### USGS NSF GRIP, GSP Opportunity

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<tr>
<th><strong>Point of Contact Name:</strong></th>
<th>John Nimmo</th>
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<td><strong>Point of Contact Email:</strong></td>
<td><a href="mailto:jrnimmo@usgs.gov">jrnimmo@usgs.gov</a></td>
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<td><strong>USGS Center:</strong></td>
<td>National Research Program, Western Branch</td>
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<td><strong>Project Title:</strong></td>
<td>The influence of preferential flow on water and solute fluxes in the unsaturated zone</td>
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<td><strong>Summary:</strong></td>
<td>Much unsaturated-zone water moves not as typically slow diffuse flow, but rapidly through preferential flow channels such as root holes and fractures. Impacts are profound and far-reaching for issues such as contaminant transport, ecohydrology, and aquifer recharge. Understanding is limited and accepted theory is lacking, making preferential flow a crucial and exciting area of earth science.</td>
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<td><strong>Project Hypothesis or Objectives:</strong></td>
<td>Much unsaturated-zone water moves not as typically slow diffuse flow, but rapidly through preferential flow channels such as root holes and fractures. Impacts are profound and far-reaching for issues such as contaminant transport, ecohydrology, and aquifer recharge. Understanding is limited and accepted theory is lacking, making preferential flow a crucial and exciting area of earth science. Although preferential flow has been a major research focus for more than three decades, most application-directed quantification is still based on formulations that treat all unsaturated-zone flow as diffuse flow or that use some adaptation of diffuse-flow techniques for the preferential component. In many ways, however, the processes of preferential flow are critically different from those of diffuse flow. For this reason our approach is to develop formulas that directly describe these processes, and to combine them with traditional formulations as needed. Because the mathematical models of diffuse flow, though conceptually simple, are difficult for practical implementation and solution, and because evidence suggests preferential flow processes may be approached with simpler math, this separate-process approach may lead to new models that are both more tractable and more accurate for predicting transport in the unsaturated zone. Research activities we pursue toward these goals include field experiments under both preferential-dominated and</td>
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diffuse-dominated flow conditions, lab experiments exploring the soil
or rock properties needed in preferential flow quantification, and
development of models, formulas, and algorithms through iterative
hypothesizing and testing against data. Examples of our methods and
tools include the Source-Responsive family of preferential flow
models (e.g. Nimmo, 2010, VZJ, v. 9, p. 295–306), combined use of
complementary field instruments such as infiltrometers that are or
are not sensitive to preferential flow, and analysis of time-series
water-content and well-level data to evaluate signature behaviors of
preferential flow processes.

Duration: Up to 12 months

Internship Location: Menlo Park, California

Field(s) of Study: Geoscience

Applicable NSF Division: EAR  Earth Sciences, CBET Chemical, Bioengineering, Environmental,
and Transport Systems, PHY  Physics

Intern Type Preference: Either Type of Intern

Keywords: Unsaturated zone, vadose zone, preferential flow, recharge,
contaminant transport, ecohydrology, soil-water, fractured rock

Expected Outcome: The project will produce journal publications, or substantial material
to go into them, that advance the understanding and theory of
preferential flow, and build a foundation for practical models and
techniques that solve critical problems such as rapid contaminant
transport and episodic aquifer recharge. The USGS will benefit from
this contribution to its mission of evaluating the problems and
effective utilization of water resources. The student will benefit by
first-hand acquaintance with the ideas and research practices of
USGS scientists, practical experience with cutting-edge research
techniques, and achieving research contributions to thesis work and
to published scientific knowledge.

Special skills/training Required: The student should have a Bachelor’s or Master’s degree in hydrology,
geology, soil science, physics, environmental science, or a related
discipline. The student will need good understanding and ability in
physics and math.

Duties/Responsibilities: The student will collaborate as a member of our team, and take
responsibility for one or more particular research components. Such a
component might be a set of lab or field experiments, development of
a formula or algorithm for predicting the behavior or consequences of
preferential flow, or developing a new technique for measurements or
calculations. The student will participate in planning, interpreting, and
preparing for publication of the research.
Center Director Name: Joe Holomuzki
USGS Responsibilities: Equipment, Facilities, Mentoring, Background Check, Volunteer Agreement Management
Preliminary Approval: I have discussed this opportunity with my Center's leadership and approval is pending.
I already have a student in mind:

Comments: