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Groundwater circulation in deep carbonate regions

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The operation of the subsurface part of the hydrologic cycle is hardly understood on basin scale due to the limitation in validated knowledge. Therefore the water balance approach is used with simplified numerical approaches during solving water related problems. The understanding of hierarchical nature of gravity-driven groundwater flow in near-surface and other driving forces in the deeper part of the lithosphere are often neglected.

In this context thick and deep carbonate regions are especially less understood because the applicability of the gravity-driven regional groundwater flow (GDRGF) concept for such ranges formerly was debated. This is because karst studies are focused rather on the understanding of heterogeneity of karst systems.

In contrary, this study found, on the basis of REV concept, that at regional scale not the local permeability values but its regional distribution is decisive. Firstly, according to the hydraulic diffusivity values it was stated that hydraulic connectivity is more effective in basinal carbonates compared to siliciclastics. Consequently, the efficient hydraulic responses for hydraulic head changes (due to water production or injection) in a carbonate system can give an indirect clue regarding hydraulic connectivity of the system rather than understanding the detailed permeability distribution. The concerns of the applicability of the GDRGF concept, therefore could be resolved. Subsequently, the concept of GDRGF can be used as a working hypothesis for understanding basinal hydraulics and geologic agency of flowing groundwater in thick carbonate ranges (Mádl-Szőnyi and Tóth 2015).

The hydrogeologically complex thick carbonate system of the Transdanubian Range (TR) Hungary was used as a study area to reveal the role of GDRGF at basin scale. Water level changes in the system, due to long-term mine dewatering exemplify the hydraulic continuity and compartmentalization of the system.

Clustering of spring data, numerical flow and heat transport simulations and interpretation of flow-related manifestations helped to understand better the nature of gravity-driven flow in the system. Simplified modelling scenarios were tested based on EPM approach to better understand the pattern of the unconfined and confined parts of the system, respectively. Spring data were used to validate the simulations. The results demonstrated that the basin geometry, water-table undulation and regional hydrostratigraphy are the focal issues of basin-scale flow, even in carbonate systems.

These results help to understand the underground part of the hydrologic cycle in deep carbonates which contains valuable water resources. In addition they could be suitable for hydrocarbon and geothermal exploration. The research was supported by the Hungarian OTKA Research Fund (NK 101356).

Reference

Mádl-Szőnyi, J. Tóth, Á. 2015: Basin-scale conceptual groundwater flow model for an unconfined and confined thick carbonate region. Hydrogeology Journal 23/7, pp 1359–1380.