Understanding Controls on Groundwater "age" in an Alluvial Aquifer

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The inversion of environmental tracer concentrations to derive groundwater "age" typically rests on considerable simplifying assumptions. In this study of an arsenic rich aquifer system in Southeast Asia, environmental tracer concentrations (noble gases, tritium, CFCs and SF_6) were initially interpreted in terms of simple lumped parameter models to develop and constrain a hydrogeological conceptual model. A numerical groundwater flow and contaminant transport simulation was then developed to further conceptual understanding of the flow and transport system. Results show that groundwater reaching a well typically consist of a wide distribution of groundwater age (often spanning > 100 years), even over short well screens (1 m). Additionally, extreme changes in hydraulic gradients driven by the monsoon cycle presents the ideal conditions for groundwater mixing, leading to multi-modal distributions of groundwater age. This study has avoided the issues of groundwater age as a scalar value and elucidated some of the potential ambiguities associated with standard fluid dating techniques. It is advised that the term "groundwater age" should be used with caution. Furthermore, dispersion of groundwater age and reversal of hydraulic gradients (monsoon cycle) implies that the processes controlling groundwater quality trends in response to point or non-point source contamination (anthropogenic or natural) are are best evaluated through long-term monitoring.