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Using a physically-based transit time distribution function to estimate the hydraulic parameters and hydraulic transit times of an unconfined aquifer from tritium measurements

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Groundwater transit time is of interest in environmental studies pertaining to the transport of pollutants from its source to the aquifer outlet (spring or pumping well) or to an observation well. Different models have been proposed to describe the distribution of transit times within groundwatersheds, the most common being the dispersion model, the exponential-piston-flow model (EPM) both proposed by Maloszewski and Zuber (Maloszewski and Zuber, 1982) and the (two or three parameter) gamma model (Amin and Campana, 1996; Kirchner et al., 1999). Choosing which function applies best is a recurrent and controversial problem in hydrogeology. The object of this study is to revisit the applicability of the EPM for unconfined aquifers, and to introduce an alternative model based explicitly on groundwater hydraulics.
The alternative model is based on the transit time of water from any point at the groundwater table to the aquifer outlet, and is used to calculate inversely the hydraulic parameters of a fractured unconfined sandstone aquifer from tritium measurements made in a series of contact springs. This model is compared to the EPM, which is usually adopted to describe the transit time distribution of confined and unconfined aquifers alike. Both models are tested against observations, and it is shown that the EPM fails the test for some of the springs, and generally seems to overestimate the older water component.

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