



Workshop on the Danube Region Geothermal Concept (DanReGeotherm)

*Budapest, 28 November 2013
Geological and Geophysical Institute of Hungary*

SLOVAKIA

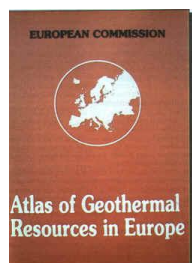
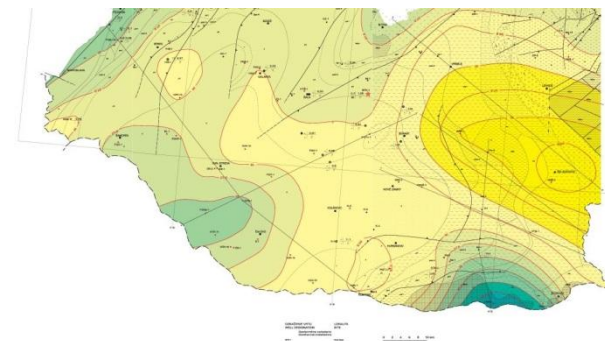
Radovan Černák – State Geological Institute of Dionýz Štúr

Marián Fendek – Faculty of Natural Sciences, Comenius University

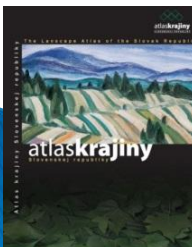
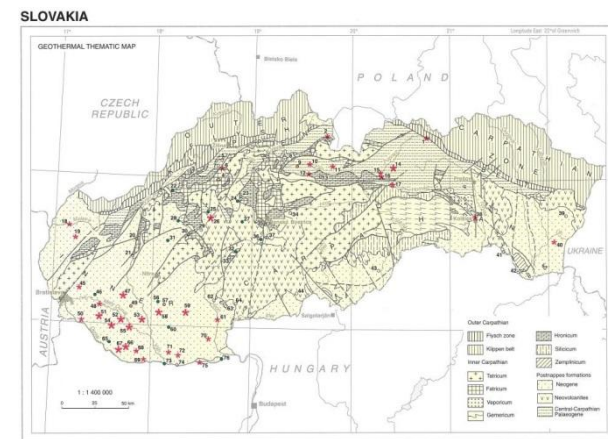
Miriám Fendeková – Faculty of Natural Sciences, Comenius University

Geothermal survey in Slovakia

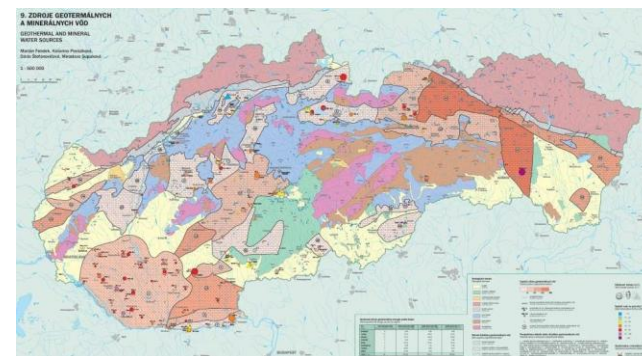
- systematic research from 1971 – funded by government
- summarization of knowledge Atlas of geothermal energy of Slovakia (Franko, Remšík and Fendek eds., 1995)



- Atlas of geothermal resources in Europe (Hurter and Haenel eds., 2002) – Slovak part – Liptovska kotlina basin and Central depression of Danube basin – authors Remšík, Fendek, Král, Mello



