

Thermal water utilization and its possible development in the early 21st century in Hajdúság, East Hungary

“Perspectives of Renewable Energy in the Danube Region”
26-27th March 2015
Pécs, Hungary

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Focus area - Hajdú cities and Debrecen

- Local population: ~330 000
- Promising renewables: biomass, solar, geothermal



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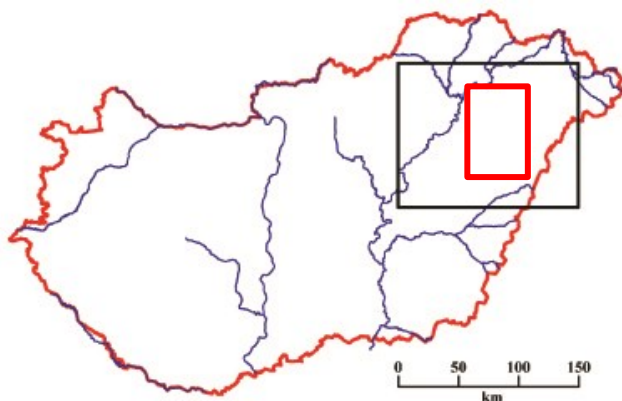


Geothermal opportunity - what a relief!

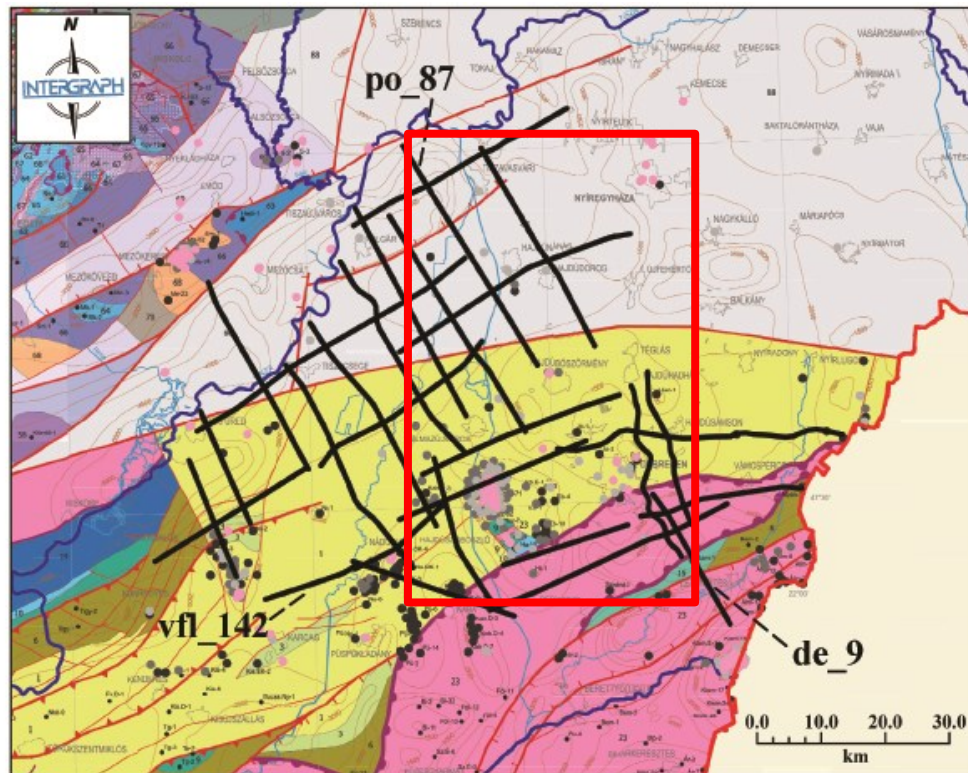
- Upper Pannonian successions: clay/claystone and sand/sandstone
- Their role: porous reservoirs
- Focusing on: thermal water
 - 60-70 °C of average temperature
 - approx. 1000 m of depth
 - high dissolved solid content
 - approx. 700 m thick source rock
- Play characteristics – reservoir modelling



Data and geo-environment



- studied seismic sections
- Depth of boreholes deeper than 500 m**
- 500 m to 975 m
- 975 m to 1400 m
- 1400 m to 1700 m
- 1700 m to 5205 m



- 62 Jura bázisos magmatitok
Jurassic basic magmatites
- 63 Középső-jura olistostroma-melanizs
Middle Jurassic olistostrome melange
- 64 Nagyon kistűkű metamorf középső-felső-jura pelágikus öszlet (radiolit, agyagpala)
Very low-grade metamorphic Middle – Upper Jurassic pelagic formation (radiolite, slate)
- 65 Középső-felső-triász metavulkanitok
Middle – Upper Triassic metavolcanites
- 66 Kistűkű metamorf középső-felső-triász platformkarbonátok
Low-grade metamorphic Middle and Upper Triassic platform carbonates
- 67 Nagyon kistűkű metamorf középső-felső-triász lejtő és medence fűlései kőkőves mészkő
Very low-grade metamorphic Middle – Upper Triassic cherty limestones of toe-of-slope and basin facies
- 68 Nagyon kistűkű metamorf felső-perm–alsó-triász sekélytengeri mészkő, homokkő, márga
Very low-grade metamorphic Upper Permian – Lower Triassic shallow marine limestones, sandstones, marls
- 69 Nagyon kistűkű metamorf úrpaleozoos és mezozoos képződmények tagolása nélkül
Very low-grade metamorphic Upper Paleozoic and Mesozoic formations in general
- 70 Nagyon kistűkű metamorf lengeri úrpaleozoos képződmények
Very low-grade metamorphic Upper Paleozoic marine formations

