Methods for the estimation of the mixing zones and the length of steady state contaminant plumes

P. Blum (1), C. Iturralde (1), U. Maier (1), M. Weede (2), P. Grathwohl (1)

(1) University of Tübingen, Center for Applied Geoscience (ZAG), Tübingen, Germany
(philipp.blum@uni-tuebingen.de) (2) URS Deutschland GmbH, Hannover, Germany

Quantification of biodegradation in contaminated aquifers is an increasingly important issue, which is often closely related to monitored natural attenuation (MNA) as an alternative remediation strategy for contaminated sites. One essential aspect is the knowledge about biodegradation and the maximum length of the contaminant plume. Among other methods qualitative evidence for biodegradation can be generally demonstrated using redox-sensitive tapes (RST) and compound-specific isotope analysis (CSIA). The latter could show that for the considered coal tar contaminated aquifer the dominant biodegradation of naphthalene is aerobic and therefore fringe-controlled. Mixing between the electron acceptor and the electron donor is therefore the most important process for active biodegradation. Thus, in the current study the mixing zone of the studied plume was determined using redox-sensitive tapes. Furthermore, the length of the steady state plume was estimated using two independently reaction models. Both models indicate that apart from the contaminated aquifer thickness, the transverse vertical dispersivity, which controls the mixing, is one of the most important parameters for the estimation. Hence, in the current study the effective transverse vertical dispersivity was approximated for each organic compound resulting in a log-normal distribution of effective transverse vertical dispersivity with a mean value of 5 cm. In contrast, the average size of the mixing zones was determined to be 10 cm. The results of the field study clearly illustrate that transverse vertical dispersivities derived from laboratory studies at the pore-scale are by more than two orders of magnitude to small for the application in the field. Reasons for the unsolved upscaling problem will also be discussed.