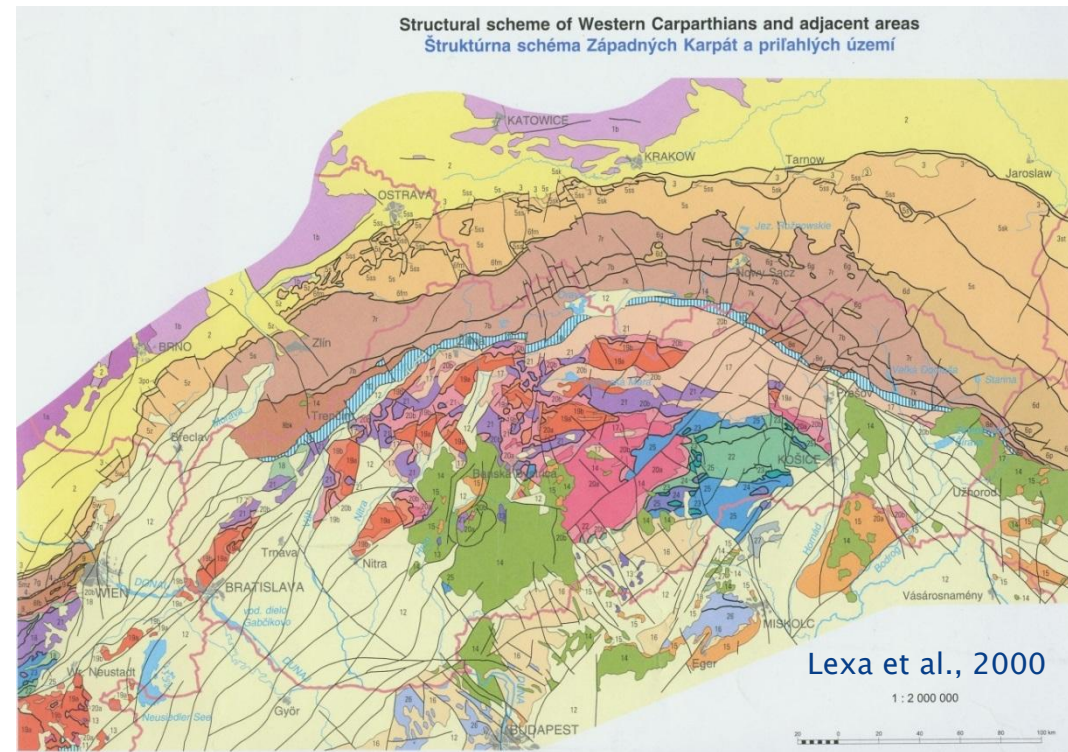
- the latest graphical review of geothermal and mineral water sources in Slovakia (map in the scale 1:500 000) part of the Landscape Atlas of the Slovak Republic (Landscape atlas, 2002) compiled by Fendek (et al., 2002)



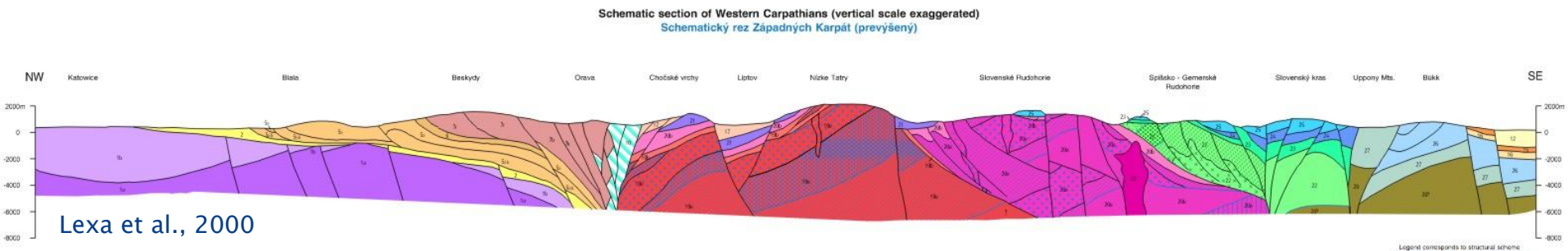
Main deep geothermal reservoirs

Geological set up:

- ▶ The Western Carpathians – long mountain ranges separated by basins
- Outer Carpathians – Neo-Alpine nappes – Tertiary series flysch character
- Inner Carpathians – Paleo-Alpine – Pre-Paleogene nappe structure – Late Paleozoic formations and Mesozoic complexes – overlain by post-nappe Cretaceous to Neogene sedimentary and volcanic formations
- The Klippen Belt – tectonic pattern represented by lenses of Jurassic–Early Cretaceous limestone which penetrate the Cretaceous and Paleogene marlstones and flysches.



