Dear Colleagues,

150 years ago, Henry Darcy published “Darcy’s Law” in an appendix of his 1856 book *The Public Fountains of the City of Dijon*. Since then methods and techniques of hydrologic measurements and our understanding of hydrologic processes have evolved greatly, but Darcy’s formula is still at the foundation of the computation of water flow through various porous media. Aside from Darcy’s Law, Darcy also made remarkable contributions to public health and the economy. He conceived and built the water supply system of Dijon in the 1830s and 1840s. The Darcy-Weisbach equation also acknowledges his significant contribution to open channel research. Therefore, 2006 is a great year to celebrate this scientific and societal role model. An inauguration of Henry Darcy Exhibition is planned on Darcy Day at the International Symposium Darcy 2006 to be held in Dijon, May 30-June 1. See p. 14 for more details.

Interestingly, hydrology is now the 7th fastest growing career field in the US (see [http://money.cnn.com/magazines/moneymag/bestjobs/other_jobs/index.html](http://money.cnn.com/magazines/moneymag/bestjobs/other_jobs/index.html)). Considering the first six fastest growing jobs are all some sort of assistants or technicians, hydrology actually ranks at the top for scientists type of jobs (32% growth over 10-yr forecast). If combined with soils career, which ranks 73rd (14% growth), perhaps hydropedology would be a super growing career in the near future?!

Below are some highlights of hydropedology-related activities reported in this issue:

- The hydropedology symposium at the 18th World Congress of Soil Science has attracted 59 papers. The oral session includes speakers from the US, Czech, Australia, Russia, and the Netherlands. More on p. 2-5.
- A special session related to hydropedology at the AGU Spring 2006 Joint Assembly. Details on p. 2.
- Food for thoughts: “Imaging Hydropedological Processes with Geophysical Tools” (p. 8-10) and “A Cattle vs. the Ground Beef: What is the Difference?” (p. 15-16).
- Five new sessions are added from this issue on: 1) Book review; 2) Landscape-Soil-Water Relationships in Intensively-Studied Watersheds around the Globe; 3) Extraterrestrial Hydropedology; 4) Jobs; 5) Fun.

I hope you will find this newsletter of interest and informative. As always, I welcome your comments and contributions at any time. For more information, please contact me at any time at henrylin@psu.edu.

Sincerely,
Henry Lin, *Editor*
Hydropedology Symposium at 18th WCSS, July 9-15, 2006, Philadelphia

Tuesday, 11 July 2006: 10:15 AM
Convention Center Room 114, First Floor
1.1A Hydropedology: Fundamental Issues and Practical Applications - Oral

Presiding: Henry Lin, Penn State University
Convener: Johannes Bouma, Wageningen University and Research Center

10:15 AM
Interpretations of Morphological Features in Wetland Soils with Hydrologic Models.
Michael Vepraskas, NC State Univ, Peter V. Caldwell, NC State Univ

10:45 AM
Hydropedology: Links to Neighboring Disciplines.
Miroslav Kutilek, Soil and Tillage Research, Donald R. Nielsen, Univ of California, Dept LAWR Hydrologic Science

11:05 AM
Calcium amendments to reduce dissolved organic carbon from subcatchments.
David J. Chittleborough, University of Adelaide, Jim W. Cox, CSIRO Land and Water, Jon Varcoe, University of Adelaide, John Van Leeuwen, University of South Australia

11:25 AM
Evolution of a spatially heterogeneous paleocryogenic soilscape and its impact upon formation of coupled moisture and thermal regimes.
Evgeny Shein, Moscow State University

11:45 AM
Interrelationships between soil and water in tropical peatlands.
Henk Wösten, Alterra - Wageningen University and Research Centre, Aswandi Idris, Jambi University

Other Sessions of the Hydropedology Symposium at the 18th WCSS (Details on p. 3-5):
1.1A Theater I: Tuesday, 11 July: 3:30 PM-5:30 PM.
1.1A Theater II: Friday, 14 July: 3:30 PM-5:30 PM. Details on p. 4. Note: these are enhanced portion of posters
1.1A Poster: All week during the Congress. Details on p. 5
NOTE: Theaters are enhanced poster sessions, where selected poster authors will have opportunity to give a short talk. These posters will also be displayed all week during the Congress.

AGU Spring 2006 Joint Assembly, May 23, Baltimore, MD

Near Surface Geophysics

<table>
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<th>Time</th>
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| 1400 | Characterizing the Subsurface in Watersheds: Issues in Geophysics, Hydropedology, and Scale (joint with Hydrology)  
Presiding: S Moysey, Clemson University; D A Robinson, Stanford University |
| 1400 | Remote sensing and scaling of satellite derived hydrological variables  
*V Lakshmi, INVITED |
| 1418 | Characterizing Watersheds with Geophysical Methods: Some uses of GPR and EMI in Hydropedological Investigations.  
*J Doolittle, H Lin, B Jenkinson, X Zhou, INVITED |
| 1436 | Improving Crosshole GPR Velocity Tomography at Close Borehole Spacings  
*J Irving, M Knoll, R Knight, INVITED |
| 1454 | The Support Volume of Geophysical Measurement: How and Why to Define It  
*R Knight, A Pidlisecky, INVITED |
| 1512 | Effects of scale and spatial process organisation in hydrogeology  
*G Bloschl, INVITED |
| 1530 | Predicting Spatial Distribution of Soil Texture with Electromagnetic Induction Mapping and Terrain Analysis Models in Small Watersheds  
*H Abdu, D A Robinson, M Seyfried, S B Jones |
1.1A Hydropedology: Fundamental Issues and Practical Applications - Theater I
Tuesday, 11 July 2006: 3:30 PM-5:30 PM
Convention Center Exhibit Hall A, Theater 3, Second Floor
Presiding: Henry Lin, Penn State Univ., Convenor: Johan Bouma, Wageningen Univ.

Comparison and Evaluation of Field Methods (Direct and Indirect) to Estimate Soil Water Fluxes.
Dennis Timlin, USDA-ARS Crop Systems and Global Change Lab, Yakov A. Pachepsky, USDA/ARS/BA/ANRI/ESML, James Starr, USDA-ARS

Comparisons of Transient Methods For Determining Hydraulic Conductivity Using Disc Permeameters.
Freeman Cook, CSIRO Land and Water, Leon Dawes, CSIRO Sustainable Ecosystems

Hood Infiltrometer - A New Type of Tension Infiltrometer.
Jürgen Punzel, UGT Environmental Measuring Techniques Ltd., Kai Schwärzel, Institute of Soil Science and Site Ecology, Faculty of Forest-, Geo- and Hydro Science, Dresden University of Technology


Bin Zhang, Chinese Academy of Sciences, Jia-Liang Tang, Chinese Academy of Sciences, Chao Gao, Nanjing University, H. Zepp, Ruhr- University Bochum

A Hydropedologic Study of Subsurface Water Flow in a Forested Catchment.
Xiaobo Zhou, Penn State University, Henry Lin, Charles Walker, Qing Zhu, The Pennsylvania State University

Transport of Colloids by Transient Wetting Fronts.
Jie Zhuang, University of Tennessee, John McCarthy, University of Tennessee, Larry McKay, University of Tennessee, Ching Tu, University of Tennessee, Ed Perfect, University of Tennessee

Transport and Transformation Processes of the Greenhouse Gas N2O in the System Groundwater/Vadose Zone of a Catchment in Germany.
Markus Deurer, HortResearch, Carolin von der Heide, Institute for Soil Science, University of Hannover, Jürgen Böttcher, Institute for Soil Science, University of Hannover, Wilhelms Duijnsveld, Federal Institute for Geosciences and Natural Resources, Klaus Schäfer, Institute for Meteorology and Climate Research

Scaling-Up Soil Trace Gas Fluxes Remotely with Hydrogeomorphic Features for Agricultural Wetlands.
Rebecca Phillips, USDA-ARS, Ofer Beeri, University of North Dakota

Remote Sensing of Surface Carbon and Water Contents using Bare Soil Imagery.
Javed Iqbal, Purdue University, Phillip Owens, Purdue Univ., Jeffery L. Willers, USDA-ARS

Using HYDRUS computer software packages to simulate multicomponent biogeochemical transport in soils.
Jirka Simunek, University of California Riverside, Diederik Jacques, SCK-CEN, Guenter Langergraber, Institute for Sanitary Engineering and Water Pollution Control, Maria C. Gonçalves, Department of Soil Science, Estação Agronômica Nacional, M. Th. Van Genuchten, George E. Brown, Jr. Salinity Laboratory, USDA-ARS, Dirk Mallants, SCK-CEN

Information Content and Complexity of Simulated Soil Water Fluxes.

