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Groundwater ages in an alluvial aquifer: Confronting lumped parameter models (3H, CFCs and SF6) and numerical transport modeling.

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Groundwater age dating using tritium and dissolved gases was undertaken in an alluvial aquifer to determine groundwater transit time and flow rate as key parameters for assessing diffuse nitrate pollution.The studied site of about 260 km2 is crossed by the Ain River and bordered by the Rhône River which is the natural drain for the aquifer. It is mainly recharged by precipitation but also receives water from the Dombes plain (NW and W), intensively cultivated, and from the Bugey and Jura karstic mountains (NE and E part).
In this study, we investigated the relevance of the gas-tracers CFCs and SF6 as age dating tools in alluvial shallow aquifers. The exponential model was chosen to conceptualize the alluvial aquifer recharge, 3H also used. Age-dating gave a mean recharge date of 5 to 18 years. CFCs, SF6 and 3H age estimation was confronted with the results of 2D transport modelling. Lumped parameter models were used to estimate the distribution of CFC and SF6 ages.

Groundwater age is a measurable quantity, provided many assumptions. One of the underlying questions is the physical meaning of "ages" obtained by the lumped parameter models. Indeed, knowledge of an apparent age does not necessarily imply knowledge of the groundwater residence time. An independent approach of groundwater age determination is based on solving the solute transport problem. Few studies seek to compare the hydrodynamic and tracers approaches. This comparison aims to increase our hydrogeological understanding of the Ain alluvial plain and to better define " groundwater age" and its meanings.

The hydrodynamic modelling was performed using MARTHE code (Thiéry, 2004). It was calibrated over a period of 8 years at a 10 days' time step. Results of the transitory regime calibration are satisfactory and allowed the use of this model for solute transport of 3H, CFCs and SF6.
Different approaches are possible for the comparison of tracer and hydrodynamic models. The first is to reproduce the tracer contents by transport modelling, Input parameters for concentration in recharge and the river are the atmospheric mixing ratios of CFCs from 1980 to 2006. Comparison between simulated and observed CFCs concentrations was inconclusive due to a strong numerical dispersion of the finite difference model.
A second approach is to compare the ages obtained by CFC age-dating and the transit times obtained by particle tracking modelling. In first step, the results will be confronted independently. In a second time, calibration taking into account the results obtained using the CFC-dating led to an improvement of the age and can make a "feedback" to improve understanding of the conceptual model. We will test a third approach consisting in entering CFC data in the hydrodynamic models in the aim of simulate its comportment in the system.