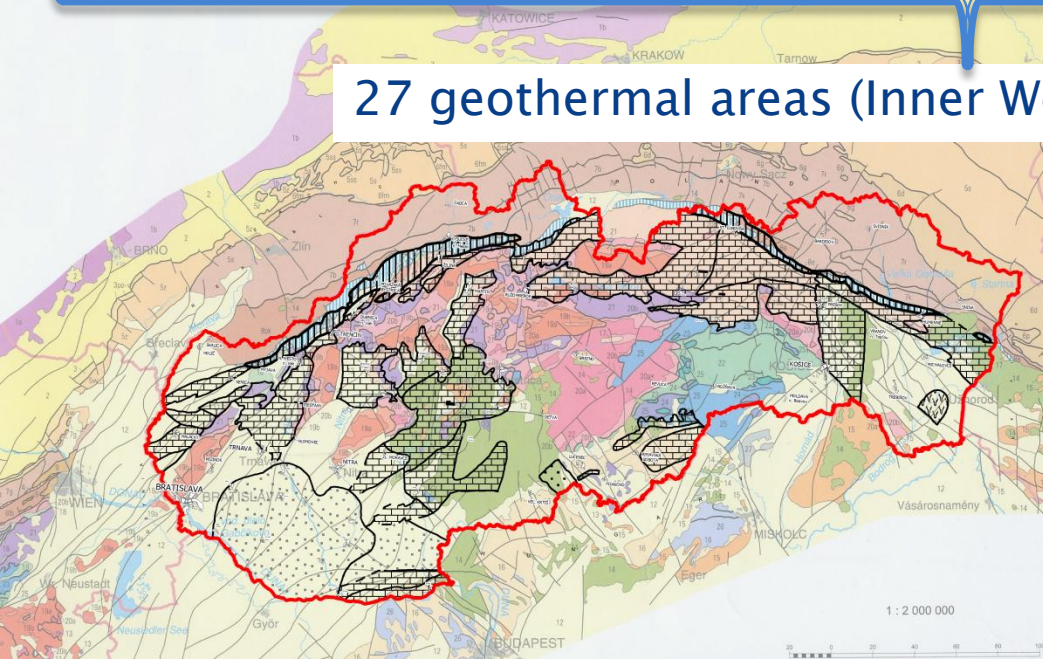
Lexa et al., 2000 / Biely, et al., 1996 / Fusán, 1987



Main deep geothermal reservoirs

- ▶ Favorable conditions for water circulation:
 - Fold–nappe structures and plunging slopes of the Tertiary rocks deep below the inner valleys
 - major extension and diversity of Mesozoic sediments (middle and Upper Triassic limestones and dolomites)
 - large extension of the Tertiary (Paleogene and Neogene) of marine and freshwater sediments (clay shales, clays, conglomerates, sandstones, sands, Miocene evaporites)
 - alpine type of tectonics of Mesozoic strata (profound folds)
 - Neogene volcanism create a suitable setting for the occurrence of geothermal energy resources

