Presented at the 2000 American Water Resources Association Montana Section Meeting

Mantle Flatulence and Septic Effluent: Sampling the Missoula Aquifer for Environmental Tracers

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Abstract

Environmental tracers are natural or anthropogenic compounds or isotopes that are widely distributed in the earth's near-surface environment and which can be used to infer the movement of water. Tritium/helium-3 (3H/3He) ratios and chlorofluorocarbons (CFC's) are tracer methods commonly used to age-date "modern" ground-water (less than 50 years old) with a precision on the order of a few months to a few years, respectively. Samples for tritium, noble gases and CFC's were collected from the Missoula aquifer in an attempt to quantify ground-water ages and assess flow rates.

Due to their low solubilities and low concentrations, noble gases and CFC's are especially vulnerable to sampling problems. Collection of ground-water samples for noble gases (e.g. He) and for CFC's requires closed paths that allow the flushing and filling of sample containers without exposure to the atmosphere and requires zero headspace in the containers. Two different sampling methods were used for noble gases, 1) a copper tube bailer apparatus, which was lowered into wells to collect water samples, and 2) in situ diffusion gas samplers. Samples for CFC's were collected in copper tubes.

Seventeen wells along transects of ground-water flow were sampled for tritium and noble gases. The results to date show good agreement between the two different sampling methods, but generally more consistent results from the diffusion gas samplers. The data also show that all of the wells sampled in the Missoula aquifer have tritium concentrations between 8.7 to 13.2 tritium units indicating water less than 50 years old. The tritium also suggests the potential to produce tritiogenic helium-3 which is necessary for 3H/3He dating, however the presence of excess terrigenic helium has hindered successful dating. The source of excess helium is not clear, but the 3He/4He ratio suggests a mantle source rather than an atmospheric (excess air) one.

Twelve wells were also sampled for CFC's; ten of those ground-water samples contained CFC's in excess of air-water solubility rendering them unsuitable for age dating. The highest CFC concentrations were detected immediately downgradient from areas of high septic tank density, suggesting that septic effluent is a potential source of the excess CFC's.