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2004 U.S. EPA/NGWA Fractured Rock Conference: State of the Science and Measuring Success in Remediation

September 13-15, 2004
Portland, Maine
Holiday Inn by the Bay

What we have learned in the past decade and what the future holds.
Fractured rock is arguably the most challenging geologic environment to characterize and remediate. Historically, it has been perceived that these sites are so complex that even after spending considerable dollars, a great deal of uncertainty remains.
As the science and technologies develop we are gaining a better understanding as to the physical and chemical nature of the systems and the fate and transport of contaminants in fractured rock. The conference is a cooperative effort by the U.S. Environmental Protection Agency and the National Ground Water Association to identify the current state of remediating contaminated ground water in fractured rock settings and make future remediation efforts more effective. Invited plenary lectures will serve as reviews of our existing understanding as well as looking at directions for the future. A perspective will be given on technical impracticability and other regulatory issues at contaminated fractured rock sites. "Performance Assessment" will be an open-microphone discussion with the panel of invited speakers on how to measure success of remediation. Each registrant will receive a full proceedings on CD-ROM.

The conference is an international consortium of engineers, scientists, regulators, responsible parties, researchers, and students gathering to understand the science of classical and innovative remediation technologies. Case studies include federal, state, and industrial sites contaminated by DNAPLs, other organics, metals, and radionuclides. The conference will feature an industry display area, platform and poster sessions, workshops, a banquet, and a field trip.

Participating Organizations
U.S. Department of Defense, U.S. Department of Energy, U.S. Geological Survey, Maine Department of Environmental Protection, Queen's University, SUNY University at Buffalo, University of New Hampshire, Bedrock Bioremediation Center, University of Maine, University of Southern Maine, and Westbay Instruments Inc.

Conference Financial Supporter
Golder Associates

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Monday, September 13, 2004

8:00 a.m. – 5:00 p.m.	Registration
9:00 – 9:05 a.m.	Welcome Rich Steimle, U.S. EPA and Bob Masters, NGWA
9:05 – 9:30 a.m.	**Keynote Address** **Ground Water Remediation: Making Progress, Challenges Ahead** Walter Kovalick Jr., Ph.D., OSWER, U.S. EPA
9:30 – 9:50 a.m.	**DNAPL Behavior in Fractured Rock –Transport Facilitated by Pickering Emulsions** Bernard Kueper, Ph.D., A. Roy-Perreault, and M.R. West Queen's University
9:50 – 10:10 a.m.	**Geophysical Characterization of Fractured Rock Aquifers: Accounting for Scale Effects and Putting Hydrology into the Geophysics** Fred Paillet, Ph.D., University of Maine
10:10 – 11:00 a.m.	**NGWA Distinguished Darcy Lecture** **Recent Advances in Characterizing Ground Water Flow and Chemical Transport in Fractured Rock: From Cores to Kilometers** Allen Shapiro, Ph.D., U.S. Geological Survey
11:00 – 11:10 a.m.	Questions and answers
11:10 – 1:40 p.m.	**Day One, Track One** **Remediation Technologies for Fractured Rock** **Moderator:** Kent Sorenson, Northwind Environmental