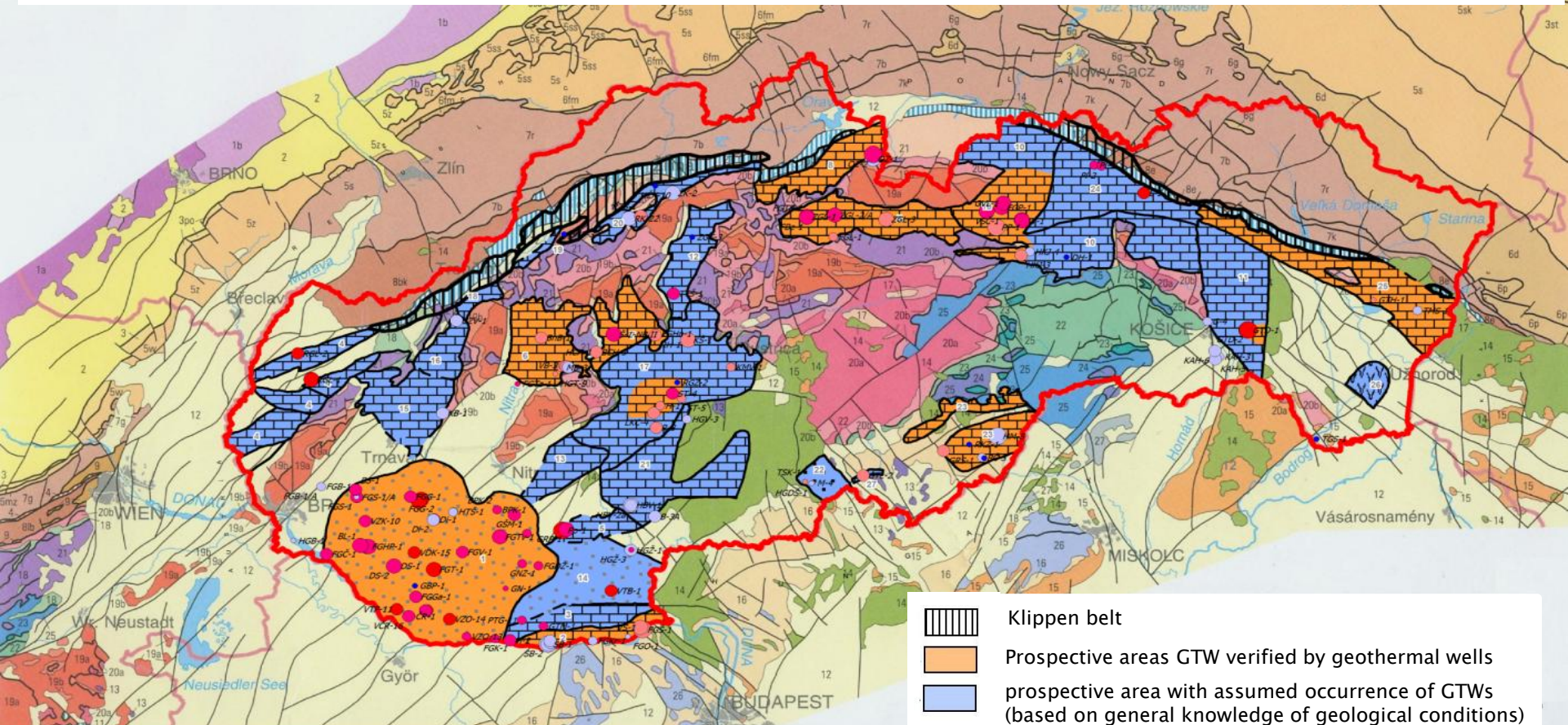
27 geothermal areas (Inner Western Carpathians)

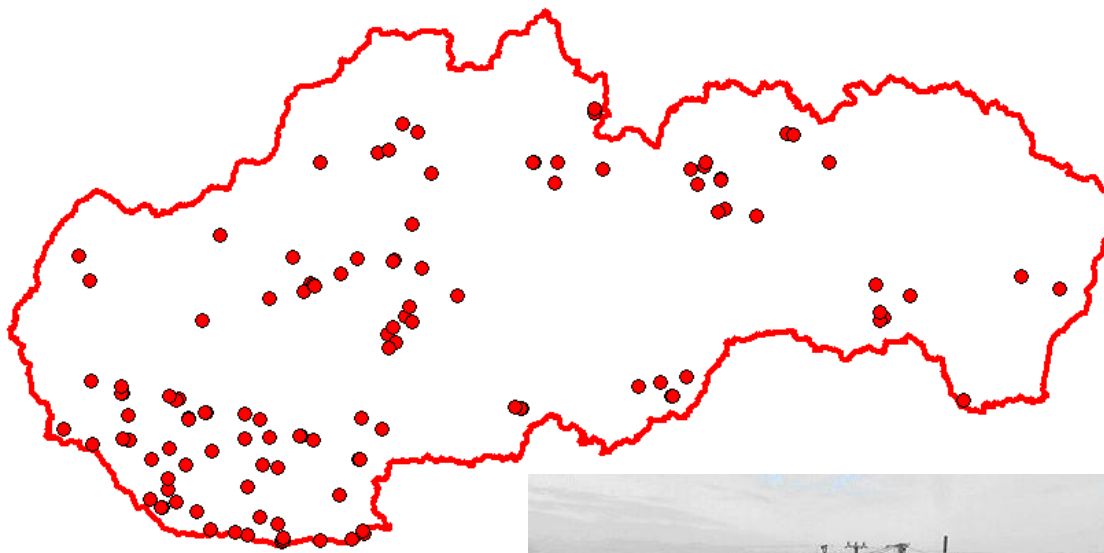


Main deep geothermal reservoirs

27 perspective areas cover 15 811 km² (32 %) of Slovakia (49 014 km²)