A Cantor Bar Model for the Effective Hydraulic Conductivity of Partially-Saturated Layered Soil.
Tairone P. Leao, University of Tennessee, Ed Perfect, University of Tennessee

Lifang Luo, Penn. State University, Henry Lin, Penn State Universtiy, Kamini Singha, Penn. State Univ.

Fractal Models of Soil Water Retention: How Good are They?.
Daniel Gimenez, Rutgers University, Roberto R. Filgueira, Facultad de Ciencias Agrarias y Forestales-Universidad Nacional de La Plata, Sung Won Yoon, Rutgers University, Hyen Chung Chun, Rutgers University
Hydropedology, Geomorphology and Groundwater Processes Hold the Keys to Land Degradation - Case Studies in SW Victoria, Australia.

Richard MacEwan, Department of Primary Industries, Peter G. Dahlhaus, Univ of Ballarat, Jon Fawcett, Department of Primary Industries

A Morphological Approach to Understanding Preferential Flow Using X-ray Computed Tomography and Image Analysis.

Sacha J. Mooney, Univ of Nottingham, Catherine Morris, Univ of Nottingham

Reduction of Iron Oxides in Wetland Soils.

Martin C. Rabenhorst, Univ of Maryland, Rebecca R. Blank, Univ of Maryland, Bruce R. James, Univ of Maryland

Modeling Soil Hydraulic Properties as a Function of Morphological Features and Land use.

Xiaobo Zhou, Penn State Univ, Henry Lin, Penn State Univ, ED White, USDA-NRCS, John Chibirka, USDA-NRCS, Yuri K. Plowden, Natural Resources Conservation Service

Hydropedology Applied to Imperfectly Drained Landscapes in Closed Basins.

Jim Richardson, NRCS-USDA, David Hammer, NRCS-USDA

Correlation of Redoximorphic Features to Hydrology.

David L. Lindbo, Soil Science Dept, North Carolina State Univ, Erik D. Severson, USDA-NRCS, Gerren Lanier, Soil Science Dept, North Carolina State Univ, Michael Vepraskas, Soil Science Dept, North Carolina State Univ

Impact of Soil Structure on Saturated Hydraulic Conductivity in the Piedmont of Georgia, USA.

L.T. West, University of Georgia, Maria E. Abreu, University of Georgia, David E. Radcliffe, University of Georgia, Miguel L. Cabrera, University of Georgia

Hydropedologically Map of the Republic of Croatia.

Zeljko Vidacek, Soil Science Dept of Agricultural Faculty Univ of Zagreb, Matko Bogunovic, Soil Science Dept Agricultural Faculty Univ of Zagreb, Stjepan Husnjak, Soil Science Dept of Agricultural Faculty Univ of Zagreb, Mario Sraka, Soil Science Dept of Agricultural Faculty Univ of Zagreb, Aleksandra Bensa, Soil Science Dept of Agricultural Faculty Univ of Zagreb

Capturing Heritage Soil Survey Data for Pedometric Analysis and Modelling: the S-map Approach.


Deriving Soils Information from Foundation Data and Knowledge.

Daniel M. Brough, Natural Resources & Mines Queensland, Mike J. Grundy, Natural Resources & Mines Queensland, Neil J. McKenzie, CSIRO Land and Water, David W. Jacquier, CSIRO Land and Water

Hydropedology in Action: Soil Changes After 40 Years of Wastewater Irrigation.


Modeling Soil Hydraulic Properties as a Function of Morphological Features and Land use.

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Richard MacEwan, Department of Primary Industries, Peter G. Dahlhaus, Univ of Ballarat, Jon Fawcett, Department of Primary Industries
Measuring Water Table Depth in Loamy Soils with Relic Features.

Edgar Menislovsky, USDA-NRCS, Reed Cripps, USDA-NRCS, Doug Wysocki, NRCS-USDA, Cathy Seybold, National Soil Survey Center

Seasonal Water Table and Temperature Relationships in Glaciomarine Soils of Eastern Maine.

David E. Turcotte, USDA - Natural Resources Conservation Svc, David E. Wilkinson, USDA - Natural Resources Conservation Svc

Use of the Non-Parametric Nearest Neighbor Approach to Estimate Soil Hydraulic Properties.


Using Ensembles of Pedotransfer Functions for Soil Water Retention in Field-Scale Water Flow Simulations.


Andrea Sz. Kishné, Texas A&M Univ, Dept of Soil and Crop Sciences, Cristine L.S. Morgan, Texas A&M Univ, Dept of Soil and Crop Sciences, László B. Kish, Texas A&M Univ, Dept of Electrical and Computer Engineering

Effects of Sedimentation on Phosphorus Retention in Seasonally Submerged Wetland Soils.

Jonathan Maynard, Univ of California, Davis, Anthony O'Geen, Jaiyou Deng, Neil Brauer, Denise Tu, Randy Dahlgren, Univ of California, Davis

Landscape and Soil Profile Development in a Dissected Coastal Plain.

Richard MacEwan, Dept of Primary Industries

Earth's Critical Zone and Hydropedology.

Henry Lin, Penn State Univ, Lawrence P. Wilding, Dept of Soil and Crop Sciences, Texas A&M Univ, Oliver Chadwick, Univ of California Santa Barbara, Gail Ashley, Rutgers Univ, Stephen Burges, Univ of Washington


Brigitta Töth, Univ of Veszprém, Geogikon Faculty of Agriculture, András Makó, Univ of Veszprém, Geogikon Faculty of Agri., Kálmán Rajkai, Research Inst for Soil Sci. and Agricultural Chemistry of the Hungarian Academy of Sciences, Péter Marth, Central Plant and Soil Protection Service


Luis Villagarcia, Univ Pablo de Olavide, Ana Were, Consejo Superior de Investigaciones Científicas, Yolanda Cantón, Univ de Almeria, Francisco Fernandez, Maria Jose Moro, Univ de Almeria, Albert Sole-Benet, Francisco Domingo, Juan Puigdefabregas, Sergio Contreras, E.E.Z.A.:C.S.I.C.

Repeated Idential Top-soil Treatment and its Influence on Soil Hydrophysical and Microbiological Characteristic Changes.

Svatopluk Matula, Czech Univ of Agri. in Prague, Dept of Soil Sci. and Geology, Pavel Ruzek, Gabriela Muhlbachova, Res. Inst of Crop Prod.

Soil Water Content Patterns in the High Plateau of Sierra De Gador (Almeria, Se Spain). Implications for the Local Water Balance.

Yolanda Cantón, Univ de Almeria, Luis Villagarcia, Univ Pablo de Olavide, Albert Sole-Benet, Francisco Domingo, Juan Puigdefabregas, Sergio Contreras, E.E.Z.A./C.S.I.C.

Estimation of the Soil Moisture Retention Curve (SMRC) using Pedotransfer Functions (PTF).

Svatopluk Matula, Czech Univ of Agri. in Prague, Dept of Soil Sci. and Geology, Kamila Spongrova, Czech Univ. of Agri. in Prague

Relating Field Indicators of Hydric Soils to Saturation and Reduction in Sandy Soils.


Hydrological Control of Phosphorus Mobility in Altered Wetland Soils.

Michael Litaor, Tel-Hai College

Predicting Saturated Hydraulic Conductivity from Water Retention Data.

Han Han, Rutgers Univ, Daniel Gimenez, Rutgers Univ

Effect of Wild Fire on Water Repellency of Sandy Forest Soils.