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11:10 – 11:30 a.m.	**Field-Scale TCE Oxidation in Sedimentary Bedrock: $KMnO_4$ and BR^- Tracer Test Results and Extended Pilot Design** Michael J. Gefell, P.G., Blasland, Bouck and Lee; Kenneth L. Sperry, P.E., Expert Design and Diagnostics; James R.Y. Rawson, Ph.D., GE Global Research Center; Edward Kolodziej, P.G., GE Corporate Environmental Programs
11:30 – 11:50 a.m.	**Field Testing of Nanoscale Zero-Valent Iron Particle Technology for In-situ Ground Water Treatment in Fractured Bedrock** F. Gheorghiu, Golder Associates Inc.; L. Walata, GlaxoSmithKline; R. Venkatakrishnan, Golder Associates Inc.; W. Zhang, Lehigh University; and R.E. Glazier, Golder Associates Inc.
11:50 a.m. – 1:00 p.m.	Lunch (on your own)
1:00 – 1:20 p.m.	**Remediation of a Chlorinated Solvent Contaminated Site Using Steam Injection and Extraction** David Parkinson and Norm Brown, Integrated Water Resources Inc.
1:20 – 1:40 p.m.	**Implementing RF Heating in Fractured Bedrock to Remediate TCA DNAPL** H. Jean Cho, R. Joseph Fiacco, John W. McTigue, Alicia R. Kabir, and Karen L. Brody, Environmental Resources Management; Ray Kasevich, KAI Technologies LLC
1:40 – 2:00 p.m.	**Remediation of Tetrachloroethene in Fractured Sandstone: A Case Study in Initial Successes and Long-Term Technological Barriers to Timely and Cost-Effective Closure** Vasanta Kalluri, Kevin Brehm, and Jeanne Tarvin, STS Consultants Ltd.
2:20 – 5:00 p.m.	**Remediation General Session** **Moderator:** Martin Derby, Contech Construction Products Inc
2:20 – 2:40 p.m.	**Remediation of a Clay and Fractured Rock Source Area Using Vacuum Extraction and Bioremediation** Gregory L. Carter, P.G., Earth Tech; Roasann Kryczkowski, CIH CSP, ITT Industries Night Vision

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2:40 – 3:00 p.m.	**Art in-Well Air Stripping Technology: Remediation in Fractured Rocks Completed in Months** Marco M. Odah, Ph.D., P.E., EnviroRemedy International Inc; Steve Pucke, Cintas Corp.; Chuck Reed, Cape Environmental
3:00 – 3:20 p.m.	Refreshment break
3:20 – 3:40 p.m.	**Blast-Fractured Enhanced Permeability Remediation System at Modern Landfill, Your, Pennsylvania: A Five-Year Update** J.R. Smerekanicz, J.J. Elsea, F. Gheorghiu, Golder Associates Inc.; M.C. Pedersen, Republic Services Inc.
3:40 – 4:00 p.m.	**Characterizing a DNAPL Site in Karst Terrain: Implications for Remediation** Keith A.White, C.P.G. and David S. Lipson, C.P.G., Blasland Bouck and Lee Inc.; Kurt Paschl, P.G., Beazer East Inc.
4:00 – 4:20 p.m.	**Evaluation of Successful MTBE Remediation in the Stockton Formation** Craig A. Kunz, P.E. and Shawn McCune, Geologic Services Corp.
4:20 – 4:40 p.m.	**Remedial Strategies Applied to a Fractured Bedrock Contaminant Plume at the University of Connecticut Landfill Study Area** John R. Kastrinos, P.G., Richard P. Standish, P.G., LEP, Haley and Aldrich Inc.; James Pietrzak, University of Connecticut; Susan Soloyanis, Ph.D., P.G., Mitretek Systems; F. Peter Haeni, F.P., Haeni, LLC; Carole D. Johnson, U.S. Geological Survey
4:40 – 5:00 p.m.	**Using Major Ions to Support the Demonstration of Hydraulic Containment in a Fractured Bedrock Aquifer** Steven P. Sayko, P.G. and William F. Daniels, P.G., Services Environmental Inc.; Richard J. Passmore, P.E., Glenn Springs Holdings Inc.
10:30 a.m. – 1:20 p.m.	**Day One, Track Two** **Project Management** **Moderator:** Kenneth J. Goldstein, Malcolm Pirnie Inc.

