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Identification of transboundary geothermal aquifers by hydrogeochemistry

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ABSTRACT

The transboudary character of the Mesozoic, Miocene and Pliocene geothermal aquifers in the Mura-Zala basin in SW Hungary and NE Slovenia was investigated by various hydrogeochemical techniques. Chemical analyses of 24 cold- and thermal groundwater samples were performed in 2010 for the T-JAM project, followed by additional 6 samples in 2011 for the TRANSENERGY project. Main components and trace element analyses confirm the vertical stratification of geothermal aquifers and indicate transboundary flow systems. Hydrogeological connections and groundwater age are interpreted from the stable (δ18O, δD, δ13C) and radioactive groundwater isotope (tritium, 14C) analyses. Organic compounds, dissolved and separated gas, and noble gas analyses indicate differences in evolution and prevalent geochemical processes in the aquifers. A distinction can be made between active and stagnant flow systems, based on our results.

METHODOLOGY

- 30 new ground- and thermal water samples collected in May, June and October 2010 and May 2011 from different aquifers in the Mura-Zala basin (SI and HU)
- Results interpreted by Excel, Statistica, Grapher and AquaChem
- Results are available at www.t-jam.eu and http://transenergy-eu.geologie.ac.at

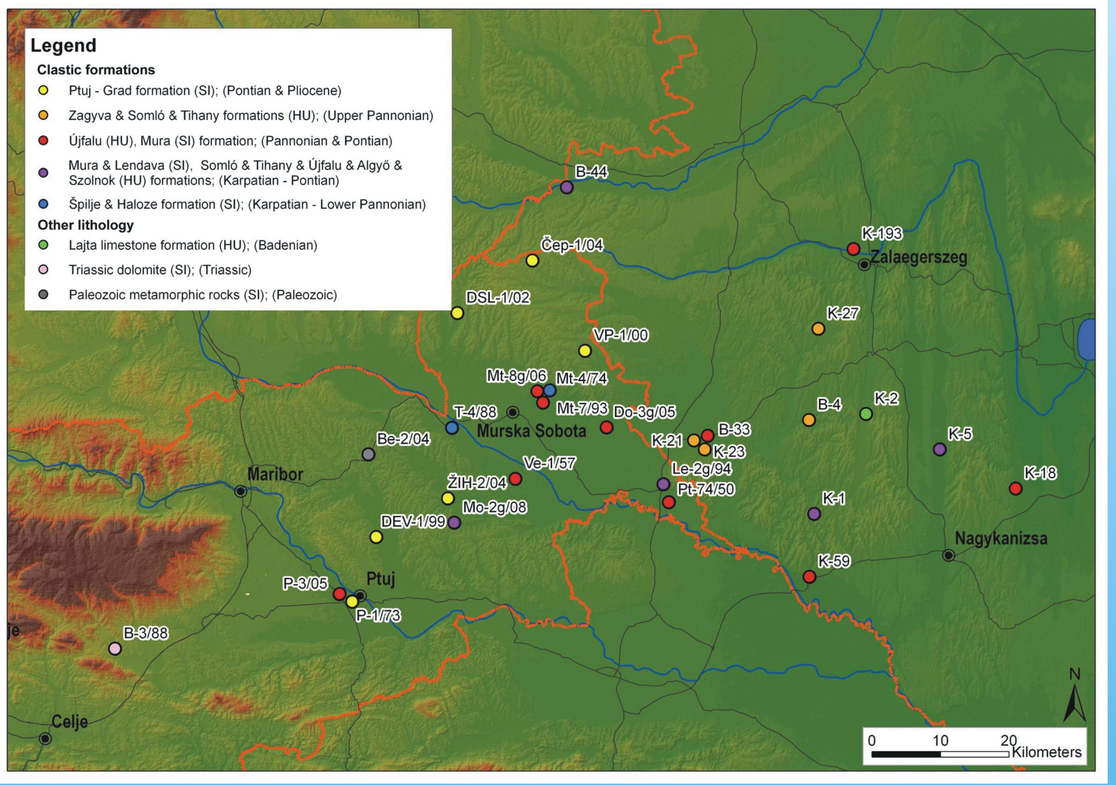


Figure 1: Location of 30 sampled groundwater and thermal water wells

Parameters analysed	Laboratory
Main components, Trace elements	Geological institute of Hungary
δ D, $\delta^{18}O$	HAS Institute for Geoch. Research
^{14}C and $\delta^{13}C$ in HCO_3^-(aq), Tritium	Hydrosys Kft.
$\delta^{34}S$ in SO_4^{2-}(aq), $\delta^{13}C$ in CH_4, Noble gas	HAS Institute of Nuclear Research
TOC, Organic compounds	Bálint Analitika Kft.
Dissolved gas, Separated gas	Vízkutató Vízkémia Kft.
Radon	Eötvös Loránd University

