UNCERTAINTY ANALYSIS IN GROUNDWATER DATING WITH ENVIRONMENTAL TRACERS USING MARKOV CHAIN MONTE CARLO METHOD

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The estimation of groundwater age has received increasing attention due to its applications in assessing the sustainability of water withdrawal from the aquifers and evaluating the vulnerability of groundwater resources to near surface or recharge water contamination. In most of the works done in the past, whether a single or multiple tracers used for groundwater dating, the uncertainties in observed concentrations of the tracers and their decay rate constants have been neglected. Furthermore, tracers have been assumed to move at the same speed as the groundwater. In reality some of the radio-tracers or anthropogenic chemicals used for groundwater dating might undergo adsorption and desorption and move with a slower velocity than the groundwater. Also there are uncertainties in the decay rates of synthetic chemicals such as CFCs commonly used for groundwater dating. In this presentation development of a Bayesian modeling approach using Markov Chain Monte Carlo method for estimation of age distribution is described. The model considers the uncertainties in the measured tracer concentrations as well as the parameters affecting the concentration of tracers in the groundwater and provides the frequency distributions of the parameters defining the groundwater age distribution. The model also incorporates the effect of the contribution of dissolution of aquifer minerals in diluting the 14C signature and the uncertainties associated with this process on inferred age distribution parameters. The results of application of the method to data collected at Laselva Biological Station – Costa Rica will also be presented. In this demonstration application, eight different forms of presumed groundwater age distributions have been tested including four single-peak forms and four double-peaked forms assuming the groundwater consisting distinct young and old fractions. The performance of these presumed groundwater age forms have been evaluated in terms of their capability in predicting tracer concentration close to the observed values and also the level of certainty they provide in estimation of the age-distribution of parameters.