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10:30 – 10:50 a.m.	**Technical and Regulatory Challenges Resulting from VOC Matrix Diffusion in a Fractured Shale Bedrock Aquifer** Kenneth J. Goldstein, Andrew R. Vitolins, Daria Navon, Malcolm Pirie Inc.; Grant A. Anderson, Stephen P. Wood, U.S. Army Corps of Engineers; Beth Parker and John Cherry, University of Waterloo
10:50 – 11:10 a.m.	**Technical and Regulatory Considerations for DNAPL Remediation in Complex Hydrogeology** Beth A. Moore, U.S. Department of Energy; Dawn S. Kaback, Concurrent Technologies Corp.
11:10 – 11:30 p.m.	**Observations from Several Bedrock Remediation Programs in EPA Region 1 (New England): A Monitoring Perspective** William Brandon, Michael J. Daly, Charles Franks, US EPA Region 1; John A. Lough, Lakeport GIS and Hydrology; Steve Mangion and Ernest Waterman, US EPA Region 1
11:30 – 11:50 a.m.	**LNAPL Behavior in Fractured Rock: Implications for Characterization and Remediation** Paul E. Hardisty, Komex Environmental Ltd.; John Roher, Imperial College of Science and Technology; Jane Dottridge, Komex Environmental Ltd.
11:50 a.m. – 1:00 p.m.	Lunch (on your own)
1:00 – 1:20 p.m.	**Bedrock: From Foe to Friend – A Case History of Investigation and Remediation in Fractured Bedrock from 1979 hrough 2003** Ian M. Phillips, LSP, Roux Associates Inc.; Michael D. Walters, Sc. D, P.E., CIH, Polaroid Corp.
1:20 – 4:00 p.m.	**Track Two, Session Two** **Hydraulic Conductivity** **Moderator:** John Williams, U.S. Geological Survey
1:20 – 1:40 p.m.	**Fractured Bedrock Aquifer Hydrogeologic Characterization for a Bioaugmentation Pilot Study** Paul Jeffers and Veryl Wittig, Geosyntec Consultants;
1:40 – 2:00 p.m.	**Fractured Rock Transmissivity Estimates From Oscillatory Slug Test Data** Jeffrey R. Hale, P.G., Key Environmental Inc.

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2:00 – 2:20 p.m.	**Ground Water in Fractured Bedrock: A Water Supply Approach** Raymond W. Talkington, Ph.D., P.G., LSP, Geosphere Environmental Management Inc.
2:20 – 2:40 p.m.	**Pumping Test Analysis in a Fractured Crystalline Bedrock** H. Jean Cho, Matthew H. Daly, and R. Joseph Fiacco, Jr., Environmental Resources Management
2:40 – 3:00 p.m.	**A New Visual Synthesis Tool for Transient Test Data** Christian Enachescu and John Wozniewicz, Golder Associates Inc.
3:00 – 3:20 p.m.	Refreshment break
3:20 – 3:40 p.m.	**Gas Injection Tests** Gonzolo Pulido, HydroQual Inc. and Thomas P. Ballestero, University of New Hampshire
3:40 – 4:00 p.m.	**Large Drawdown Slug Tests** Gonzalo Pulido, HydroQual Inc; Thomas P. Ballestero, and Nancy E. Kinner, University of New Hampshire
4:00 – 5:00 p.m.	**Day One, Track Two** **Regional Scale Geology** **Moderator:** Carole Johnson, U.S. Geological Survey
4:00 – 4:20 p.m.	**Assessing the Potential for Saltwater Intrusion in a Coastal Fractured-Bedrock Aquifer Using Numerical Modeling** Thomas J. Mack, P.G., U.S. Geological Survey
4:20 – 4:40 p.m.	**Vertical Distribution of Hydraulic Conductivity in Cambrian Sandstones in South-Central Wisconsin** Kenneth R. Bradbury, David J. Hart, David L. LePain, University of Wisconsin-Extension; Beth L. Parker, Diane C. Austin, Jessica R. Myer, University of Waterloo
4:40 – 5:00 p.m.	**Hydrogeology of Granitic Terrains: A Comprehensive Study of Minho Region (Northwestern Portugal)** A.S. Lima, Universidade de Minho and M.O. Silva, Universidade de Lisboa
11:10 – 11:50 a.m.	**Day One, Track Three: Field Studies** **Moderator:** Nancy Kinner, University of New Hampshire, Bedrock Bioremediation Center

