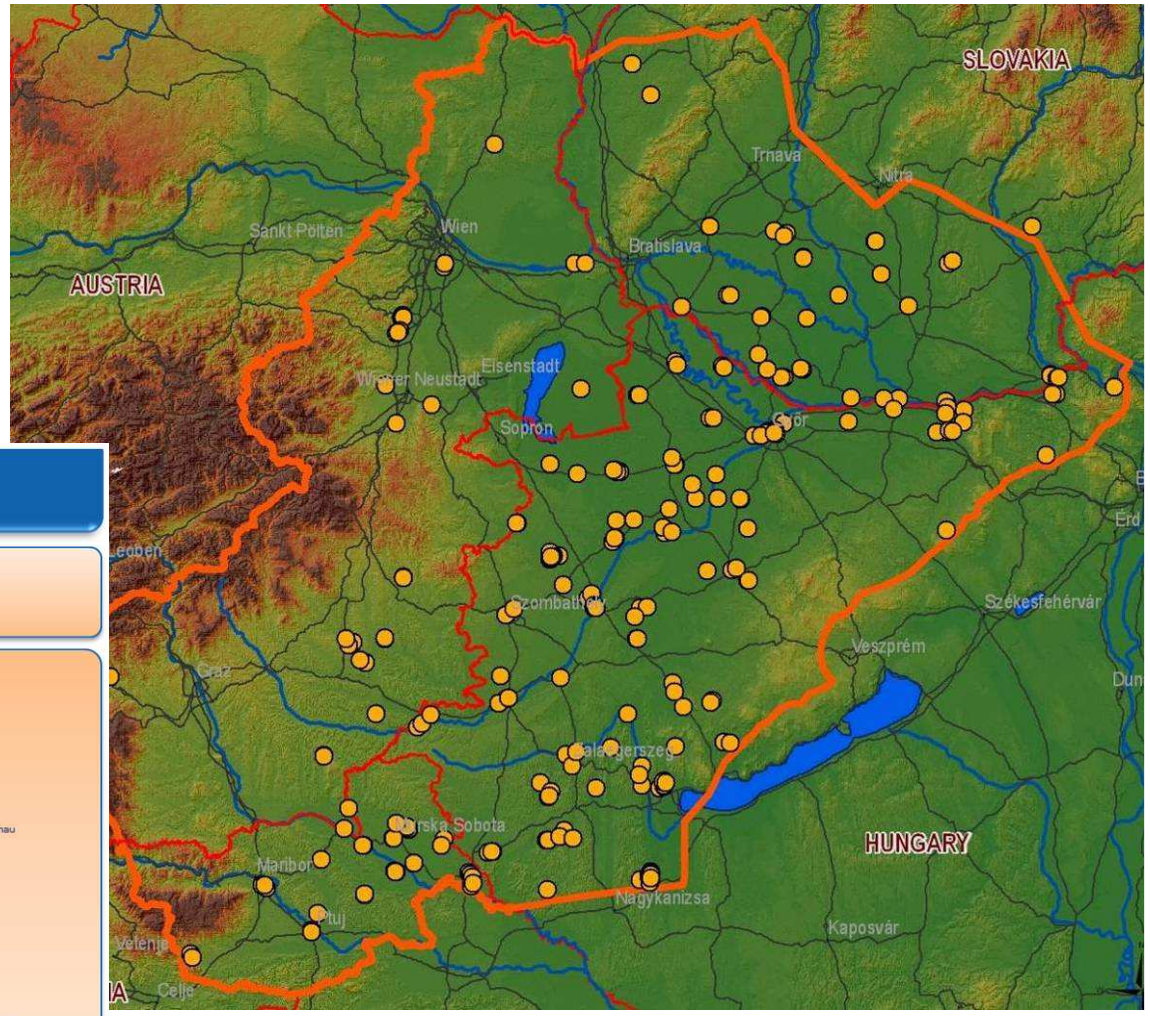






Location of the geothermal users identified in the TRANSENERGY project area

	Organi-zations	Forma-tions	Boreholes
SLO	23	27	35
SK	28	31	39
AT	20	26	50
HU	104	131	184
Total	175	215	308



