Karst flow system information from shape analysis and numerical modeling of tracer concentration curves

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Dye tracing constitute a very valuable tool for investigating the origin of groundwater and delineating flowpaths in karst media, providing direct and quantitative information about the hydraulic properties and solute transport dynamic within a conduit (and/or fracture) dominated system. In this sense, data obtained from 8 single- and multi-injection tracer experiments performed during last years in different carbonate aquifers located in Malaga province (southern Spain) have been re-examined following the numerical solutions provided by a dual process-based approach: advection–dispersion model (ADM) and two-region non-equilibrium model (2RNE). Tracer tests were conducted under different hydrological conditions (high-intermediate-low flow) affecting the aquifers, and the fluorescent substances were injected into sinkholes (5), losing streams (4), karrenfields (1) and dolines (1), while springs commonly served as detection points (manual sampling and eventually field fluorimeters). Flow and transport parameters estimates obtained from the simulation of 13 tracer breakthrough curves (BTCs) provided mixed information on a wide range of hydrogeological behaviors: from well-developed conduit flow paths to flow and storage modalities in a fissured-like systems. The statistical treatment of the analytical and numerical results, jointly to the field observations, has been especially useful for the characterization of the predominant solute transport processes in the studied experimental sites, given the significant deviations that have been eventually found between the shape of the measured and modeled curves (marked skewness, single/multi-pulse geometry, long-tailing effect, etc). These findings will allow for a better understanding of the structure and dynamic of the karst systems investigated and will may help to protect and preserve karst water resources in the region.