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11:10 – 11:30 a.m.	**Vertical Cross Connection in a Single borehole: A Case Study in Fractured Sandstone** Sean N. Sterling, M.Sc., INTERA Engineering Ltd.; Beth L. Parker, Ph.D. and John A. Cherry, Ph.D., University of Waterloo; John W. Lane, U.S. Geological Survey; John H. Williams, U.S. Geological Survey; F. Peter Haeni, U.S. Geological Survey - Emeritus
11:30 – 11:50 a.m.	**Characterizing the Hydraulic Properties of Fractured Bedrock – A Fractured Sandstone Example** Edwin A. Romanowicz, Plattsburgh State University; Fred Paillet and Andrew Reeve, University of Maine, Matt Becker and Gregory Baker, University at Buffalo; David Franzi, Plattsburgh State University
11:50 a.m. – 1:00 p.m.	Lunch (on your own)
1:00 – 2:30 p.m.	**Fractured Rock Characterization** **Moderator:** Roberto Aguilera, Ph.D.
1:00 – 1:30 p.m.	**Road Salt Behavior as a Dense Aqueous Phase Liquid in Fractured Bedrock** Joshua Katz, M.S., Maine Department of Transportation
1:30 – 2:00 p.m.	**Characterization and Monitoring Techniques for Solvent Contamination within Fractured Bedrock** Scott Pearson, Parsons Corp.; Brian Murphy, Camp Stanley Storage Activity
2:00 – 2:30 p.m.	**Assessing the Role of Structural Geologic Elements in Aquifer Hydraulics and Plume Migration** Matthew Erbe and Robert Keating, Environmental Resources Management Inc.; Connie Travers, Stratus Consulting Inc.; Lonnie Norman and William Cutler, FMC Corp.; Todd Martin, Integral Consulting
2:30 – 5:00 p.m.	**Regional Scale Geology** **Moderator:** Matthew W. Becker, University at Buffalo, State University of New York

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2:30 – 3:00 p.m.	**The Regional Bedrock Structure at Loring Air Force Base, Limestone, Maine; The Unifying Model for the Study of Base-Wide Ground Water Contamination** Peter Thompson, Peter Baker, and Scott Calkin, MACTEC Engineering and Consulting Inc.; Peter Forbes, Air Force Real Property Agency
3:00 – 3:20 p.m.	Break
3:20 – 3:40 p.m.	**Hydrogeologic Framework Based on Van Houten Cyclic Stratigraphy and Gamma-Ray Logging, Naval Air Warfare Center, West Trenton, New Jersey** Pierre Lacombe, U.S. Geological Survey; Jeffery M. Dale, U.S. Navy; Jean C. Lewis-Brown, U.S. Geological Survey
3:40 – 4:00 p.m.	**Elevated Naturally-Occurring Radioactivity in Ground Water from Three Fractured Bedrock Settings: Implications for the State of Vermont** Jonathan Kim and Laurence Becker, Vermont Geological Survey
4:00 – 4:20 p.m.	**Geochemical and Isotopic Characterization of a Local Catchment within Crystalline Basement in Benin/West Africa** Thorsten Fass, and Barbara Reichert, University of Bonn
4:20 – 4:40 p.m.	**Isotopic and Chemical Characterization of Water from Mine Pits and Wells on the Mesabi Iron Range, Northeastern Minnesota, as a Tool for Drinking Water Protection** James F. Walsh, Minnesota Department of Health
4:40 – 5:00 p.m.	**Time Lapse Geophysical Monitoring in Fractured Rock Aquifers** Carole Johnson, Ph.D., U.S. Geological Survey
5:00 – 7:00 p.m.	**Poster session and ice breaker reception**

Poster Session

Lessons Learned from Bedrock Blast Fracturing and Bioremediation at a Superfund Landfill
Stuart C. Pearson, P.E.; Brian B. Johnson, P.E.; Nelson Walter, P.E., MACTEC Engineering and Consulting Inc.; Richard Galloway, Honeywell

An Integrated Approach to Contaminant Mass Removal from Vadose and Saturated Fractured Bedrock
Brian Vanderglas, Parsons Corp.; Brian Murphy, Camp Stanley Storage Activity

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Evaluating the Performance of a Seepage Barrier Constructed with Coal Combustion Product Grout to Reduce the Loss of Ground Water Seeping into a Former Coal-Mining Shaft
Nathaniel Warner, Matthew Erbe and Leonard Rafalko, Environmental Resources Management Inc.; Paul Petzrick, Maryland Power Plant Research Program; Gary Fuhrman, Western Maryland Resource Conservation and Development