RESULTS

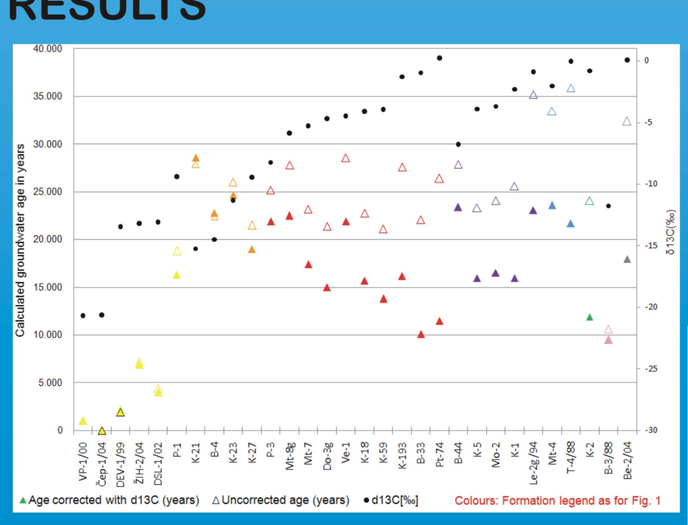


Figure 3: Box & whisker diagrams showing the TDS distribution intervals of water from the main geothermal aquifers in the Mura-Zala basin in Slovenia and Hungary

Figure 2: Calculated groundwater age for different geothermal aquifers in the Mura-Zala basin in Slovenia and Hungary

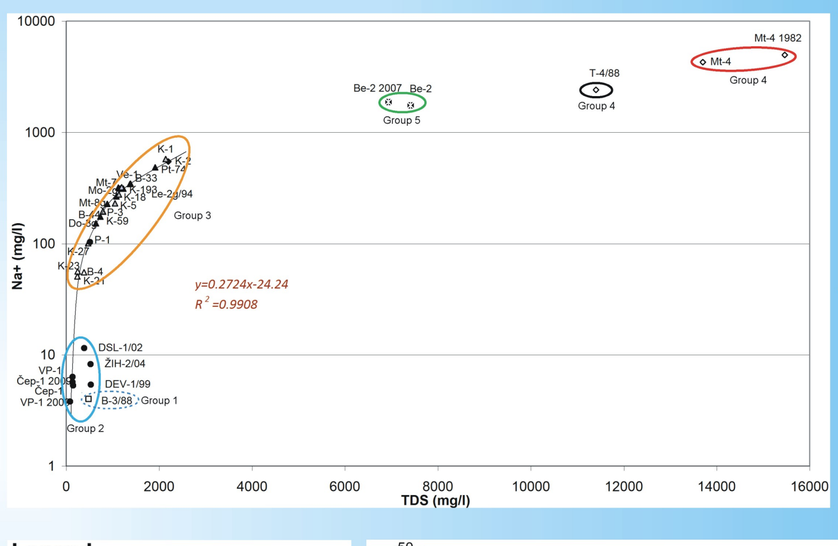
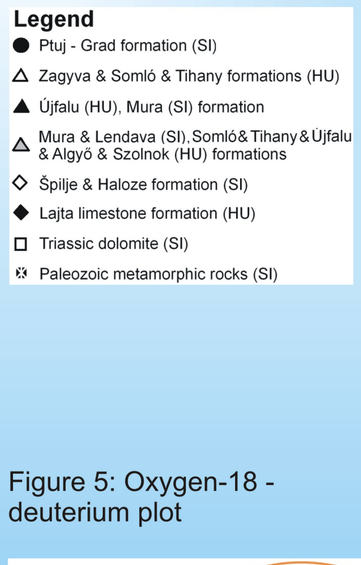