Pavel Dlapa, Dept of Soil Sci., Comenius Univ, Ivan Simkovic, Ladislav Somsak, Dept of Soil Sci., Faculty of Natural Sciences, Comenius Univ

Flooding on the Virgin River, USA: Impacts and Historic Perspective.

Douglas Merkler, USDA NCRS


Adam Gray, Univ of Maryland, Martin C. Rabenhorst, USDA-NRCS, Doug Wysocki, NRCS-USDA, Cathy Seybold, National Soil Survey Center

Identification of Parent Material of Soils along a Lithotoposequence in a Sedimentary Area using Particle-size Distribution and Mixing Equation.


Aeration in Grasslands, It Only Works Some-of-the-Times.

Dorcas H. Franklin, USDA ARS, J. Phil Campbell Sr., NRCC, Miguel L. Cabrera, Univ of Georgia, David Butler, Univ of Georgia

Effect of Relief on Soil Development: A Case Study of Two Toposequences in Northeast Thailand.

Suphicha Thanachit, Dept of Soil Science, Faculty of Agriculture, Kasetsart Univ, Anchalee Sudhiprapakarn, Irb Kheouenromrne, Dept of Soil Science, Faculty of Agriculture, Kasetsart Univ, Robert J. Gillies, School of Earth and Geographical Sciences, The Univ of Western Australia

Simulation of Coupled Relationship Between Land Use and Groundwater Flow in the Western Arid Land of China.

Chengyi Zhao, Xinjiang Inst of Ecology and Geography, Chinese Academy of Science, Xi Chen Sr., Xinjiang Institute of Geography and Ecology, CAS, Minjiang Deng Sr., Dept of Water Resources of Xinjiang

Soil Moisture Temporal Patterns in a Forested Catchment.

Qing Zhu, Dept of Crop and Soil Science, The Pennsylvania State Univ, Henry Lin, Penn State Univ, Xiaobo Zhou, Pennsylvania State Univ

Preliminary Study on Vertisols and Vertic Soils in Heilongjiang Province, NE China.

Shanmei Wu, Nanjing Agri. Univ/Univ of California, Xainzhou Long, Heilongjiang Water Conservancy and Hydpower Inst, Shengrong Xu, Nanjing Agri. Univ, Qing Xu

Cotra Costa College
Mike Vepraskas
Soil Science Dept.
Box 7619
North Carolina State University
Raleigh, NC 27695

Phone: 919-515-1458, Fax: 919-515-2167
Email: Michael_Vepraskas@ncsu.edu

Mike is a Professor of Soil Science at NCSU where he teaches and conducts research. Currently he teaches classes on wetland soils and soil physics. The wetlands course is also taught on-line. He also co-teaches week-long field classes on Soil Geomorphology and Hydric Soils, and is developing an on-line program for a Masters of Soil Science degree. Mike’s research interests include: wetland restoration, using hydrologic models to interpret soil color patterns, developing methods to identify hydric soils, and determining hydrologic needs of wetland plants. He also works with the USDA’s National Technical Committee for Hydric Soils to improve wetland identification policies and techniques.

Miroslav (Mirek) Kutílek
Nad Patankou 34
CZ 160 00 Prague 6,
Czech Republic

Tel./Fax: (420) 2 3333 6338
E-mail: miroslav.kutilek@volny.cz

Mirek is a Professor Emeritus (1993) of Czech Technical University (CTU), Prague. He received his CSc (= PhD) at CTU Prague in 1956 and DrSc at CTU Prague in 1966. His professional career includes: Assistant Professor, Baghdad University, 1960; Associate Professor, CTU Prague, Division of Water Resources, 1962-65, and 1968-73; Reader, University of Khartoum, Faculty of Agriculture, Sudan, 1965-68; Professor, CTU Prague, 1973-90, and 1992-93; Deputy Dean, Division of Water Resources, CTU Prague, 1974-85; Professor, Bayreuth University, Fachbereich Geöökologie, Germany, 1990-92. His research has focused on soil physics and soil hydrology. As a professor in pension, he is now mainly engaged in studies on soil porous systems and how their characteristics are reflected by soil hydraulic functions.
David J. Chittleborough
Soil & Land Systems
School of Earth & Environmental Sciences
University of Adelaide, South Australia

Prof. Chittleborough was featured in April 2005 Issue 4 of this newsletter.

Shein Evgeny
Department of Soil Physics and Reclamation
Faculty of Soil Science,
Moscow State University
119899 Moscow, RUSSIA
Email: shein@physics.soils.msu.su or shein@soil.msu.ru
Phone-Fax: (495)9393684

Professor Evgeny is a Head of the Department of Soil Physics and Reclamation, Faculty of Soil Science of Moscow State Univ. His main fields of investigation are development of methods and concepts for estimating soil physical properties, water and matter movement in soils, soil-plant-atmosphere system, plant physiology, physical processes in irrigated soils, mathematical models in soil science, agrophysics, landscape planning, and soil diversity. He is teaching courses in soil physics, modeling in soil science, agrophysics. Current research interests are associated with special soil processes: water movement through macropores, “finger effect”, soil structure formation and organic matter, hydrophylic and hydrophobic properties, landscape design, geotechnologie, soil colloids, pedotransfer functions, and data bases. Dr. Shein is a Member of Doutchaev Russian Soil Science Society and Soil Science Society of America.

Henk Wösthen
Alterra – Wageningen University and Research Centre
P.O. Box 47
6700 AA Wageningen
The Netherlands
Phone: +31 317 474287
Fax: +31 317 419000
Email: Henk.Wosten@wur.nl

Henk is a senior researcher at Alterra. Alterra engages in strategic and applied research to support design processes, policy making, and management at the local, national and international level. Henk was trained as a soil physicist at Wageningen University. After being active in the development of pedotransfer functions for soil physical parameters his interest is now with tropical peatlands in SE Asia. Reinstating the hydrological integrity of these often damaged ecosystems is a top priority for the survival of these unique and fragile wetlands. Recognition of the carbon sequestration capability of peatlands did generate new, global interest in their functioning. Henk coordinates a project in which 14 institutions from Europe, Indonesia, Malaysia and Vietnam work together on the restoration of tropical peatlands.
Imaging Hydropedological Processes with Geophysical Tools

Kamini Singha, Dept. of Geosciences, Penn State Univ.

Quantifying the connection between hydrology and pedology is imperative to understanding the mechanisms and time scales of hydrologic response, including the movement of fluids through soil and estimation of fluxes between the vadose and saturated zones. Although extensive data are often required in predicting preferential flow, calculating residence times in the vadose zone, and understanding the significance of soil types in hydrology, there are frequently limited data for building relations between soil and hydraulic properties. Minimally invasive geophysical methods can provide inexpensive, spatially exhaustive measurements in 2-D and 3-D for understanding hydrologic processes and characterizing soil structure. Geophysical methods have been increasingly applied in hydrologic studies in recent years. The benefit of these methods is that they provide spatially exhaustive data on the sub-meter to 10s-of-meters scale, and certain methods, such as electrical resistivity, are especially useful for monitoring time-lapse processes. Other methods, such as ground-penetrating radar, provide a way for us to image soil structure and quantify properties like soil density. These and other electric and electromagnetic methods are sensitive to changes in water content, salinity, and soil type, and have the potential for imaging changes in the elevation of the water table or complex processes such as flow anisotropy. Geophysical methods have also been proven to be successful in many settings for measuring static properties such as depth to bedrock and soil complexity. These data may allow us to better understand subsurface processes where limited “hard” data exist, and allow us to better categorize spatial and temporal changes over multiple scales.

Hydrogeophysics is a relatively new field that attempts to use geophysical data, in a quantitative way, to understand hydrologic processes and parameters in the subsurface. Hydrogeophysical studies have allowed for better understanding of flow in fractured rock, the transport of contaminants and/or tracers in the subsurface, and changes in water content in the soils. The use of geophysical methods in hydropedological studies has not been extensive, but these methods allow us to improve the prediction of processes associated with landscape water flux and contaminant transport. Geophysical methods also hold promise for creating better pedotransfer functions. Many questions remain about how to best transfer the geophysical properties we measure in the field to hydropedologic properties of interest. Despite this, unique contributions to multiple scientific fields, including agriculture, natural resources, and hydrology, may be made by integrating geophysical techniques with hydropedology.