Toward an Improved Risk Assessment of the Contaminant Spreading in Fractured Underground Reservoirs
Christos Tsakiroglou, Ph.D., Maria Theodoropoulou, Ph.D., Vaggelis Karoutsos, Ph.D, FORTH/ICE-HT; Knud Erik S. Klint, Ph.D, and Peter Gravesen, Ph.D., Geological Survey of Denmark and Greenland; Catherine Laroche, Ph.D., Laurent Trenty, Ph.D., and Pierre LeThiez, Ph.D., Intstitut Francais du Petrole

Importance of Flowmeter Logging for Aquifer Characterization at Contaminated Bedrock Sites
Carole D. Johnson, John H. Williams, and Frederick L. Paillet, U.S. Geological Survey

Angled Borings in Fractured Crystalline Bedrock Investigations
Mark A. Worthington and Michael Y. Horesh, Environmental Resources Management; Bernard H. Kueper, Queen's University; Michael J. Elliott and Patrick Webb, Texas Instruments

Characterization of Heterogeneous Flow Zones in a Crystalline Aquifer with Borehole Logging and Cross-borehole Flowmeter Experiments
T. Le Borgne, Université de Rennes; F.L. Paillet, University of Maine; O. Bour, Université de Rennes

Evaluating a Conceptual Model for Distant Coal Tar Migration by Bedrock Fracture Flow
Lynette B. Mokry, George M. Thomas, P.G., and Michael J. Gefell P.G., Blasland, Bouck and Lee Inc.

Use of the In Situ, Troll 9000 to Locate Fractures Contributing to Ground Water Flow in Bedrock Wells
R. Sernoffsky and G. Robbins, University of Connecticut; R. Mondazzi, U.S. Geological Survey

An Innovative Approach to Investigation of an MTBE Plume in Fractured Bedrock
Timothy S. Burke, Sarah A. Czajka, and David C. Raymes, Geologic Services Corp.

Hydrochemical Facies Analysis of 1,1,1-Trichlorethane and its Degradation Products in Fractured Bedrock
H. Jean Cho, R. Joseph Fiacco, Mathew H. Daly and John W. McTigue, Environmental Resources Management

Examination of the Relationship of Rock Structure to Ground Water Flow in a Fractured Limestone Aquifer
William Brandon, U.S. EPA Region I and Robert Hoey, Maine DEP

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Aqueous Chemistry of Various Hydrogeologic Units of the Fractured Bedrock Aquifer in the North Carolina Piedmont
Jack L. Stutts, P.G., Mecklenburg County Land Use and Environmental Services Agency

Tuesday, September 14, 2004

7:30 a.m. – 2:00 p.m.	Registration
8:30 – 9:30 a.m.	**Invited Plenary Session**
8:30 – 8:50 a.m.	**Oil Field Techniques for Characterizing Fractured Reservoirs** Roberto Aguilera, Ph.D., Servipetrol Ltd.
8:50 – 9:10 a.m	**Utility of Rock Core for Characterizing Contamination in Fractured Sedimentary Rocks** Beth Parker, Ph.D., University of Waterloo
9:10 –9:30 a.m.	**Blast Fracturing and Application for Permeable Reactive Barriers in Bedrock** Vince Dick, Haley and Aldrich Inc.
9:30 – 10:00 a.m.	Refreshment break
10:00 – 12:00 p.m.	**Day Two, Track One** **Lessons Learned in Monitored Natural Attenuation** **Moderator:** Bernard H. Kueper, Ph.D., Queen's University
10:00 – 10:20 a.m.	**Hydrogeologic Investigation of VOC Contamination in Bedrock Using Mass Flux Analysis: A Case History** Richard K. Eby, Arcadis G and M Inc.; Robert E. Zimmermann, C.P.G., Roadway Express Inc.; Michael T. Paczkowski, Arcadis G and M Inc.; Terence Regan, TR Associates
10:20 – 10:40 a.m.	**Effectiveness of Monitored Natural Attenuation at Predicting In-Situ Biodegradation in a TCE Contaminated Granitic Bedrock** N.E. Kinner, M. Mills, T. Eighmy, T. Ballestero, J. Coulburn, and L. Tisa, University of New Hampshire
10: 40 – 11:00 a.m.	**Evidence of Biodegradation at a DNAPL Contaminated Fractured Bedrock Field Site Using Stable Carbon Isotopes** Michelle M.G. Chartrand, Penny L. Morrill, and Georges Lacrampe-Couloume, University of Toronto; Kevin T. Finneran, Paula Chang, and Peter Zeeb, Geosyntec Inc.; Barbara Sherwood Lollar, University of Toronto