Figure 4: TDS - sodium plot



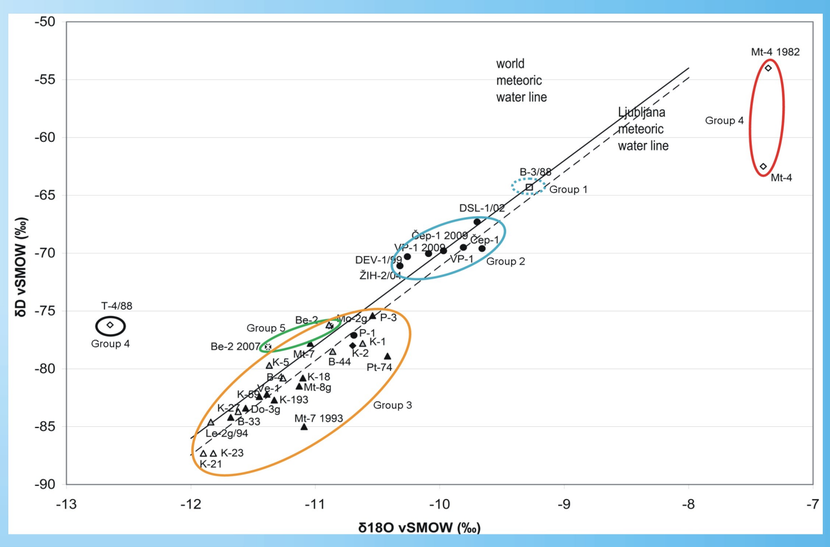


Figure 5: Oxygen-18 - deuterium plot

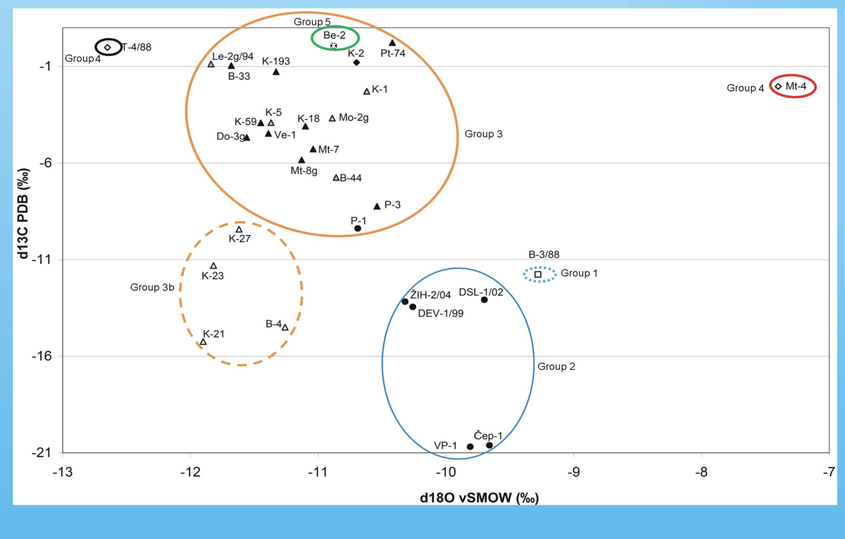


Figure 6: Oxygen-18 - carbon-13 plot

The 1st group is represented by very young water in Tertiary dolomite (SI). The 2nd group comprises of young waters in Ptuj-Grad formation (SI), which differ slightly depending on their position in the recharge area. The 3rd group comprises of older waters in Mura (SI), Zagyva, Újfalu and Somló&Tihany (HU) formations and their mixtures with water from older formations. A subgroup of much older waters from Lenti (HU) is also evident (K-21, K-23). The 4th group is represented by waters in Špilje&Haloze formation (SI), while the 5th type of water is stored in Paleozoic metamorphic rocks (SI). Waters from these two groups have been greatly affected by different geochemical processes and are not comparable to the other groups or even between each other.

CONCLUSIONS

- Ptuj-Grad (SI), Zagyva and Somló&Tihany (HU) formation aquifers: active transboundary regional groundwater flow system, with recharge from Goričko hills (SI) towards southeast (HU).
- Mura (SI) and Újfalu (HU) formation aquifers: active transboundary regional groundwater flow system, probably hydraulically separated from the shallower one but with similar flow direction.
- Lendava (SI) and Szolnok (HU) formation aquifers: currently inactive transboundary regional groundwater flow system. Water probably infiltrated at the same time, but is mostly stagnant and isolated from the surroundings. Due to tectonics some parts have a locally active flow system.
- Lower and Middle Miocene formation aquifers: are of limited extent or very isolated.
- The Mesozoic and Paleozoic aquifers investigated are not comparable.

- Investigated groundwaters are fresh to 28 000 years old, depending on their recharge, aquifer depth, activity of the flow system and water-rock-gas interaction.
- Noble gases indicate that young waters were infiltrated in a warm period, while older waters in a colder period. They are locally exposed to subsurface degassing and mantle helium.

Reference

- RMAN, N., SZŐCS, T. 2011: Hydrogeochemical conceptual model for T-JAM project (http://en.t-jam.eu/project-results/)
- RMAN, N., LAPANJE, A., PRESTOR, J. 2011: Water Concession Principles for Geothermal Aquifers in the Mura-Zala Basin, NE Slovenia. Water Resources Management DOI: 10.1007/s11269-011-9855-5.
- SZŐCS, T., RMAN, N., SÜVEGES, M. 2011: Radiocarbon age study of Slovenian-Hungarian transboundary groundwater. Central European Geology, Vol. 54, p. 149.
- T-JAM interactive borehole database (http://akvamarin.geo-zs.si/t-jam_boreholes/)
- Transenergy website (http://transenergy-eu.geologie.ac.at/)

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