- 1 Senon-paleogén pelágikus márga, flis
Senonian paleogene pelagic marls, flysch
- 3 Senon szárazföldi, sekély- és mélytengeri képződmények
Senonian continental, shallow and deep marine formations
- 6 Alsó-triász bázisos vulkanitok és ezek átalakított lengeri üledékei
Lower Cretaceous basic volcanites and their reworked marine deposits
- 9 Középső-jura–alsó-triász pelágikus mészkő, kőkőves mészkő
Middle Jurassic to Lower Cretaceous pelagic limestones, cherty limestones
- 10 Alsó-középső-jura pelágikus, finom sziliklasztos öszlet
Lower and Middle Jurassic pelagic fine siliclastic formations
- 14 Alsó-triász folyóvízi és delta fűlései, sziliklasztos képződmények
Lower Triassic siliclastic formation of fluvial and delta facies
- 15 Kistűkű metamorf mezozoos képződmények
Low-grade metamorphic Mesozoic formations
- 23 Variszskori metamorfitt öszlet (gneisz, csillámpala, amfibolit)
Variscan metamorphic complex (gneiss, mica schists, amphibolite)

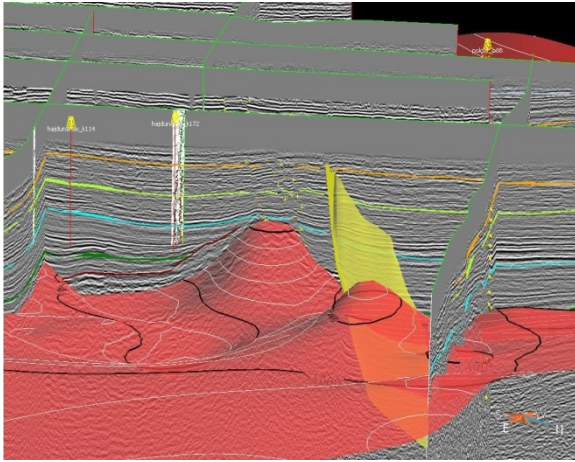
TEKTONIKA / TECTONICS

- Elővidéki karcsos tektonikus elem
Forearc Carpathian tectonic line
- Másodrendű karcsos tektonikus elem
Second-order Carpathian tectonic line
- Másodrendű karcsos normálvető
Second-order Carpathian fault
- Másodrendű karcsos eltolódás
Second-order Carpathian overthrust
- Harmadrendű karcsos tektonikus elem
Third-order Carpathian tectonic line
- Eltolódás irány
Direction of lateral displacement
- Elsőrendű mezozoos határ
First-order Mesozoic boundary
- Elsőrendű felületeltető mezozoos határ
First-order Mesozoic nappe thrust
- Elsőrendű mezozoos határ, lejtő
First-order Mesozoic nappe fault
- Másodrendű mezozoos tektonikus elem
Second-order Mesozoic tectonic line
- Másodrendű mezozoos tektonikus határ
Second-order Mesozoic tectonic line thrust
- Másodrendű mezozoos tektonikus elem
Second-order Mesozoic tectonic line thrust
- Másodrendű mezozoos eltolódás
Second-order Mesozoic overthrust

EGYÉB JELEK / OTHER SYMBOLS

- 88 Víznyelvény határ
Water divide boundary
- 89 Elővidéki mezozoos határ
Forearc limit of the pre-Carpathian basement
- 90 Elővidéki mezozoos határ
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- 100 Elővidéki mezozoos határ
Forearc limit of the pre-Carpathian basement

Modelling phases



**geological
mapping**

- measurements, mapping
- data base management

solid modell

- geological interpretation
- recognition of patterns and units
- recognition of structural elements

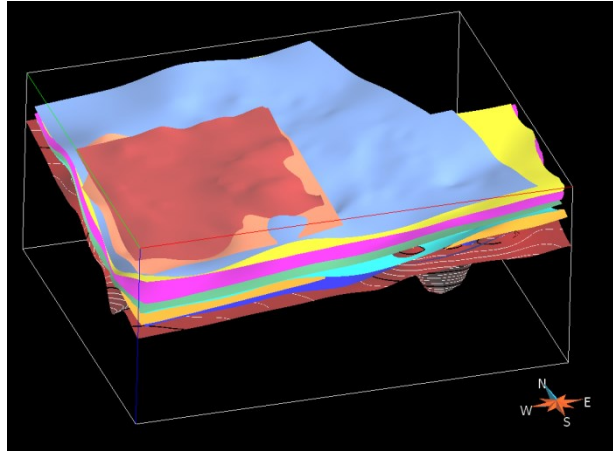
**hydrodynamic
modelling**

- expectable depression,
- water table changes by time

**geothermal
estimations**

- geothermal energy expectancy
- What about the geothermal potential of the area?

