WHITE PAPER

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Geoenvironmental Research Experience (last 5 years):

Distributed Measurement of Temperature, Moisture and Strain for Civil Engineering Applications in Subsurface Using a Fiber Optic Sensor, NSF, 2003.

Development of a SBS Fiber Optic Sensor for Strain, Temperature and Moisture Measurements in Subsurface, PITA, Pennsylvania Technology Alliance, Pennsylvania Department of Interior, 2003.

Feasibility of the Use of Cathodic Protection and Electro-Chloride Extraction Technology for Structures in PA, Pennsylvania Department of Transportation, 2001.

Electro-Osmotically Enhanced Treatment of TCE in LLNL Site Soil, Lawrence Livermore National Laboratories, Department of Energy, 2000

Electro-Osmotically Enhanced Removal of Perchlorate From Contaminated Soil at the Aerojet Plant Site, Weiss Associates, Emeryville, Ca,1999

Electro-Osmotic Testing Program for the Former Solvents Underground Storage Tank Site at Stanford Linear Accelerator Center, Weiss, Associates, Emeryville, Ca,1998.

Geoenvironmental Teaching Experience:

Soil Mechanics
Foundation Engineering
Geo-environmental Engineering
Soil Behavior

Geoenvironmental Consulting Experience:

Bethlehem Steel Corporation, Bethlehem, PA
Pfizer Corporation, Easton, PA
Horsehead Resource Development Co., Palmerton, PA
American Zinc, Co., Palmerton, PA
Pennsylvania Power and Light Co., PA
Public Service Electric and Gas, NJ
Systech Environmental Co., Xenia, OH
GenCorp Aerojet, Sacramento, CA

Appraisal of Geoenvironmental Research, Education and Practice:

Geoenvironmental engineering is a multi-disciplinary field, which has gained much opportunity for broad application over the last two decades. Practice has been driven mostly by regulatory needs and in certain cases by economic gains. Research; by large has been limited to bench-scale or small scale-simulations with empirical findings. Although a number of researchers have conducted critical fundamental work, it has been the attempts of the industry and their collaboration with researchers responsible mostly for the bold advancements in the field. Standardization remains an important issue both for the industry and the research environment.

Geoenvironmental engineering has become an integral part of undergraduate geotechnical education. However, the subject area is highly broad therefore difficult to attract students to the field through the introductory undergraduate courses. Expertise often requires not only good mathematical skills but also flexibility and ability to deal with open-ended problems and ability to integrate various science and engineering concepts, which may not entirely rest in the civil/geotechnical engineering domain. A geoenvironmental engineer is often expected to be a good geotechnical engineer as well, which may pose high demands on the students and the academic program. The involvement of the industry and practicing engineers in the education aspects may be helpful in increasing student interest and their understanding of geoenvironmental engineering. The practitioners may be involved through presentations and lectures to students, by providing opportunities for field trips, and opportunities for summer internships in field laboratories and the practice.

Perspective on Emerging Geoenvironmental Issues and Technologies:

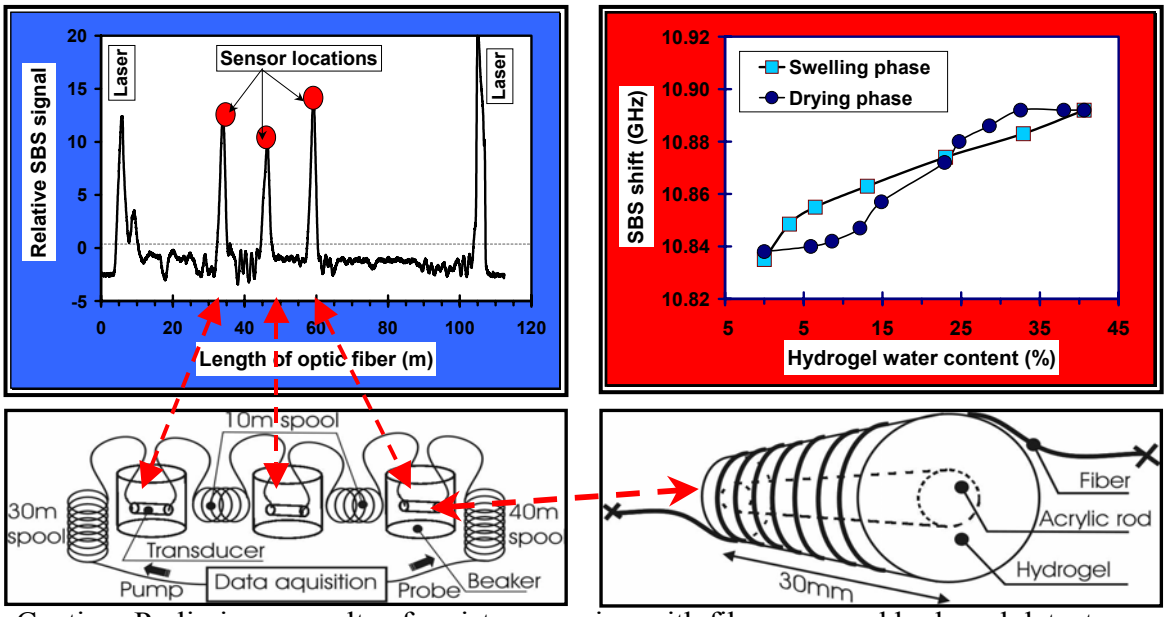
Innovation and integration has been the main focus of geoenvironmental research for many years. Although many techniques have been developed, only a few have emerged feasible for field applications. Nevertheless research and development has never ceased and with the advances in information technologies and materials, geoenvironmental research may change direction slightly and perhaps become more product-oriented.

Attached below is description of such a product that that may pose promising applications in geoenvironmental engineering:

Distributed Sensing of Water and Selected Chemicals in Geo-media Using Polymer Coated Fiber Optic Lines

Sibel Pamukcu, Assoc. Prof., Dept. of Civil and Environmental Engr., Lehigh University
Jean Toulouse, Prof., Dept. of Physics, Lehigh University

An interdisciplinary team of researchers from Civil and Environmental Engineering, Physics, and Polymer Science and Engineering at Lehigh University are developing a distributed sensing system for continuous monitoring of chemical contents and moisture in extended surface and subsurface environments of water and geo-media. The sensor is a new development in distributed chemical sensing based on Stimulated Brillouin Scattering (SBS) in optical fibers, coupled with reactive polymers. SBS is a nonlinear effect, in which light is back scattered at well-defined points along the fiber, where the acoustic properties of the fiber are being locally modified by the environment. The fiber is hitched or bonded with selective polymers that are mass detectors in direct contact with the surrounding medium. The polymer reacts to the surrounding (i.e. moisture, pH, target chemical) as it swells by selectively absorbing the target compound. Localized swelling of the bonded or hitched polymer produces tangential, axial or radial stresses on the fiber depending on the physical coupling. These stresses result in axial straining of the fiber and a measurable change in its local acoustic properties. An SBS signal is generated at the sensing location which, is detected by the measurement of the arrival time of the SBS pulse at one end of fiber. The polymer mass sorption and the corresponding SBS pulse magnitude is calibrated for quantitative measurement of content. Since the sensing is based on fiber straining and not energy consumption, the entire length of the fiber is available for distributed sensing. The technology is viable for potentially continuous off-site monitoring of target chemicals with a linear spatial resolution of one meter or better, over 20-km of fiber stretched or laced over the sensing area.



Caption: Preliminary results of moisture sensing with fiber wrapped hydrogel detectors over 90 m of fiber