- Fissure –karst aquifers of Mesozoic carbonates (Triassic dolomites and limestones of the Fatricum and Hronicum units Silicicum unit) 8 428,35 km² 53,3%
- Intergranular aquifers of Neogene sediments 5 534,7 km² 35%
- Intergranular aquifers of Neogene sediments overlaying fissure –karst aquifers of Mesozoic carbonates 1 848,2 km² 11,7%





- Geothermal aquifers are localized in the depth from 80 to 5000 m
- Water temperature in aquifer is 20–240 °C
- 141 boreholes (drilled mainly between 1971 – 2011)
- Depth of boreholes 64 – 3 616 m
- Yields of wells 0,2 to 100 l.s⁻¹
- Water temperature on the well head 18 – 129 °C
- Verified 2 084 l.s⁻¹ of geothermal waters, which represents the heat power of 345 MWt
- Prevailing Na-HCO₃, Ca-Mg-HCO₃, Ca-Mg-HCO₃-SO₄ and Na-Cl type waters

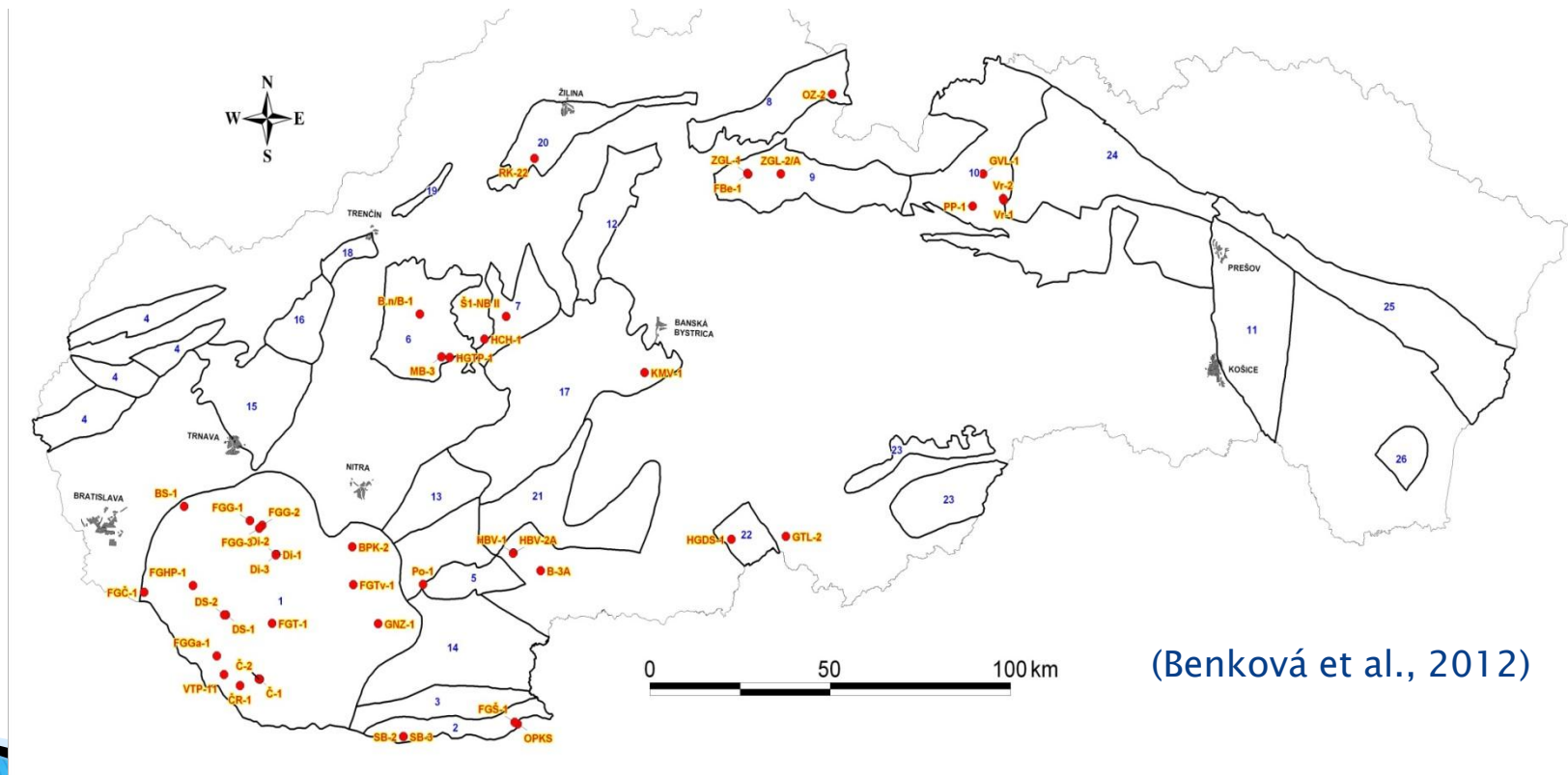
Potential of geothermal energy in Slovakia is 6 234 MWt

Remaining amount of the geothermal energy still matter of verification/prospection 5 889 MWt
(Remšík, 2012)

Utilization of geothermal energy

Utilization data – based on information reported to SHMI, 2010,
– excluding wells that are in evidence on Ministry of Health
of SR, Inspectorate of Spas and Springs

Active utilization from 46 geothermal wells (operating on 35 sites in 13 geothermal areas)



Map of the exploited geothermal wells in the period 2000–2010 according to the reported data by the users to SHMI

Utilization of geothermal energy

- Active utilization from 46 geothermal wells
 - 23 utilized geothermal wells (50 %) – Neogene sands and sandstones
 - average production from interval 1200 – 1550 m
 - water temperature on well head 19 – 91°C (average cca 60°C)
 - TDS in interval 0,4 – 6,9 g.l⁻¹ (average 2,5 g.l⁻¹),
 - 40% of the average annual utilized amount of water (2000–2010) cca 95 l.s⁻¹

 - 23 geothermal wells (50 %) – 23 vrtoev (50 %) Triassic carbonates
 - average production from interval 635 – 1130 m
 - water temperature on well head 20 – 80°C (average 42,5°C).
 - TDS in interval 0,5 – 19,6 g.l⁻¹ (average 3,25 g.l⁻¹).
 - 60% of the average annual utilized amount of water (2000–2010) cca 142 l.s⁻¹

- 46 geothermal wells total abstraction yield of geothermal water (average 2000–2010) of 6,3mil m³ per year (236,65 l.s⁻¹).

- For all these wells – relevant state water administration issued permits for the abstraction of geothermal water, totaling 17,5 mil m³ per year (721 l.s⁻¹).

Exploitation of geothermal water is 33% of the available amount by permits

Main types of current utilization of geothermal energy

Geothermal energy utilization purposes:

- **recreational purposes (87 % of sources used)**. Geothermal water from 40 geothermal wells is used for filling swimming pools or water heating for swimming pools. Seasonal and year-round thermal pools (wellness)
- **heating buildings** is thermal energy used geothermal water from 22 wells (48 % of the number of sources used). Most importantly heating hospitals and settlement in Galante (distric heating) as well as heating of ventilation air for brown coal mine in Nováky. The water parks and thermal pools are open year round geothermal water heated and hotel rooms. It is a site Dunajská Streda, Velky Meder, Galanta, Horné Saliby, Senec , Čilistov , Poľný Kesov , Štúrovo , Podhájska , Bánovce nad Bebravou , Malé Bielice, Chalmová, Oravice, Bešenová, Liptovsky Mikulas, Vrbov, Poprad and Velka Lomnica
- In **agriculture**, the use of geothermal water from 11 wells (24 % of the sources used) at 10 locations in the winter for heating greenhouses and the fish farming (Vrbov).
- **Electricity – no generation** of electricity from geothermal energy so far – potencial in Kosice basin (Durkov)

Data policy

State Geological Institute of Dionýz Štúr (Geofond) – data from geological prospection



- Geological / Geochemical / Hydrogeological / Geothermal final reports
- > 80 000 reports
- Geological/Hydrogeological maps
- Register of boreholes