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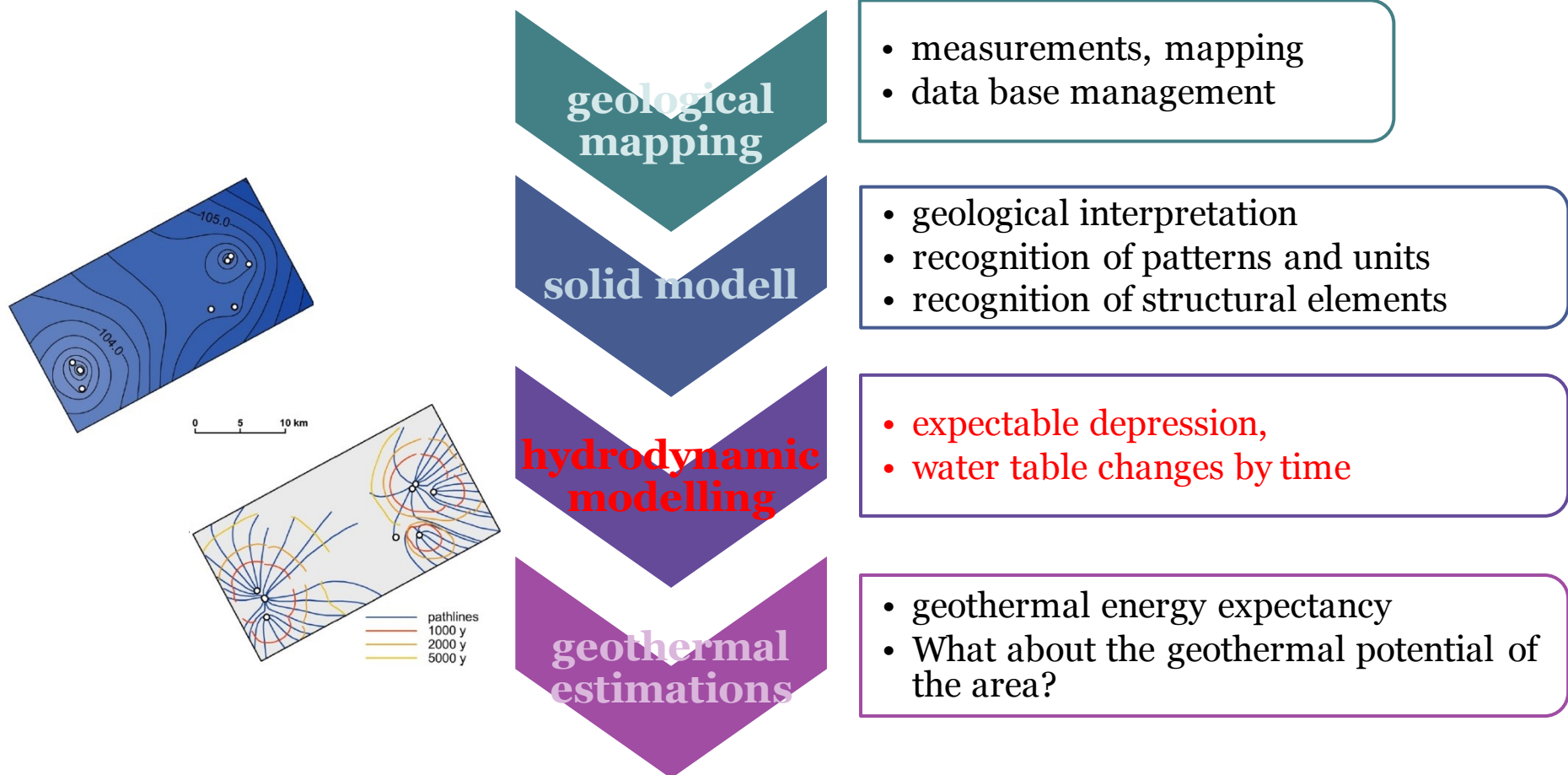
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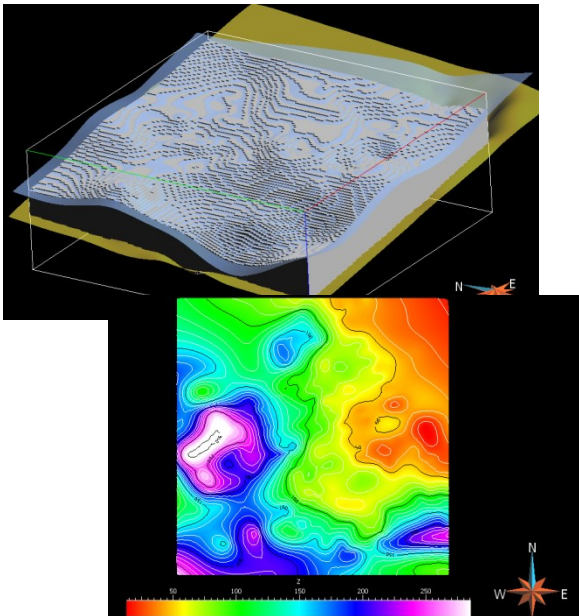
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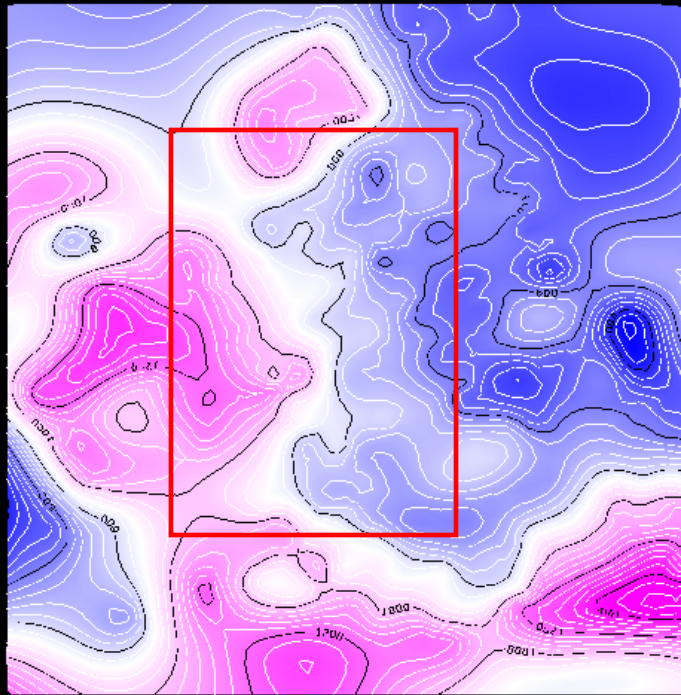
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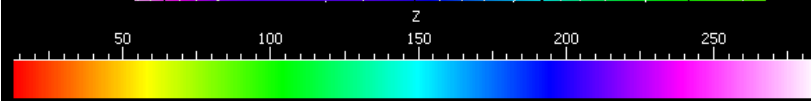
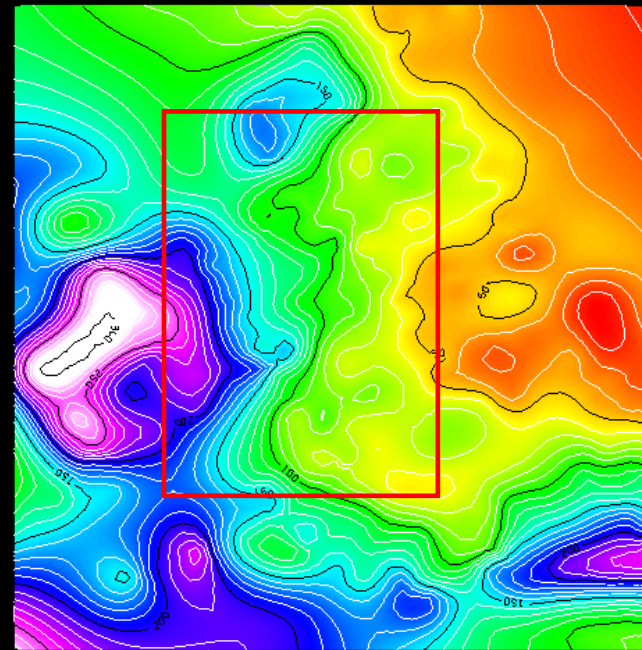
Modelling results - *what a relief!* ...and more



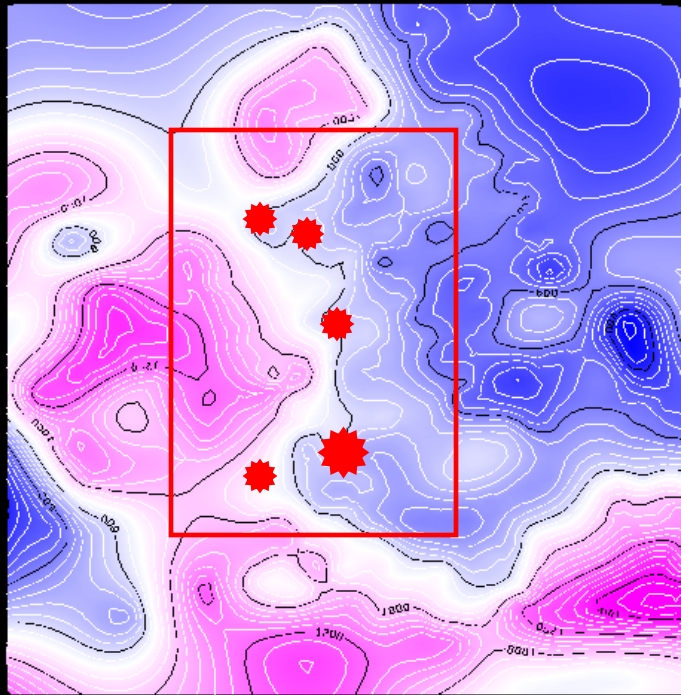
depth of a Pannonian unit (m)



energy density of this Pannonian unit (GJ/m²)