For further information, check out:

This is the state of the practice: Error is propagated through traditional estimation processes. Geophysicists generally apply empirical relations to convert the geophysical data back to the parameters of interest, which means that while we get good qualitative information about subsurface processes, the final images cannot be used quantitatively. One way to get around this is to insert hydropedologic insight to help constrain the geophysical inversion.

**Ground-penetrating radar (GPR)** image of a subsurface (a swale) in the Shale Hills Catchment, PA. The green curve indicates an interpreted depth to bedrock. The dash lines separate 3 soil series along the hillslope.
An example of imaging tracer transport in the subsurface using **electrical resistivity tomography (ERT)**. Cool colors on the right indicate an increase in electrical conductivity associated with the transport of a sodium-chloride tracer. From these spatially exhaustive data, the mass, center of mass, and spatial variance of the tracer plume can be estimated through time.

An example of **electromagnetic induction (EMI)** map showing the distribution ECa values in a wet season in the Shale Hills Catchment, PA.
Publications of Interest

- **Special Session in Vadose Zone Journal: From Field to Landscape-Scale Vadose Zone Processes.** A total of 20 papers were published in Feb. 2006 issue of VZJ, as a result of a Landscape Processes Symposium organized at the 2004 ASA-CSSA-SSSA Annual Meeting (31 Oct.– 4 Nov. 2004, Seattle, WA) and the 2003 EGS-AGU-EUG Joint Assembly session From Pore to Core to Field: Processes and Observations (Nice, France, April 2003), plus other invited papers specifically solicited.

- **Global Warming is Real.** The topic of global climate change is receiving heated attention lately. Even the skeptics are having a hard time keeping their heads in the sand. This warning is fueled by the latest study by NASA JPL and Univ. of Kansas Center for Remote Sensing of Ice Sheets indicating that Greenland ice loss doubled in the past decade, as its glaciers flowed faster into the ocean in response to a generally warmer climate. The sustained large lose of Greenland's glaciers is progressively affecting the entire ice sheet and increasing its contribution to global sea level rise. The Greenland ice sheet's contribution to sea level is an issue of considerable societal and scientific importance. For more info: see Science Vol. 311 Issue 5763 (Feb. 17, 2006) and Time’s special report on global warming (April 3, 2006).

- **Hydrology 2020 – An Integrating Science to Meet World Water Challenges.** Edited by Taikan Oki, Caterina Valeo & Kate Heal. IAHS Publ. 300. 2006. This book is claimed to be a milestone capturing the state of the art in hydrological science at the beginning of 21st century, a chart for hydrologists exploring the new frontiers in hydrology, and a guide for those involved with developing and implementing water policies. The book is written by a group of 12 younger hydrologists, with experience across the full spectrum of hydrology, as commissioned by IAHS in 2001 to look to the future and explore how hydrological sciences can evolve to meet the world water challenges that are expected to prevail by 2020. This book reports their deliberations. It considers the capability that hydrological sciences will, and should have by 2020, and what needs doing now in order to achieve this. There is an emphasis on societal issues and interdisciplinary work pertinent to hydrology as hydrologists cannot and should not work in isolation from society and other scientific disciplines.

- **Predictions in Ungauged Basins: International Perspectives on the State of the Art and Pathways Forward.** Edited by Stewart Franks, Murugesu Sivapalan, Kuniyoshi Takeuchi & Yasuto Tachikawa. IAHS Publ. 301. 2005. Recognising the diversity of interests and expertise of hydrologists, and practical prediction needs, PUB has adopted a philosophy of plurality in terms of applications, hydro-climatic regions and prediction methods, yet converges to focus on the assessment, and eventual reduction, of predictive uncertainty as its overall target. The PUB Workshop held at Perth, Western Australia, brought together researchers and practitioners (from Australia, Japan and elsewhere) to assess current hydrological prediction capabilities, and future research directions to achieve significant improvements given the decline of hydrological gauging networks, natural variability, and long-term climate and land-use changes. This volume is the outcome of those deliberations. It combines chapters presenting innovative theoretical and practical possibilities of different approaches for prediction, with contributions describing the differing perspectives and specific needs of Australia and Japan in particular.

- **Benchmark Papers in Hydrology Series.** A new Series from IAHS that collects together, by theme, the scientific papers that provided very significant contributions to hydrology in the 20th Century. Being published across a wide spectrum of disciplines, these papers are often unknown and/or inaccessible to younger hydrologists, yet the ideas are as relevant today as then. The Series Editor is Jeff McDonnell. Keith Beven accepted the invitation to select and comment on the papers for the first volume, on the theme of Streamflow Generation Processes. The volume, now in press, reprints 31 original papers, including some of the contributions by Horton, Hewlett, Jones and Kirkby, with a Commentary on each and an Introduction giving the wider context.
Book Review


At first, I wasn’t sure why I want to carry this nicely-bound heavy volume. But its intriguing title relevant to hydropedology and an appealing cover image that shows beautifully water-rock-soil-biology interactions at Yellowstone Falls attracted me to read through it. Soon I found the value of this book: a state-of-the-knowledge of aquatic geochemistry and its relation to weathering and soils; a comprehensive summary of the history, methodologies and tools, and fascinating developments of near-surface geochemistry; and modern applications of geochemical cycles, including water quality, global carbon cycle, importance of weathering and erosion in controlling global changes, geomicrobiology, human and land use impacts on the chemistry of surface and ground water, scale transfer from laboratory results (of chemical mass balance, equilibria and kinetics) to the field, and the use of isotopes to determine flow rates and subsurface processes. This is Volume 5 of the impressive 10-volume series of Treatise on Geochemistry that covers nearly all aspects of geochemistry, ranging from the chemistry of the solar system to environmental geochemistry.

The Volume Editor, James Drever of Univ. of Wyoming, a former president of the Geochemical Society, assembled a distinguished group of international scholars to write a series of chapters that together summarize the field. Jim provided an excellent and concise overview of the volume in his Introduction. This introductory essay “glues” nicely the 18 chapters of the volume, giving readers an integrated perspective of topics covered and a highlight of modern geochemistry developments. The Executive Editors’ Foreword by H.D. Holland of Harvard and K.K. Turekian of Yale provided the “big picture” of the 10-volume series – how it came about and why it was needed, thus putting readers into a right perspective regarding the vast knowledge base of geochemistry. The Treatise is clearly not meant to be an encyclopedia or a handbook; instead, emphasis has been placed on integrating individual chapters and several volumes.

Interestingly, the first chapter of this book is on Soil Formation by Ron Amundson of UC-Berkeley, and the last chapter is on Palesols (fossil soils) by Greg Retallack of Univ. of Oregon. These two chapters seem to close the loop of various (bio)geochemical processes discussed in this volume, though the book’s main theme is centered on water-rock interactions. These front end chapters of the volume have a strong focus on the role of soils in global carbon cycle, suggesting the critical role of soil carbon in accounting the “missing sink” of the global C budget. While carbon cycle is discussed in detail in Volume 8 (Biogeochemistry) of the Treatise, these two chapters clearly demonstrate the growing interest in soils among scientists outside agriculture, particularly geochemists, hydrogeologists, and ecologists. These two chapters rightly bring pedology back to its multidisciplinary origins. Chapter 1 lays down a good foundation of soil-forming theory, soil geography, mass balance calculations, and mechanistic modeling of soil C processes. Chapter 18 describes interesting record of past soils and global change through the long history of our planet, with alternating greenhouse and icehouse times.

The sequence of the remaining chapters is a bit confusing to me, although one can tell that it goes from fundamental geochemical principles (Chapters 2 to 6) to the chemistry of surface water bodies (Chapters 7 to 9 and 13), important chemical tracers (Chapters 10 to 12), ground water geochemistry (Chapters 14 to 15), and deep fluids in the continents (Chapters 16 and 17). I found the Volume Editor’s Introduction a more meaningful way to connect various chapters together.

Chapter 2 by D. Nordström outlines the main concepts and key developments in geochemical modeling for low-temperature environments. It starts with brief model concepts and definitions, and follows with a short history of geochemical models, a discussion of databases, various codes that embody models, and recent examples of how these codes have been used in studying water-rock interactions. Like modeling in many other disciplines, sophistication for geochemical codes does not imply a parallel advance in the understanding of geochemical processes. The sophistication of software has outdistanced our capacity to evaluate the software over a range of conditions and outdistanced our ability to obtain the field data to constrain and test the software.

Chapter 3 by S. Brantley summarizes the general techniques of measuring dissolution and precipitation rates of rock-forming silicates and carbonates, and discusses exclusively on seven factors that cause the discrepancy between laboratory- and field-determined rates. While hydrological and biological factors are acknowledged as important factors, they were not included in this chapter. Quantitative extrapolation from laboratory samples to field systems remains difficult and reaction transport modeling faces challenges in field applications where dissolution-precipitation may be rate-limited by transport.

The short Chapter 4 by O. Bricker, B. Jones and C. Bowser reviews the mass-balance approach to interpret weathering reactions in watershed systems, including methods of mass balance, mass-balance modeling, and the discrepancy of weathering rates determined in the field vs. in the laboratory. The concept of mass balance is one of the major modern approaches to understanding the chemistry of surface and ground water. Thus, to a large extent, many chapters of this Volume deal with issues related to this idea and its various uses.

The focus of Chapter 5 by A. White is on natural weather rates of silicate minerals, which are equivalent to chemical fluxes in natural systems that span spatial-temporal scales from microscopic mineral surface to soil profile, small catchment, large river basin, continent and globe. This complements well several other chapters in the volume that deal in greater detail with some of specific weathering environments, e.g., soils, glacial environments, watersheds, and river systems. This chapter reviews the chemical, physical, and hydrologic processes that control silicate mineral natural weathering rates and summarizes the key factors involved. I found Chapter 5 particularly relevant to watershed hydropedologic studies, and that a bridge between Chapters 3 and 5 represents a fundamentally needed connection between dissolution rates in lab experiments and the weathering rates in the field.
Chapter 6 by E. Berner, R. Berner and K. Moulton enlightens the growing attention to biological factors in accelerated mineral weathering. Field studies evaluating the effects of higher plants on weathering are reviewed, and the key role plant evolution has on silicate rock weathering is linked to global cooling and the glaciers development in the Carboniferous and Permian, thus demonstrating the control of atmospheric carbon dioxide by plants over geological time. As geomicrobiology is currently the fastest-growing subfield of geochemistry, the exclusion of microbes in this chapter and the lack of a stand-alone chapter in this volume on the effects of microbiology on weathering is a weak aspect of this state-of-the-science book.

Chapters 7 to 9 and 13 cover the chemistry of various surface water bodies in relation to geochemical weathering, including glacial and proglacial environments (Chapter 7), rivers (Chapters 8 and 9), and saline lakes (Chapter 13). Chapter 7 integrates the ongoing research of geochemical weathering in largely frozen regions, and documents the factors leading to chemical erosion rates in glaciated terrains that are comparable to those of temperate catchments because of their unique hydrology. Chapter 8 covers the distribution of riverine major ions, C species, and silica over the continents, and the major factors that control their global distribution and yields (i.e., lithology, climate, and human). Chapter 9 reviews the recent literature on trace elements in rivers, in particular by incorporating the results from measurements of inductively coupled plasma mass spectrometry (ICP-MS). Chapter 13 summarizes the geochemistry of saline lakes throughout the world. After a theoretical background of the evolution of closed basin waters, five field examples are selected to represent the major water types.

Chapters 10 to 12 are introduced for both weathering and hydrologic studies, and are applicable to all components of the hydrologic cycle. The inclusion of dissolved organic matter and isotopic species represents a major advancement in modern geochemistry. These three chapters clearly indicate that the integration of chemical and isotopic data with complex hydrologic and geochemical models constitutes a frontier of hydrologic and (bio)geochemical research. Chapter 10 provides an inventory of dissolved organic matter in various freshwaters. After a brief review of the major areas of research since the early 1950s, this chapter devotes extensively to a synthesis and analysis of the published literature on the chemical properties of organic matter in natural waters. Chapter 11 provides an overview of the use of naturally occurring stable isotopes to track water paths and reaction paths in hydrosystems. After describing water isotopes (H and O), solute isotopes of C, N, and S are emphasized for tracing the relative contributions of potential solute sources to surface and ground water. Chapter 12 is organized into three general areas in which radiogenic isotopes have the most significant contributions to the understanding of weathering and hydrology, i.e., identification of mineral dissolution reactions, differentiation of atmospheric- from weathering-derived cations in ecosystems, and tracing hydrologic flow paths and subsurface mixing.

Chapter 14 is an induction to the principles of mass balance, equilibrium chemistry, and microbiology as applied to ground water geochemistry in a variety of geologic settings. It also reviews equilibrium and kinetic frameworks for documenting the spatial and temporal distribution of redox processes in ground water systems, as well as a brief discussion on petroleum hydrocarbon and chlorinated solvent contamination in aquifers. Chapter 15 is another chapter particularly relevant to hydropedology and subsurface hydrology. After describing the nature of ground water flow systems and solute transport mechanisms in subsurface water, this chapter summarizes various ground water age tracers at the vadose zone, local, aquifer, and regional scales. Because measurement of certain geochemical constituents in water can define residence times and fluxes in subsurface systems, the authors suggest that the interpretation of the hydrogeochemical system, with adequate attention to issues of transport and mixing, will yield major advances for both geochemistry and quantitative hydrogeology.

Chapters 16 to 17 are sister chapters dealing with deep fluids in the continents and the interrelationships between hydrogeochemistry and geochemistry. Chapter 16 focuses on sedimentary basins in the continental and transitional continental oceanic crust, with an emphasis on water below the zone of shallow meteoric ground water circulation, and on the main processes responsible for the modifications of the chemical and isotopic compositions of these waters. Chapter 17 focuses on crystalline rocks, with a review of chemical and isotopic composition of ground water found in these rocks and their origin and evolution, followed by some examples from underground research sites found in crystalline environments.

A carefully-listed subject index at the end of the book may come handy when search for a specific topic in this large compiled volume, in which major discussion page is in bold and figures and tables are suffixed by f and t after page numbers. Numerous illustrative figures and tables throughout the book, mostly reproduced from published works, certainly make the reading of this highly technical volume more understandable and memorable. Many equations are also present throughout the book, suggesting the need towards a quantitative geochemistry.

I highly recommend this book to researchers and students who are serious about the latest developments in geochemistry, watershed hydrology, and the Earth’s Critical Zone studies. While this book is not designed to be a textbook, general readers may still find it interesting and informative to read, particularly for those who seek to bridge the disciplines among geochemistry, biogeochemistry, hydrogeology, hydropedology, pedology, soil science, hydrology, and biology.

Henry Lin
Penn State Univ.
Meetings and News Flashes

Celebrating 150 Anniversary of Darcy’s Law

International Symposium Darcy 2006, May 30-June 1, Dijon, France

The French Hydrogeology Committee, the National Committee of the International Association of Hydrogeologists (IAH), organizes this symposium to celebrate simultaneously the 150th anniversary of the publication of Darcy’s Law and the 50th anniversary of IAH’s creation. Dijon is Henry Darcy’s native town, where he directed the drinking water supply works of the town and where he carried out, in the cellar of the town hospital, his experiments on flows through porous media that led to his famous law.


Aug. 27 – Sept. 2 2006, Paris and Dijon, France. Full description of this GeoTrip organized by the GSA can be found at: http://www.geosociety.org/geoVentures/professionals/2006/GT_france.htm.

