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Quantitative classification of carbonate aquifers based on hydraulic behaviour

Attila Kovacs [1,2]

[1]*Mining and Geological Survey of Hungary,*
[2]*MTA-ME Geoengineering Research Group*

Corresponding Author(s): kovacs.attila@mbfsz.gov.hu

While hydrogeological systems hosted in igneous rocks are typically considered as fractured systems, those hosted in carbonate rocks are traditionally considered as karst systems. Little effort has been made to quantitatively distinguish between well-developed karst systems and poorly karstified or fractured systems hosted in carbonate rocks. At the same time, there is an inconsistency in the application of investigation techniques. While most carbonate systems are proven to manifest karstic hydraulic behaviour, equivalent porous medium models are extensively used for simulating hydrodynamic and transport processes.

It is crucial to determine the hydraulic behaviour of strongly heterogeneous systems in order to select the most appropriate investigation techniques and modelling approaches.

While limestone aquifers usually manifest karstic hydraulic behaviour, dolomite aquifers represent an ambiguous group of carbonate rocks. While classical karstic landforms such as sinkholes or dry valleys might be present, they usually lack well-developed hierarchical conduit networks.

Spring and well hydrographs contain important information about the hydraulic behaviour and geometric characteristics of carbonate aquifers. Analytical formulae have been developed to describe hydraulic behaviour and to quantitatively classify strongly heterogeneous systems based on hydrograph analysis.

The proposed method is demonstrated through the application of field data. Several test sites including limestone and dolomite aquifers have been studied through systematic spring discharge and piezometric level monitoring. Hydrograph analysis of flood peaks was undertaken to determine aquifer characteristics and to classify aquifer hydraulic behaviour. The results of hydrograph analysis were verified through field observations.

The proposed quantitative classification method provides crucial information about the hydraulic functioning of carbonate hydrogeologial systems, and facilitates the selection of adequate investigation and modelling techniques.