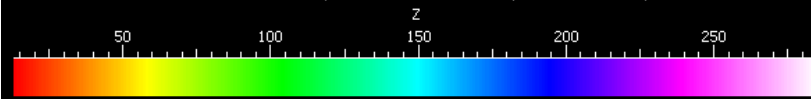
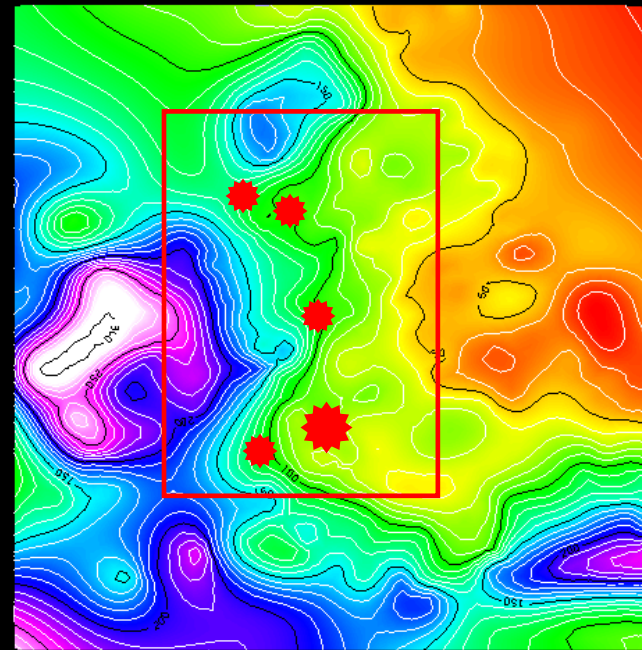
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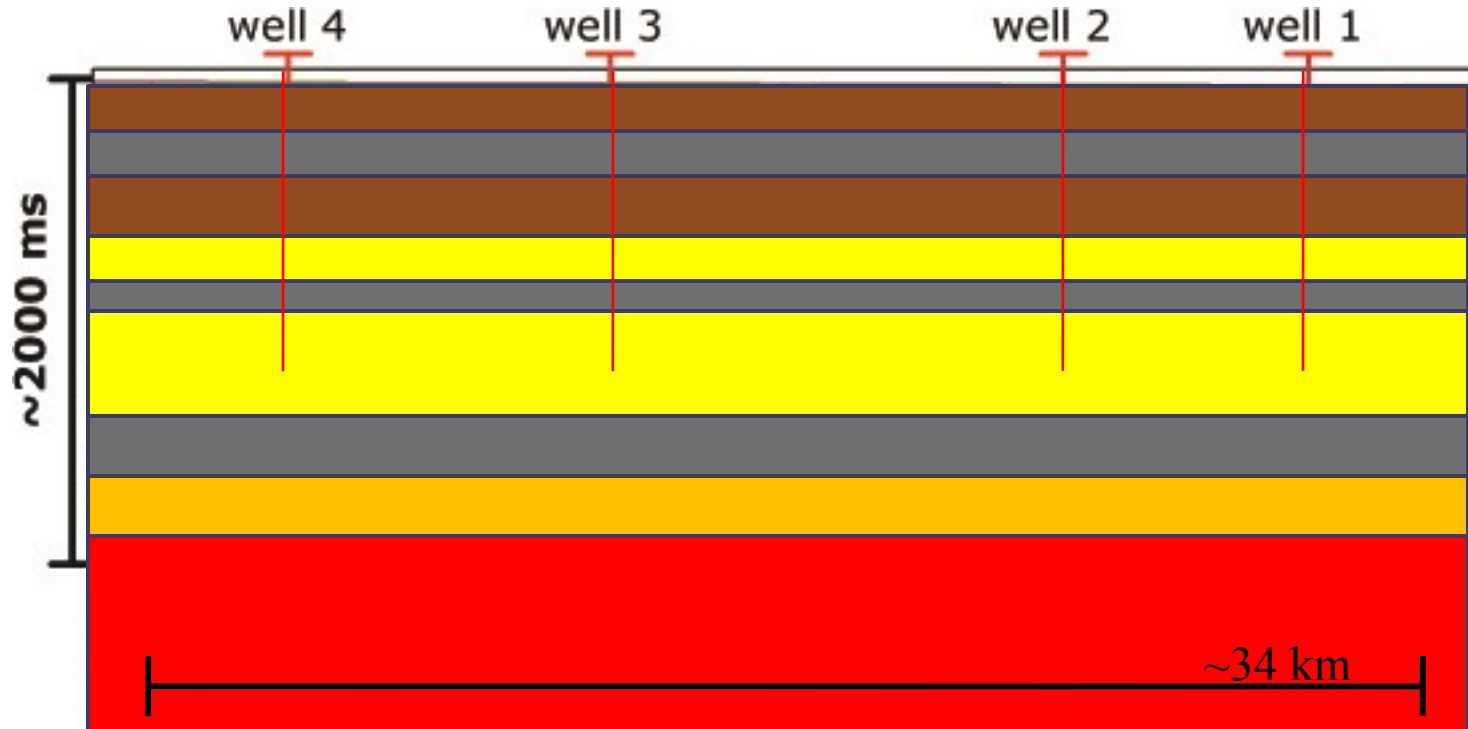
depth of a Pannonian unit (m)