Flow & Transport In Permeable Media, July 30 - August 4, 2006, Andover, NH

This Gordon Conference brings together researchers from a wide variety of backgrounds and with interest in many different applications concerning physical, chemical and biological processes in porous media for an interdisciplinary exchange of ideas. The conference attracts petroleum engineers from both industry and academia, researchers interested in groundwater hydrology, contaminant transport and carbon storage, soil scientists, geologists, biologists, mathematicians, and physicists. In the spirit of the Gordon Conferences, the format is designed to encourage in-depth discussion. Free afternoons and evening social gatherings provide ample time for more informal interactions. Most attendees prepare one or more posters.

• 18th World Congress of Soil Science: July 9-15, 2006, Philadelphia, PA. It is now is full swing. The complete program can be viewed at http://www.colostate.edu/programs/IUSS/18wcss/program.html.

• 4th World Water Forum: held from Mar. 16-22, 2006 in Mexico. theme "Local Actions for a Global Challenge.” The meeting is held every three years under the auspices of the World Water Council and the host country and attracts a large attendance from governments, commerce, professional societies, NGOs and the public. On Mar. 22, 2006 UN Secretary-General Kofi Annan said: “On this World Water Day, let us recognize the cultural, environmental and economic importance of clean water, and strengthen our efforts to protect rivers, lakes and aquifers. We need to distribute water more equitably, and increase the efficiency of water use, especially in agriculture. Let us mount a sustained effort – among international bodies, Governments and local communities, and across traditions and cultures - that will reach our goals.”

• IAH 50th Anniversary: International Association of Hydrogeologists was found at the International Geological Congress in Mexico City in 1956. IAH will be holding two celebrations, one in Europe and one in Asia. Future IAH congresses: Sept. 17-21, 2007 in Lisbon, Portugal (Groundwater and Ecosystems) and Oct. 28-Nov. 1, 2008 in Toyama, Japan (Integrating Groundwater Science and Human Well-being).


• Renewing Hope: A Design Strategy for the Next Century: William McDonough, world-renowned architect and designer, presented this keynote speech on April 24, 2006 at Penn State for the 3rd Annual Colloquium on the Environment. McDonough's leadership in sustainable development is recognized worldwide. He has won 3 U.S. presidential awards: the Presidential Award for Sustainable Development (1996), the National Design Award (2004); and the Presidential Green Chemistry Challenge Award (2003). Time magazine recognized him as a "Hero for the Planet" in 1999, stating that "his utopianism is grounded in a unified philosophy that-in demonstrable and practical ways-is changing the design of the world."
A Cattle vs. the Ground Beef: What is the Difference?

Henry Lin, Penn State University

When I teach courses of hydropedology and soil physics, I always like to ask my students this simple question: "What is the difference between a cattle and the ground beef?" The answers I’ve got have always been refreshing. I then encourage students to give an analogy of their own imagination to illustrate the essential difference between naturally-formed soil vs. ground-sieved soil material. Here are samples of their answers:

- A building vs. a pile of debris
- A house vs. a pile of wood and nails
- A car vs. a pile of metal
- A computer vs. its parts
- A tree vs. pieces of wood
- A plant vs. its tissues
- A wheat vs. a bread
- A sandwich vs. a salad
- A orange vs. orange juice
- …

The list goes on and on… This leads to my point of this writing: Is there any merit in distinguishing pedology from the general term of soil science? I believe so. Because a crushed sample of soil is as akin to a natural soil profile as a pile of bricks is to a beautiful building. Hence, the traditional way of studying soils using glass beads, beach sands, ground and sieved soil materials, and isolated soil columns (especially repacked soil columns) should be replaced more with in situ soils that have distinct characteristics of pedogenic features, structures, layers, and heterogeneity in a landscape context.

“Ped” is a unique term in soil science, and “ped-ology” captures that well. Peds are naturally-formed soil aggregates with various strengths, sizes, and shapes that are separated by planes of weakness (see the illustrative figures). Ped strength, size, and shape combined are termed pedality (pedologists’ vocabulary). Pedality, along with the interrelated macroporosity, are routinely described (but not yet measured) by pedologists in the field. Such natural soil “architecture” is influenced by the five interacting soil-forming factors, plus human activities, at the landscape scale, and is governed by interrelationships between inorganic-organic constituents and physical, chemical, and biological processes at the meso- or microscopic scales. Water and chemical movement or retention, mineral weathering or synthesis, gas production and temperature fluctuation, plant root or insect activities, and microorganism habitats are all strongly influenced by such soil architecture. Other pedogenic features (such as hydromorphicity, soil layering or horizonation, and different soil types over a landscape), as pedologists routinely observe/record in field surveys, are valuable datasets that are underutilized for soil and hydrologic modeling and prediction.
Numerous soil macro- and micro-morphologic features are indicative of vadose zone hydrology (such as crusts, cutans, coatings, infillings, aggregations, lamellae, crystallaria, septaria, and many others). For example, soil hydromorphism is a result of permanent or temporary state of water saturation in the soil associated with conditions of reduction. Soil hydromorphic features are formed predominantly by the accumulation or loss of Fe, Mn, S, or C compounds by the processes of alternating reduction-oxidation due to saturation-desaturation and the subsequent translocation or precipitation of the chemical compounds in the soil. Repeated periods of saturation and/or inundation of more than a few days occur in nearly all hydric soils, but a total saturation is not absolutely indispensable for the formation of redox features. The presence of organic matter, high enough temperature, and a not too low pH are also generally required for hydromorphism to occur. Such biochemical process might have implications for finding clues to life on Mars if Martian soil hydromorphism can be found since biological activity is often involved (although not absolutely required) in soil hydromorphism on earth, while diagenetic hydromorphism is also considerably accelerated by microorganisms.

Soil heterogeneity and the resulting non-uniformity of variably-saturated flow, as demonstrated by soil hydromorphism and dye-tracing water flow patterns, suggest that the boundary condition and the hydraulic gradient as prescribed by Darcy’s Law are hard to define. Hence, the ability to measure integrated hydraulic conductivity and water flux in 4D (3D + time) in a block of land poses significant challenges, leading to questionable closure of mass balance that all existing hydrologic models assume. One possible path to address this challenge is to define and classify fundamental soil and hydrologic landscape units and to identify flow pathways and patterns. The purpose of soil surveys is to partition soils and landforms into stratified subsets that are less variable; hence, the storage, flux, pathway, and residence time of water in the soil-landscape continuum (if properly defined and measured) may be used to subdivide landscapes into similarly functioning hydrologic units. The hydrologic community is now embracing the comparative analysis of diverse watersheds guided by a robust classification system. The existing knowledge base of soil classification systems and major land resources areas is worth of looking into for hydrologic applications.

A distinguished soil physicist once said that “the foundation of our models is shaky.” This leads me to wonder: without a solid foundation, how can we build a reliable skyscraper? No matter how fancy a skyscraper may look on paper, it is going to crash sooner or later if it is built on a shaky foundation. A renowned hydrologist also suggested that “the advent of computer actually has slowed down the advancement of the hydrologic sciences.” This is an interesting and alarming statement. The collection and analysis of field data has been undervalued in the present computer modeling frenzy. In the past, many research publications were devoted to field data collections, analyses, and interpretations. Indeed, such publications provided some of the most fundamental insights into hydrologic processes. For example, Darcy’s Law (1856), Jenny’s theory (1941), and Horton’s Law (1945) were all developed without any use of computer. Yet today field data based publications are out-numbered by modeling papers in numerous journals. As Keith Beven (2006) pointed out, hypothetical studies of flow and transport in heterogeneous surface and subsurface have been widely reported in the literature, but there have been very few detailed studies of field sites (with the exception of some of the large scale ground water tracing experiments) where it has been attempted to characterize the statistics of flow properties. Nearly all hydrologic, water quality, and sediment transport models use the same small scale laboratory homogeneous domain theory to represent integrated fluxes at the much larger scales of hillslope and catchment elements (Beven, 2006).

So, the value of differentiating a cattle and the ground beef is obvious, and so is the recognition of the difference between pedology and general soil science. Apparently, it is much more challenging to raise a cattle than to keep the ground beef. But to address the seminal question of “what is soil?”, we need to have an in-depth understanding and appreciation of this unique gift from nature that we call soil and its essential characteristics in the landscape. That is what pedology and hydropedology attempt to focus on.