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11:00 – 11:20 a.m.	Open
11:20 – 11:40 a.m.	**Natural Attenuation of Solute Plumes in Bedded Fractured Rock** Michael West and Bernard Kueper, Queen's University
11:40 a.m. – 12:00 p.m.	**Microfracture Geochemistry as an Indicator of Terminal Electron Accepting Processes in TCE-Contaminated Bedrock** T. Eighmy and J. Spear, W. Bothner, J. Coulburn, L. Tisa, and N. Kinner, University of New Hampshire
12:00 a.m. – 1:00 p.m.	Lunch (provided)
1:00 – 3:20 p.m.	**Chemical Oxidation** **Moderator:** Mark R. Harkness, GE Global Research
1:00 – 1:20 p.m.	**Measuring Mass Balance, Oxidant Half-Life, and Treatment Efficiency: Field-Scale PCE Oxidation Using $KMnO_4$ in Fractured Phyllite** Michael J. Gefell, P.G., Blasland, Bouck and Lee Inc.; Bernard H. Kueper, Ph.D., P.Eng., Queen's University; Kenneth L. Sperry, P.E., Xpert Design and Diagnostics LLC; James R.Y. Rawson, Ph.D., GE Global Research Center
1:20 – 1:40 p.m.	**In-Situ Chemical Oxidation of Volatile Organic Compounds in a Fractured Bedrock Aquifer** Paul D. Rohde, and Cynthia R. Butler, P.E., CH2M Hill
1:40 – 2:00 p.m.	**Fractured Crystalline Bedrock Ground Water Remediation of Dissolved TCE via Sodium Permanganate Solution Injection and Re-circulation** William F. Simons, P.G., M.S. and Paul D. Steinberg, P.E., L.S.P., Mabbett and Associates Inc.
2:00 – 2:20 p.m.	**In-Situ Remediation of Fractured Bedrock DNAPL Sites Using Chemical Oxidation** J.S. Konsuk, L.K. MacKinnon, E.D. Hood and E.E. Cox, GeoSyntec Consultants
2:20 – 2:40 p.m.	**Implementation of In-Situ Chemical Oxidation in Fractured Bedrock** Timothy J. Pac, Richard Lewis and R. Joseph Fiacco, Jr., Environmental Resources Management; Edwin Madera, Raytheon Company