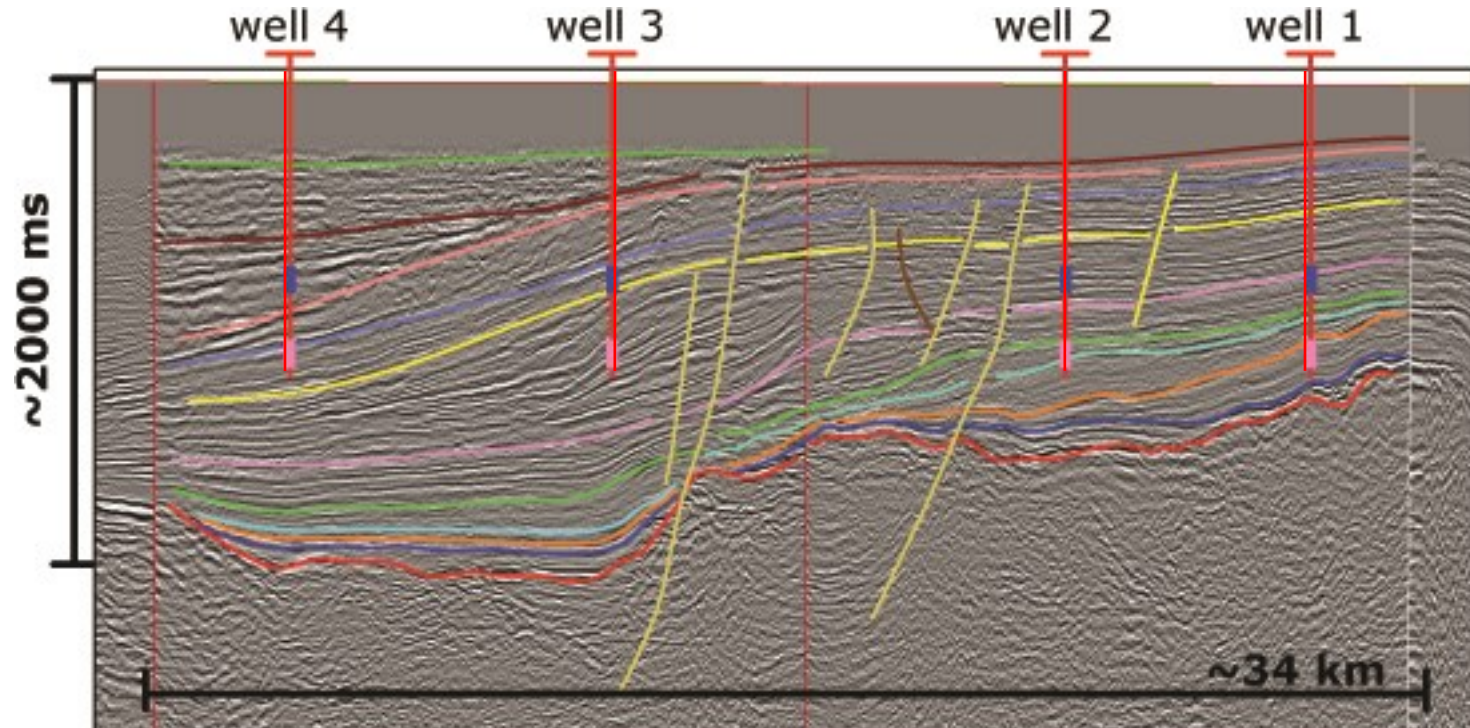
energy density of this Pannonian unit (GJ/m²)



Stratigraphic units - real life expectations

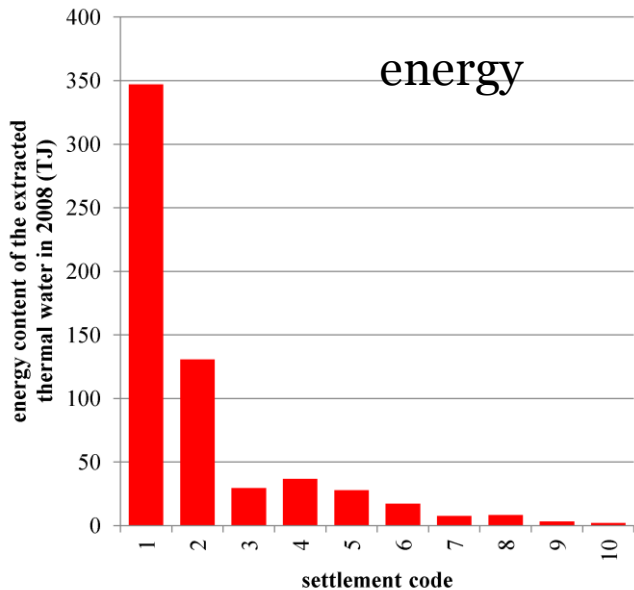
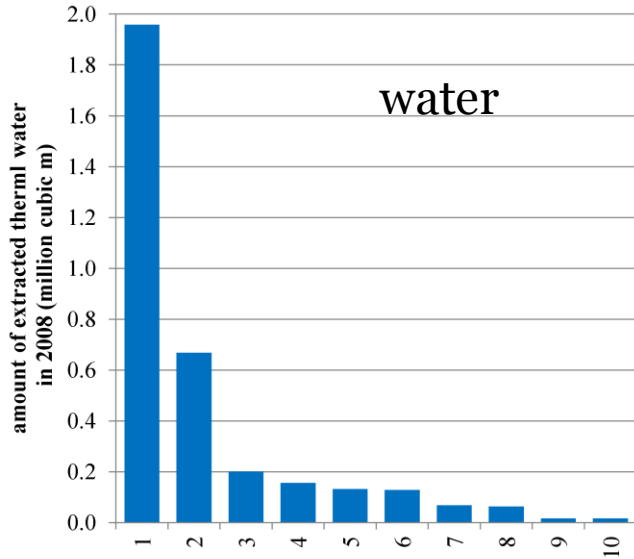


