USGS

WATER RESOURCES RESEARCH GRANT PROPOSAL

1. Title. The Use of Seasonal Oxygen -18 Signatures in Modeling Shallow Groundwater Recharge.

2. Focus Categories. HYDROL, GW, MOD, MET

3. Keywords. Isotopes, Groundwater Recharge, Mean Residence Time

4. Duration. October 1, 1998 to August 31, 1999

5. Federal funds requested. $62,822

6. Non-Federal (matching) funds pledged. $125,644

7. Principal Investigators.

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8. Congressional District. 5th of Pennsylvania

9. Statement of critical regional or State water problems.

Understanding the groundwater recharge process is essential in protecting groundwater and streamflow source quality. Short transit times associated with the recharge process can potentially adversely affect groundwater quality due to lack of attenuation time or contaminant decay. Recharge water from an agricultural field, for example, containing pesticide may infiltrate through the subsurface and potentially impact groundwater quality for drinking water. In addition to groundwater recharge contamination potential, mechanisms controlling recharge play an important role the soil/stream water chemistry. Preferential flow bypasses the soil matrix and reduces the ability of the soil react with solutes carried by the infiltrating water. Preferential flow decreases the time for infiltrating water containing contaminants or nutrients to react with the soil-plant and microbial system.

Residence time estimation offers benefits to evaluating recharge water flow through the subsurface to groundwater sources. Mean residence time (MRT) determined from seasonal isotope variations in input water (precipitation) and output water (subsurface water or streamflow) can provide information about groundwater recharge processes and contamination vulnerability. Seasonal variations of environmental isotopes (i.e., deuterium and oxygen-18) in water are attenuated during movement through the subsurface system. This attenuation is related to the recharge pathways (both matrix and macropore controlled) and residence time of the system (Clark and Fritz, 1997). Thus, MRT can be used in assessing whether a groundwater source is vulnerable to contamination from recharge on the surface or in providing a hydrologic connection from surface water to groundwater. A surface hydrologic connection is needed to provide evidence of "direct influence of surface water" to groundwater sources in the Federal Surface Water Treatment Rule (SWTR) (Federal Register, 1989). The SWTR mandates that groundwaters "under direct influence" be filtered for public drinking water supplies. Evaluation of MRT of groundwaters could be useful in assessing the need for such filtration.

10. Statement of results or benefits.

This project will demonstrate a technique based on isotopic seasonal variations that has been used to estimate MRT of infiltrating water (DeWalle et al., 1997; Stewart and McDonnell, 1991; Maloszewski et al., 1983). The study will utilize the MRTs along points within the groundwater recharge process to gain a better understanding of the nature of water flow in the vadose zone and its connection to the groundwater reservoir. Specifically, the results from this project will yield information on recharge processes in different soil and shallow aquifer types common to central Pennsylvania, and the limitations of MRT models on these aquifer types. This can potentially be used for assessing groundwater quality impacts, quality of source water for streamflow, and groundwater sources under direct influence of surface water.