



USGS NSF GRIP, GSP Opportunity

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● USGS Center:	National Research Program - Eastern
● Project Title:	Physical, Chemical, and Biological Processes Affecting the Retention and Release of Organic Contaminants in Fractured Rock Aquifers
● Summary:	Physical, chemical, and biological processes control the retention and release of organic contaminants in the matrix of fractured sedimentary rocks and affect the longevity of groundwater contamination and the design of groundwater remediation strategies.
● Project Hypothesis or Objectives:	<p>Chlorinated solvents have been widely used at industrial, commercial, and federal facilities for more than six decades, which has resulted in thousands of releases into the environment. In many of these situations, chlorinated solvents migrate to the groundwater table, resulting in degraded groundwater quality and the need for remediation. It is projected that the cost of characterization and remediation at these sites will exceed 100 billion dollars in the coming decade.</p> <p>Understanding the processes that affect the transport of chlorinated solvents in subsurface environments is needed to design and apply remediation technologies effectively. In many groundwater systems, the effectiveness of common groundwater remediation technologies is hindered by aqueous phase chlorinated solvents that have diffused from permeable groundwater pathways into low-permeability geologic materials. The aqueous phase contaminants in low-permeability regions of the aquifer act as a spatially pervasive source of contamination that can slowly diffuse back into the permeable groundwater pathways and adversely affect downgradient groundwater quality for decades, centuries, or millennia. Characterizing the retention and release of organic contaminants in the primary porosity (or rock matrix) of fractured rock aquifers has proven to be a particularly challenging and costly. It is estimated that nearly 75% of the resources that are to be</p>

dedicated to the characterization and remediation of groundwater contamination in the Nation will be expended on 10% of the sites of groundwater contamination that are categorized as geological complex, such as those in fractured rock.

The purpose of this research is to quantify the magnitude of physical, chemical, and biological processes that affect the retention and release of organic contaminants in the primary porosity of fractured sedimentary rock aquifers through the design and implementation of in situ and laboratory experiments. This research also addresses the influence of spatially variable physical and chemical rock properties in the retention and release of organic contaminants. Recent research has shown that the organic carbon content and the total porosity of fine-grained sedimentary rocks can vary over two orders of magnitude over dimensions of centimeters in the rock matrix. Current practices of characterizing the retention and release of organic contaminants in the rock matrix have relied on assigning average values of rock properties based on the analysis of a small number of core samples. Understanding the roles of the sedimentary deposition, lithification, and post-lithification processes may provide insight into the magnitude and variability of physical and chemical rock properties. In addition, recent research has shown that the distribution of pore diameters in the rock matrix varies over a range that may support microbes that are known to degrade organic contaminants anaerobically. Designing innovative in situ and laboratory experiments to quantify biological processes that can degrade organic contaminants in the rock matrix will further advance this research effort. This research will draw from detailed field investigations and analyses of rock core collected from a site of trichloroethene (TCE) contamination in a fractured mudstone aquifer. This research will also include modeling investigations that synthesize data from field and laboratory experiments and test hypotheses associated with the processes affecting the retention and release of organic contaminants in the rock matrix.

 Duration:	Up to 12 months
 Internship Location:	Reston, VA
 Field(s) of Study:	Chemistry, Engineering, Geoscience
 Applicable NSF Division:	EAR Earth Sciences
 Intern Type Preference:	Either Type of Intern
 Keywords:	Fractured rock Groundwater Contamination

Expected Outcome: The intern will participate in a highly innovative research project that will introduce participants to quantitative hydrogeology investigations, including the formulation of hypotheses, the design and collection of field or laboratory data, and the synthesis and interpretation of physical, chemical, or biological processes through modeling investigations. The intern will work with world-recognized experts on fractured rock hydrology, geochemistry, and microbiology from the U.S. Geological Survey (USGS) and will be responsible for critical components of the research program, which will culminate in the publication of products describing research results.

This research project continues the program of research the USGS has been conducting in characterizing groundwater flow and transport processes in complex geologic settings. This research is fundamental in addressing the missions of the USGS in areas of improving human and ecosystem health and water availability.

Special skills/training Required: Familiarity with quantitative groundwater flow and chemical transport processes is expected. It is not anticipated that the intern will have extensive experience in groundwater flow and chemical transport modeling; however, fearlessness in applying groundwater flow and chemical transport models is expected. Interns that participate in field and laboratory activities are expected to assist in the design, installation, and execution of the experimentation. Field activities will be moderately strenuous, as they will require the installation of equipment into bedrock boreholes. In addition, the intern will be responsible for documenting results and participating in the preparation of research reports and articles.

Duties/Responsibilities: The duties of the intern will depend on the duration of the internship: Durations of 2 months will focus on modeling investigations in support of the research program using currently available data to formulate and test hypotheses on the distribution of organic contaminants in the rock matrix and the spatial distribution of rock properties. Longer tenures will include participation in the design, implementation, and interpretation of in situ or laboratory experiments. The internship will be organized to facilitate the preparation of research publication at the conclusion of the tenure. The research publication may not be completed at the conclusion of the intern's tenure; however, continued collaboration after the intern's tenure is anticipated to complete the research publication and design follow-on experimentation, if appropriate.