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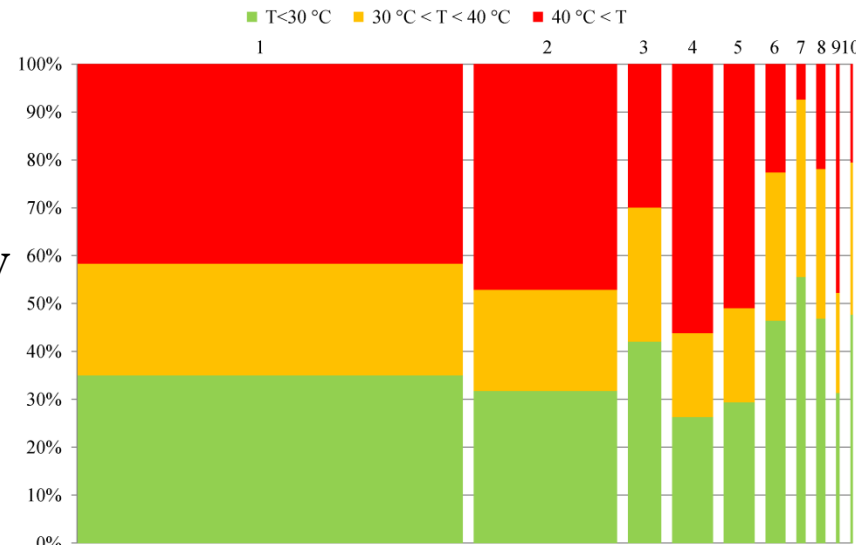
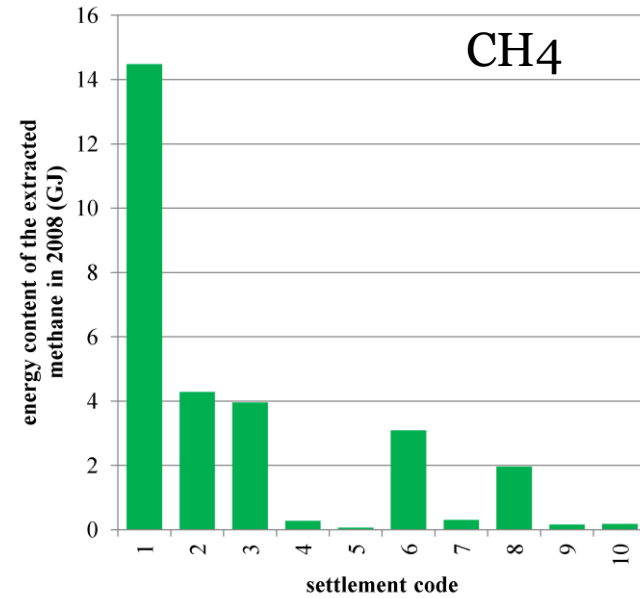
geometry – continuity – connectivity – local pressure

Energy studies



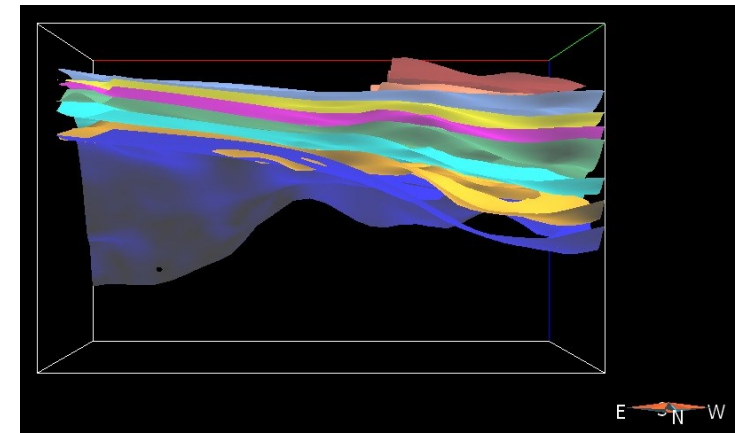
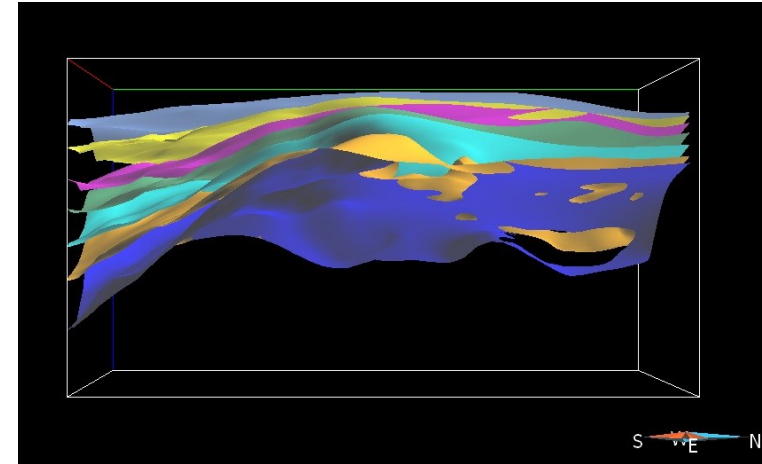
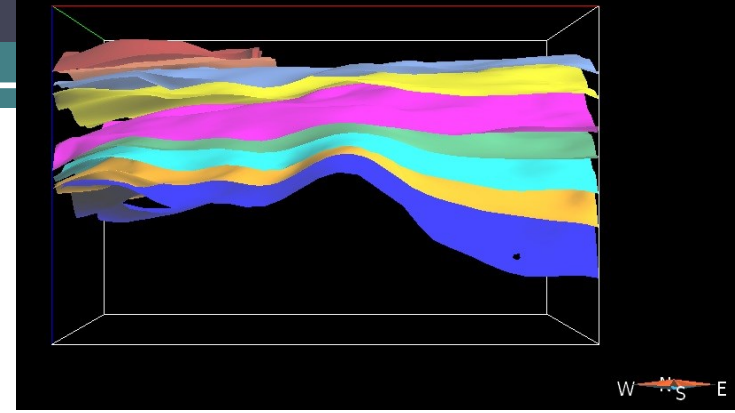
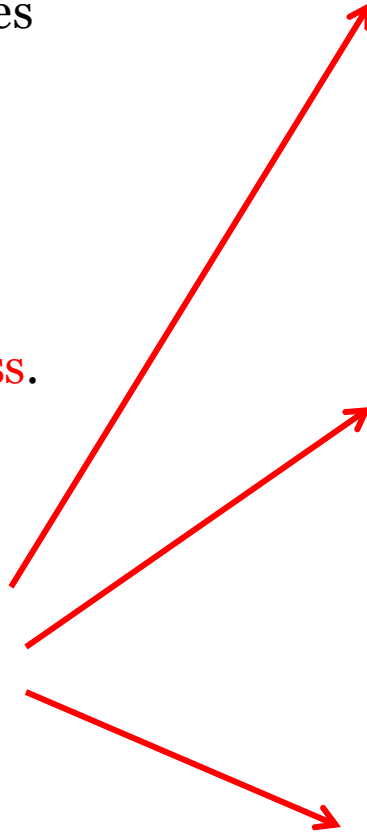
settlement code