Slovak Hydrometeorological Institute – data from geothermal utilization



- Utilization reporting – temperature and exploitation amount, cumulative year and used volumes of geothermal water per month

Ministry of Health of the Slovak Republic, Inspectorate of Spas and Springs



Ministerstvo zdravotníctva SR

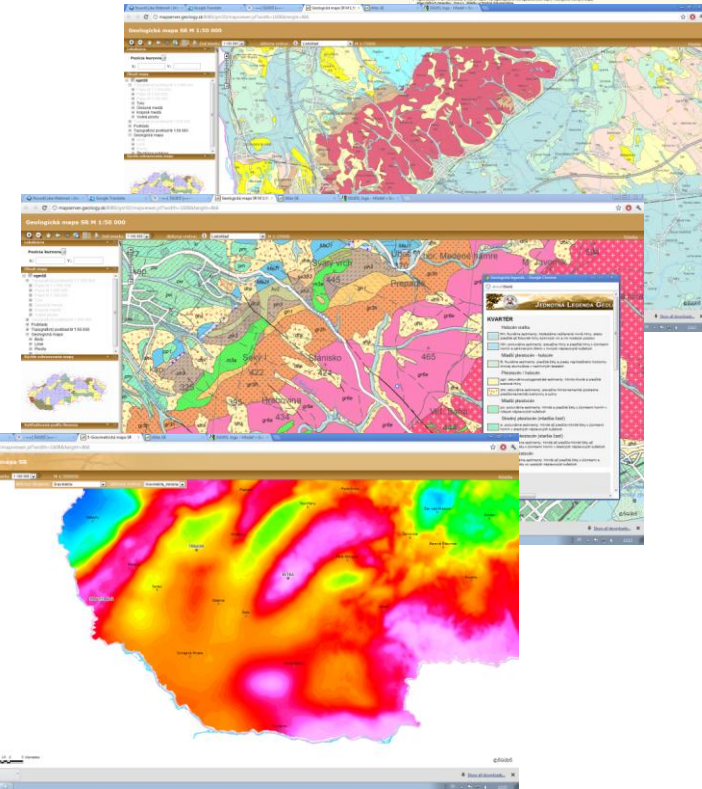
- natural healing waters, natural treatment spas, spa locations and natural mineral waters – balneological use

Data policy

Online Map Server – State Geological Institute of Dionýz Štúr
http://www.geology.sk/index.php?pg=geois.mapovy_server

Country updates about the utilization of geothermal water:

- Department of Hydrogeology, Faculty of Natural Sciences, Comenius University
- State Geological Institute of Dionýz Štúr



Period	Research & Development Incl. Surface Explor. & Exploration Drilling	Field Development Including Production Drilling & Surface Equipment	Utilization		Funding Type	
			Direct	Electrical	Private	Public
1995 – 1999						
2000 – 2004						
2005 – 2009						

	Geothermal		Fossil Fuels		Hydro		Nuclear		Total	
	Capacity MWe	Gross Prod. GWh/yr	Capacity MWe	Gross Prod. GWh/yr	Capacity MWe	Gross Prod. GWh/yr	Capacity MWe	Gross Prod. GWh/yr	Capacity MWe	Gross Prod. GWh/yr
In operation in December 2009	-	-	3,237	9,259	1,653	4,782	2,640	17,026	7,590	31,067
Under construction in December 2009	-	-								
Funds committed but not yet under construction in December 2009	-	-								
Total projected use by 2015	6	40	4							

	Installed Capacity [MW]	Annual Energy Use (TJ/yr)	Capacity Factor
Individual Space Heating	16.7	381.1	0.723
District Heating	10.8	232.0	0.681
Air Conditioning (Cooling)			
Greenhouse Heating	17.6	461.1	0.831
Fish Farming	11.9	271.0	0.722
Animal Farming			
Agricultural drying			
Industrial Process Heat			
Snow Melting			
Bathing and Swimming	73.6	1,708.5	0.736
Other Uses [specify]			
Subtotal	130.6	3,053.7	0.741
Geothermal Heat Pumps	1.6	13.5	0.267
Total	132.2	3,067.2	0.733

(Fendek and Fendekova, 2010)

Thank you for attention

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