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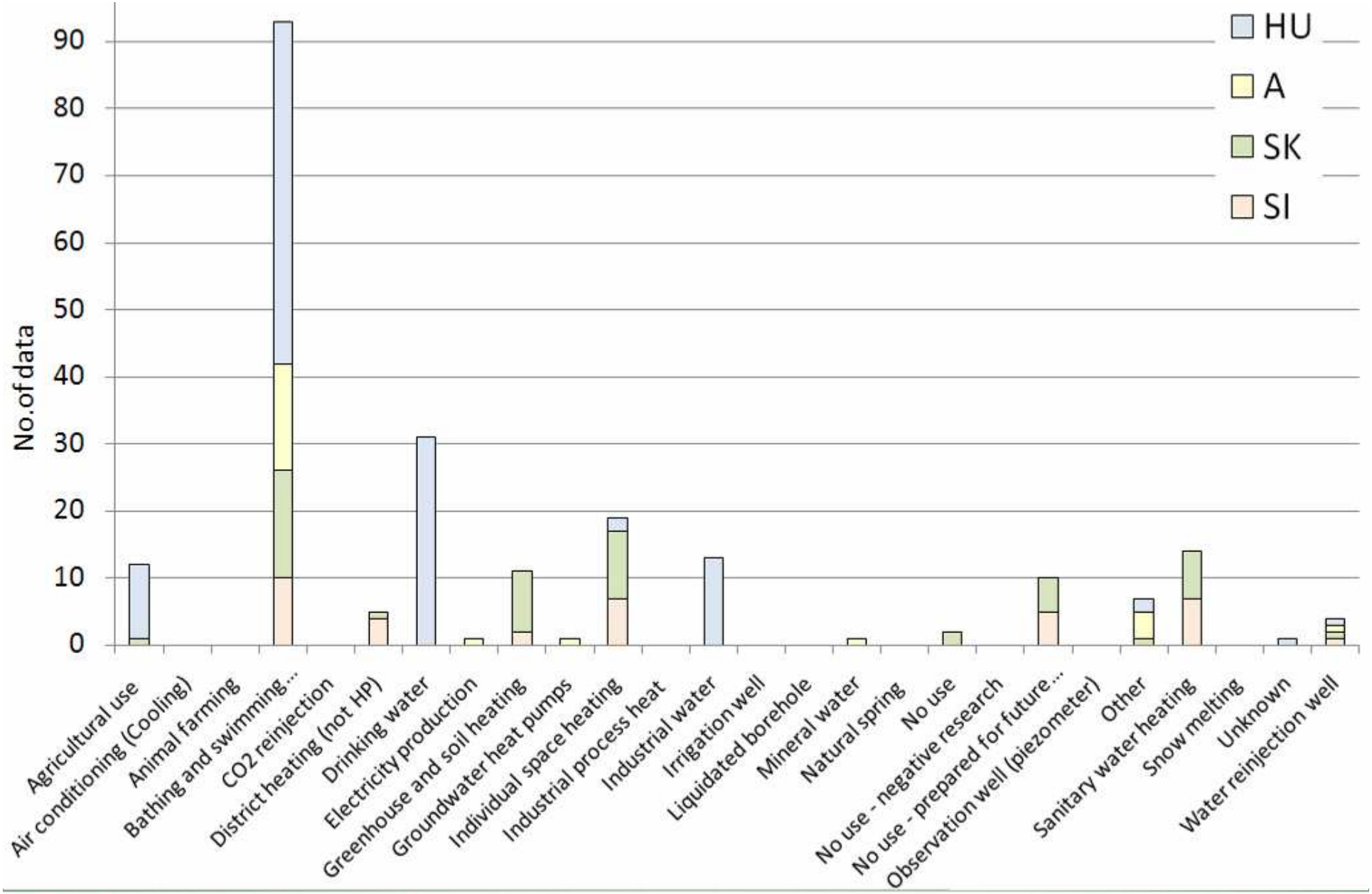
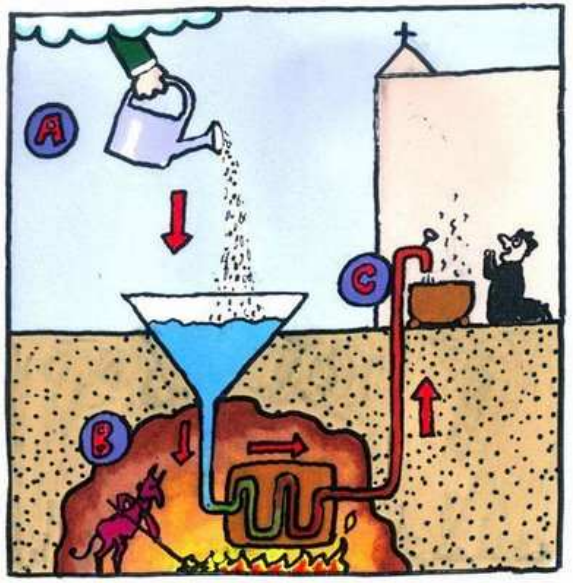

HU
A
SK
SI
No.of data
0
10
20
30
40
50
60
70
80
90
Agricultural use
Air conditioning (Cooling)
Animal farming
Bathing and swimming...
CO2 reinjection
District heating (not HP)
Drinking water
Electricity production
Greenhouse and soil heating
Groundwater heat pumps
Individual space heating
Industrial process heat
Industrial water
Irrigation well
Liquidated borehole
Mineral water
Natural spring
No use
No use - negative research
No use - prepared for future...
Observation well (piezometer)
Other
Sanitary water heating
Snow melting
Unknown
Water reinjection well

Only harmonized, multi-national management strategies can lead to sustainable utilization of transboundary geothermal resources



Results (*uploaded continuously according to the progress of the projects*) are available at:

www.t-jam.eu

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