1. Hajdúszoboszló
2. Debrecen
3. Hajdúböszörmény
4. Tiszacsege
5. Hajdúnánás
6. Kaba
7. Polgár
8. Nádudvar
9. Hajdúdorog
10. Püspökladány



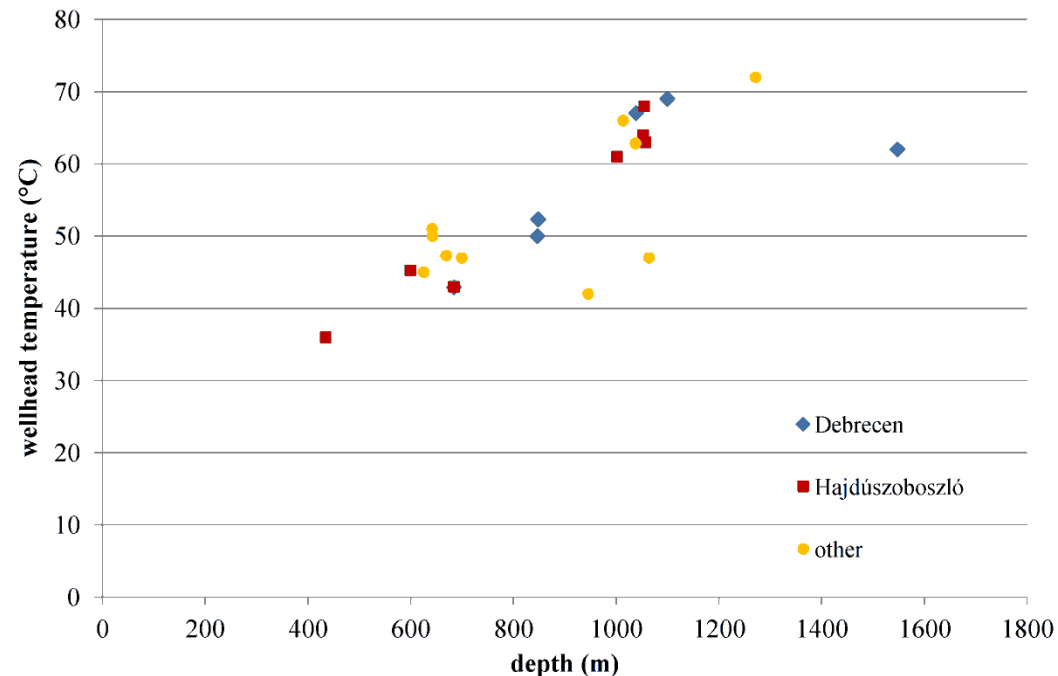
Results and Conclusions I.

- ✓ Sustainable utilization requires many conditions and to know the targeted reservoirs and their environment is fundamental to achieve it.
- ✓ **More data, more modelling, more knowledge, more success.**
- ✓ This must be recognized.
- Pannonian s.l. shows local specialities in facies distribution, geometry, basement relief and type, tectonic disturbances, etc. affecting the reservoir properties.



Results and Conclusions II.

- ✓ Production should **target less deep reservoirs** if the parameters are sufficient for the goals.
- ✓ **Harmonization** of thermal water wells (and usage) should be handled more carefully to avoid overproduction and reservoir damage.
- ✓ Thermal water utilization holds **a great opportunity to develop** for the Hajdú cities and the surrounding cities, towns.
- ✓ A wide range of accurate regional policy based on **researches** is needed for developmental reasons.
- ✓ **More attention on renewable**, e.g. geothermal energy.



Closing remarks

- Our interpretations, models and simulations hold also uncertainties, we have attempted to search and apply new methods in order to describe the system as accurately as we can.
- We are happy to receive any comments and suggestions or help.
- Common work, research, sharing and new ideas, applications are needed in order to develop.
(internationally, inter-institutionally)



Thank you very much for your kind
attention!



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