**Reference cited:** Beven, K. 2006. Searching for the holy grail of scientific hydrology: \( Q_t = H(S, g)A \) as closure. HYDROLOGY AND EARTH SYSTEM SCIENCES (in press).
**Editor’s Note:** “Soil-landscape” relationship is the paradigm of pedology. We now reverse that order and add water into the picture to form “landscape-soil-water” relationship for hydropedology. Any difference? You be the judge. From this issue on, a showcase watershed will be selected from around the world to illustrate. In addition, integrated studies of the Earth’s Critical Zone, including mapping, monitoring, and modeling of coupled hydropedological and biogeochemical processes across scales, will be in demand.

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**Shale Hills Catchment**

The Shale Hills Catchment is a 7.9-ha forested watershed located in central Pennsylvania. It is characteristic of low-lying shale hills of the Ridge and Valley Physiographic Province of the eastern United States that extends from central New York to northern Alabama. This V-shaped catchment, with up to 25-48% slope of concave, convex, or linear types, has four basic landforms: 1) south-facing slope with deciduous forest and underbrush, 2) north-facing slope with deciduous forest and thicker underbrush, 3) valley floor or floodplain of a first-order headwater stream, with evergreen trees along the western side and deciduous forest and deeper soils. Depth to bedrock (>200-m thick Rose Hill shale) ranges from <0.25 m on the ridge tops and upper side slopes to >2 m in the valley bottom and swales. The soils of the catchment were formed from shale colluvium or residuum, with many channery shale fragments throughout most of the soil profiles. Five soil series (the Weikert, Berks, Rushtown, Blairton, and Ernest series) have been identified, mapped, and characterized for this catchment.

Starting in 1960s and 1970s, the Penn State Forest Hydrology group has investigated this catchment (Leavesley, 1967; Lynch, 1976). A comprehensive hydrologic experiment was conducted to determine the physical mechanisms of streamflow generation at the upland forested catchment and to evaluate the effects of antecedent soil moisture on stormflow volume and timing. A spray irrigation network was installed to apply a controllable amount of rainfall over all or part of the watershed. The hydrologic and soil moisture data were collected using a network of piezometers, neutron access tubes, rain gauges, and four weirs. The robust dataset collected during that time period is still yielding valuable information.

In the mid-1990s, hydrologic engineers at Penn State revisited the Shale Hills dataset for the purpose of validating a dynamical model for hillslopes and small catchments (Duffy, 1996). One product of this effort was to make the dataset available to the hydrologic community as a testbed for dynamic catchment response.
Since 2003, there have been renewed research activities from the Penn State Hydropedology team, with the intent to make the Shale Hills a long-term Hydropedologic Observatory (Lin, 2006; Lin et al., 2006). The goal is to use such a field laboratory for investigating fundamental processes of landscape water fluxes at multiple scales, and to characterize spatio-temporal patterns of surface and subsurface water flow mechanisms, soil moisture distributions, and their relations to landscape features and the hydrologic cycle. Detailed maps of soils, elevation, landforms, depth to bedrock, and vegetation have been completed, along with a number of ground-penetrating radar and electromagnetic induction surveys for mapping the subsurface features and understanding the soil variability. A total of 115 multi-depth TDR access tubes have been installed, along with nested tensiometers, piezometers, thermocouples, and shallow wells at selected locations. Stream discharge at the catchment outlet and rainfall have been recorded continuously. A conceptual model of the hillslope hydrology has been developed that portrays typical soil moisture profiles along the hillslope and identifies main flow pathways downslope (i.e., subsurface macropore flow, subsurface lateral flow at A-B horizon interface, return flow at footslope and toeslope, and flow at the soil-bedrock interface). Further testing of this model will enhance the understanding and modeling of preferential flow at the small watershed scale, particularly in relation to soil distribution and lateral flow.

In 2004, a NSF-supported Real-time Hydrologic Monitoring Network (RTH_Net) project was initiated to investigate multi-scale, multi-process dynamics of the terrestrial water and energy balance. The Shale Hills is being developed as a “super-site” within RTH_Net where detailed eddy covariance flux analysis will be combined with soil and groundwater measurement arrays, flow gaging, and micrometeorological stations. RTH_Net will extend the current sensor systems within the Shale Hills to resolve the roles of soil moisture and groundwater within the water cycle through the use of Evaporation-Transpiration-Recharge (E-T-R) sensor arrays to fully capture the essential space-time scales of terrestrial hydrology. The RTH_Net field facility will promote research into how currently available real-time sensor systems can be used to directly measure the natural coupling between atmosphere, land surface, and subsurface processes at multiple scales of interest. RTH_Net will help identify how thresholds, feedbacks, and nonlinearities in atmosphere-soil-stream-groundwater systems serve to amplify low-frequency modes in runoff.

In 2005, the Center for Environmental Kinetics Analysis (CEKA) at Penn State has selected the Shale Hills as its focused field site to begin investigations of weathering rates and redox reactions in soils and rocks. The established hydrologic database will facilitate CEKA’s efforts to apply data developed from modeling and lab investigations to the field. CEKA, an Environmental Molecular Sciences Institute based at Penn State with members at 3 National Laboratories (Sandia, Lawrence-Berkeley, and Pacific Northwest), is a joint research and education initiative of the National Science Foundation, the U.S. Department of Energy, and Penn State. CEKA brings together chemists, geochemists, biochemists, soil scientists, materials scientists, and engineers to measure and synthesize kinetic data for environmental systems and to model the temporal evolution of such systems. This initiative emphasizes the problem of scaling in terrestrial environmental kinetics, with emphasis on mineral-water interface with and without cells and biofilms.

The Shale Hills has been selected as one of the top five sites for the Critical Zone Exploration Network. This catchment is also an integral part of a testbed for a potential river basin hydrologic observatory – The Susquehanna River Basin Hydrologic Observing System – that is being proposed. In the long run, we hope to make the Shale Hills a well-coupled test site for Hydrologic Observatory and Critical Zone Exploration.

For more information, please contact Henry Lin at henrylin@psu.edu about hydropedology, Patrick Reed at preed@engr.psu.edu about RTH_Net, and Susan Brantley at brantley@essc.psu.edu about CEKA.

References cited:

• Leaviesley, G.H. 1967. Effects of aspect, slope, and soil moisture in relation to streamflow on two Shale Hills Watersheds. MS Thesis. The Pennsylvania State University, University Park, PA.
**Bright Soil Near 'McCool Hill': Salty Deja Vu?**
While driving, the wheels of Mars Exploration Rover Spirit churned up the largest amount of bright soil discovered so far in the mission. This image, taken on March 21, 2006, shows the strikingly light tone and large extent of the deposit. A few days earlier, Spirit's wheels unearthed a small patch of light-toned material informally named "Tyrone." Spirit's instruments confirmed that those soils had a salty chemistry dominated by iron-bearing sulfates. These discoveries indicate that light-toned soil deposits might be widely distributed on the flanks and valley floors of the "Columbia Hills" region in Gusev Crater on Mars. The salts may record the past presence of water, as they are easily mobilized and concentrated in liquid solution. Image credit: NASA/JPL-Caltech.

**The Mystery of the Sparkling Spheres**
This image, taken by the microscopic imager, an instrument located on the NASA’s Mars Exploration Rover Opportunity's instrument deployment device, or "arm," reveals shiny, spherical objects embedded within the trenched soil wall at Meridiani Planum, Mars. Researchers are highly intrigued by these objects, which are considered great indicators of past water on Mars. The area in this image measures approximately 3 cm across. Image credit: NASA/JPL/USGS.

**Colonizing Mars?!**
Humanity's first view of Mars from the surface came in July 1976 when Viking 1 touched down in this field of rocks in the Chryse Planitia. The craft's sampler arm mucked with the surface, leaving marks in the foreground. The robotic arm on the Viking lander scooped up soil samples for various testing, looking for signs of life – the Viking mission’s main task. Credit: NASA.