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2:40 – 3:00 p.m.	**In-situ TCE Oxidation Using Potassium Permanganate in the Columnar-Jointed Preakness Basalt of New Jersey** Brian A. Blum, C.P.G, Bill N. Stephanatos, Ph.D., P.E., and Michael E. Poland, Langan Engineering and Environmental Services Inc., Gary M. Fisher, Lucent Technologies Inc.
3:00 – 3:20 p.m.	Refreshment break
3:20 – 4:00 p.m.	**Chemical Oxidation Continued** **Moderator:** Todd W. Schrauf, Hydro Geo Chem
3:20 – 3:40 p.m.	**In-Situ Chemical Oxidation Using Permanganate for Remediation of Chlorinated VOCS in a Fractured Shale Matrix** Andrew R. Vitolins, Kenneth J. Goldstein, Daria Navon, Malcolm Pirnie Inc.; Grant A. Anderson, Stephen P. Wood, U.S. Army Corps of Engineers; Beth Parker and John Cherry, University of Waterloo
3:40 – 4:00 p.m.	**In-Situ Chemical Oxidation with Sodium Permanganate in a fractured Crystalline Bedrock Aquifer: A Case Study** Charles D. Race, C.G., L.S.P. and Liyang Chu, Tetra Tech NUS Inc.
4:00 – 5:00 p.m.	**Characterization with Surface and Borehole Geophysics** **Moderator:** Carole Johnson, Ph.D., U.S. Geological Survey
4:00 – 4:20 p.m.	**Multi-Method Geophysical Approach for Characterizing a Deep Fractured Bedrock Aquifer, Anniston Army Depot, Anniston, Alabama** Brian S. Murray, P.G. and Matthew B. Vest, P.G., Science Applications International Corp.
4:20 – 4:40 p.m.	**Ground Water Exploration by VLF Techniques: A Case Study in Granitic Terrains of Northwestern Portugal** Luis Macedo and Alberto S. Lima, University of Minho
4:40 – 5:00 p.m.	**Hydrogeological Exploration by Electrical Resistivity Surveys in Hard Rocks of Montalegre Area (Northern Portugal)** Alcino Canas and Alberto S. Lima, University of Minho; João Fonseca, University of Aveiro

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10:00 a.m. – 2:20 p.m.	**Day Two, Track Two** **Characterization with Surface and Borehole Geophysics** **Moderator:** Fred Paillet, Ph.D., University of Maine
10:00 – 10:20 a.m.	**Hydrogeology of the Châteaguay River Transboundary Aquifers, Canada – USA** M. Nastev, Geological Survey of Canada; C. Lamontagne, Quebec Ministry of Environnement; T. Tremblay, F. Hardy, and M. Lamothe, Université de Québec à Montréal; R. Leferbvre, A. Croteau, M. Lavigne, and D. Blanchette, Institut National de Recherche Scientifique; D. Paradis, Geological Survey of Canada; N. Roy, Institut National de Recherché Scientifique
10:20 –10:40 a.m.	**The Use of Borehole Geophysics to Optimize Bedrock Drilling Locations** Gene Schrager, C.G., and Brian F. Thomas, GS Environmental and Ground Water Associates Inc.; Mark Blackey, Geophysical Applications Inc.
10:40 – 11:00 a.m.	**Analysis of Geophysical Logs at North Penn Area 6 Superfund Site, Lansdale, Montgomery County, Pennsylvania** Randall W. Conger, P.G. and Dennis J. Low, P.G., U.S. Geological Survey
11:00 – 11:20 a.m.	**Integrated Characterization of a Naturally Fractured Igneous-Metamorphic Ground Water System for Open Pit Mining Operations** Bob Will, Schlumberger Water Services
11:20 – 11:40 a.m.	**Use of Fracture Fabric Analysis Facilitates Well Siting and Assessment of Contaminant Distribution in Bedrock** Daniel Folan, Ph.D., P.G., Dennis Albaugh, P.G., A. Curtis Weeden, P.G. and Mark Gerath, ENSR Corp.
11:40 a.m. – 1:00 p.m.	Lunch (provided)
1:00 – 1:20 p.m.	**Fracture Characterization Using Borehole Radar: Computer Simulation and Field Calibration** Lanbo Liu, University of Connecticut; Fred Day-Lewis, Bucknell University; John W. Lane, U.S. Geological Survey