An envisioned greenhouse for the Red Planet. The 21st (or 22nd?) century Mars may offer comfy quarters for off-Earth settlers?! Credit: Space.com.
**Faculty**

**North Carolina State University - Assistant Professor: Soil Physics.** Dep. of Soil Science. The successful candidate will develop a nationally recognized research program in basic soil physical processes that are related to the fate and transport of chemicals, colloids, and/or microorganisms. A doctorate degree in Soil Science or a related field is required. Applicants should have significant expertise in one or more of the following: assessing water movement and solute transport through the vadose zone, reducing sediment transport and erosion, mathematical modeling of the fate and transport of solutes, and **hydropedology**. Experience with GIS and statistical techniques for assessing soil properties is preferred. More info at: [http://www.soil.ncsu.edu/about/news/Soil_Physics_Position_2006.pdf](http://www.soil.ncsu.edu/about/news/Soil_Physics_Position_2006.pdf). Deadline: May 31, 2006.

**North Carolina State University - Assistant Professor: Soil Science, Biogeochemistry.** Dep. of Soil Science. Organize and conduct grant-funded basic research on microbial-mediated chemical processes at soil interfaces that are relevant to the speciation, distribution, and transport of nutrients and environmental contaminants. A Ph.D. is required in Soil Science, Geochemistry, Geomicrobiology, Biogeochemistry, or related field with extensive training in microbiological and chemical analytical techniques. Training in organic or biochemistry is also desirable, and experience with design and execution of both laboratory and field scale projects. More info at: [http://www.soil.ncsu.edu/about/news/Biogeochemistry.pdf](http://www.soil.ncsu.edu/about/news/Biogeochemistry.pdf). Deadline: Aug. 1, 2006.

**University of California, Riverside – Assistant Professor of Watershed Hydrology.** The appointee will be expected to develop an independent research program in surface hydrology which integrates hydrologic processes with pedological, ecological, and biogeochemical processes. Candidates must have a Ph.D. with strong training and demonstrated interest in conducting research in surface hydrology, transport processes in soils and watersheds, and modeling. Experience in field experimentation and GIS applications in hydrology are highly desired. More info at: [http://envisci.ucr.edu/faculty/facrecadhydrologist.doc](http://envisci.ucr.edu/faculty/facrecadhydrologist.doc).

**Michigan State University - Assistant Professor: Soil Physics or Hydrology.** The Departments of Crop and Soil Sciences and Geological Sciences and the Environmental Science and Policy Program at Michigan State Univ. invite applications for a new tenure-track assistant professor position in soil physics and hydrology with emphasis on unsaturated flow and transport. This research and teaching position will emphasize water and solute transport processes in the unsaturated and capillary zones. The ideal candidate will combine experiments with quantitative models to explore the complex physical, chemical, and biological processes that govern unsaturated flow and transport across multiple scales. The candidate will be expected to teach an undergraduate and graduate course, train graduate students, and establish an extramurally funded multidisciplinary research program that builds on the expertise across campus in soil science, groundwater hydrology, solution and surface chemistry, environmental engineering, and microbial ecology. Applicants must have a Ph.D. in soil physics, hydrology, geological sciences, or a related field. More info at: [http://www.css.msu.edu/soilphysics/](http://www.css.msu.edu/soilphysics/). Deadline: August 1, 2006.

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**Postdocs & Grads**

**Postdoctoral Fellow in Watershed Hydrology.** Dept. of Natural Resources and Environ. Management at Univ. of Hawaii at Manoa. Temporary for one year, renewal dependent upon performance and availability of funds. Qualified applicants are invited to contact Dr. Ali Fares at afares@hawaii.edu.

**Postdoctoral Position in Vadose Zone Hydrology.** 32-month postdoctoral position in vadose zone hydrology within the Dept. of Earth and Planetary Sciences at the Univ. of Tennessee - Knoxville. This position is funded through the Department of Energy’s EMSP program, and is part of a larger project on contaminant transport in partially-saturated, layered sediments involving researchers at the nearby Oak Ridge National Laboratory. Contact Dr. Ed Perfect at eperfect@utk.edu.

**PhD Fellowships in Catchment Science.** The Catchment Science Centre at Univ. of Sheffield has Marie Curie funding from the European Commission for six PhD Fellowships for a project called CatSci, a multidisciplinary research training within a large team. The Fellowships are available before 31st Dec. 2006, and are 3-year fixed term appointments. More at [www.shef.ac.uk/csc/catsci.html](http://www.shef.ac.uk/csc/catsci.html).
When It Rains …  By Henry Lin

When it rains, animals hide, humans “shy” away from outdoor, … and the Blue & White game ruined;
What is really going on out there when it rains? -- Plants thrive, microbes work hard, the earth is renewed, and hydropedology is in action:
When it rains … Water runs down the hill and the soil may be eroded if not properly protected;
When it rains … Toxic scums ooze out of the soil in superfund sites and leaky landfills;
When a storm comes … Nutrients and contaminants likely flush down to aquifers and pollute streams;
When a hurricane comes … River banks and levees may break and a mudslide or landslide could occur in unstable hillslopes …
After all, whenever it rains, it is a critical moment that the environment refreshes rigorously;
So, we ought to get out when it rains and take students along to observe and learn the real world in action…

Have A Cup of Dirt !!!

One day, my family was eating at TGI Friday’s, a nice new restaurant in the town. My 6-years old son said excitedly, “I want to order a cup of dirt … it is really yummy!” I was surprised to hear that, saying to him: “What? This is not the place to joke like that.” He was pretty sure: “I ate that before in school.” I got nervous about it – how could he eat dirt in school?! Then my 8-years old daughter joined, “Yes, I like it too!” I was really puzzled … Then I found myself embarrassed: being a “dirt doctor” for so many years, I didn’t know there is such a cup of dirt that you can enjoy in restaurant! The cup of dirt we ordered came in a nice mug, with chocolate pudding, crumbled Oreo cookies, and gummy worms. It really tasted yummy!!! So, I decided to advertise this cup of dirt here by showing the one ourselves made (see the photo above) and the recipe I found on the Internet (see below). If you like to eat more dirt, which I certainly encourage, read on … (HSL)

Have A Cup of Watershed Tea!

Along its journey from rainfall through the forest canopy, to water percolating through the forest litter and ultimately to the ground water supply, water steeps living and dead plants as well as the soil and produces a “watershed tea.” Each watershed has its own brew, and in turn, the quality of the watershed tea has implications for understanding watershed dynamics and water quality protection. This is why watersheds are the first stage of our drinking water protection and treatment. For more info, you may check out Dr. Louis Kaplan’s research at Stroud Water Research Center in Avondale, PA and many other watershed scientists’ work around the globe on the Internet.

Eat More Dirt

Results 1 - 10 of about 1670 for cup of dirt:
1. DIRT PIE
Chop Oreo cookies in … until cookies look like dirt. Mix butter, cream … with gummy worms on top.
Ingredients: 7  (cheese .. cookies .. milk .. sugar .. whip …)
2. DIRT CAKE
Cream the butter, cream … Oreo's. Line the inside of a clay flower pot … and a plastic flower. Enjoy!
Ingredients: 7  (boxes .. cheese .. cookies .. milk .. sugar .. whip …)
3. DIRT CAKE - WORM PIE
Crush cookies in food … to crush fine for dirt. Add candy bar … crazy, but it is good!) ……….

Cook It!

How To Make A Cup of Dirt

• What you need: 1 packet of chocolate pudding, gummy worms, crushed oreos. First, make the pudding and put it into a cup or bowl. Then you would bury the gummy worms in the pudding. Next you would put the crushed oreos on top. And last, but not least eat your wormy treat! (From: http://www.zeeks.com/27894.html)

• What you need: vanilla ice cream, oreos, gummy worms. What you do: First you put the ice cream in a bowl then you crumble up the oreos and put them on top and then stick the gummy worms out of the bowl. IT LOOKS LIKE A REAL CUP OF DIRT!!! (From: http://www.zeeks.com/14514.html)

Have A Cup of Watershed Tea !