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1:20 – 1:40 p.m.	**Determining Geological Structures in Fractured Bedrock from the Surface for Aquifer Characterization: A Practical and Inexpensive Approach** Italo Alfredo Guagnelli, Integrated Environmental Management Services; Scott Ian Koolik, P.E., QEP
1:40 – 2:00 p.m.	**Hydrologic and Geophysical Investigation of Bedrock Observation Wells at the University of Maine** Eric Rickert, Andrew Reeve, Ph.D, Frederick L. Paillet, Ph.D., University of Maine
2:00 – 2:20 p.m.	**Systemic Characterization of a Bedrock Aquifer in Coastal New England** John Alastair Lough, Gannett Fleming
2:20 – 5:00 p.m.	**Conceptual Models** **Moderator:** Grant Anderson, U.S. Army Corps of Engineers
2:20 – 2:40 p.m.	**Conceptual Flow Model and Ground Water Characterization Strategy for Sedimentary Bedrock Sites** Andrew Michalski, Ph.D., CGWP, Michalski and Associates Inc.
2:40 – 3:00 p.m.	**Thermal Hydrosystem of Gerês Spa (Northwestern Portugal): Proposal of a Conceptual Model** Alberto S. Lima, University of Minho
3:00 – 3:20 p.m.	Refreshment break
3:20 – 3:40 p.m.	**Characterization of Fractured Rock to Develop Conceptual Models of Ground Water Flow and Transport of Mercury** Philip T. Harte, James R. Degnan, Stewart F. Clark Jr., U.S. Geological Survey; Margaret Bastien and Thomas J. Mack, New Hampshire Department of Environmental Services
3:40 – 4:00 p.m.	**Evolving Conceptual Models and Monitoring Well Reconstruction in the Passaic Formation in New Jersey** John N. Dougherty and Andrea Soo, CDM; Robert M. Alvey, U.S. EPA

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4:00 – 4:20 p.m.	**Using Fractran Fracture Flow Modeling in Tandem with Modflow to Assist in the Development of Wellfield Protection Zones for Municipal Wells in Bedrock** T.K. Wiezel and G.G. Violette, Neill and Gunter; S.T. Hamilton, New Brunseick Department of the Environment and Local Government
4:20 – 4:40 p.m.	**Evaluation of Various Slab-Fissured Models for Characterization of Fractured Rock Aquifers: Eastern Pennsylvania** Joseph A. Fishcer, P.E., James G. McWhorter, P.G., and Joseph J. Fischer, Geoscience Services
4:40 – 5:00 p.m.	**Control of Fractured Bedrock Structure on the Movement of Chlorinated Volatile Organics in Bedrock and Overburden Aquifers, Newark Basin of New Jersey** Robert M. Bond, P.G. and Katherine E. Linnell, Langan Engineering and Environmental Services Inc.
10:00 – 11:40 a.m.	**Day Two, Track Three** **Conceptual Models** **Moderator:** Richard Willey, U.S. EPA
10:00 – 10:20 a.m.	**Historical and Present Site Conceptual Models for a Fractured Bedrock Superfund Site in New York State** Lisa G. Campbell, Susan E. Schofield, P.G., Kristen E. Carpenter, and John N. Dougherty, P.G., CDM
10:20 – 10:40 a.m.	**Fractured Bedrock DNAPL/Dissolved Phase Plume Conceptual Model Development at the Eastland Woolen Mill Superfund Site, Corinna, Maine** Scott Calkin, Peter Thompson, and Peter Baker, MACTEC Engineering and Consulting Inc.; Scott Acone, U.S. Army Corps of Engineers; Ed Hathaway, U.S. EPA
10:40 – 11:00 a.m.	**Structural Characterization and Passive Remediation of NAPL in Fractured Bedrock at a Former MGP Site: Mechanicville, New York** Michael Gutmann, Eriko Fujita, Beth Guidetti, URS Corp.; Tracy Blazicek, New York State Electric and Gas Corp.

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11:00 – 11:20 a.m.	**Use of Vertical Gradient to Compensate for Disparate Completion Depths when Characterizing Horizontal Flow Direction in Stacked Fractured Aquifers During an MTBE Investigation, Maripos County, California** William Ackland and Herman Schymiczek, HerSchy Environmental Inc.
11:20 a.m.– 1:40 p.m.	**Geochemical Characterization** **Moderator:** Nancy Kinner, Ph.D., University of New Hampshire
11:20 – 11:40 a.m.	**Monitored Natural Attenuation of Chlorinated Solvents in Fractured Bedrock as a Selected Remedy for Ground Water at a Superfund Site** Rebecca Lindeman, P.E. and David S. Lipson, CPG, Blasland Bouck and Lee Inc.
11:40 a.m. – 1:00 p.m.	Lunch (provided)
1:00 – 1:20 p.m.	**Characterization of Three Water Types in a Fractured Schist, High Arsenic, Watershed in Maine** Gail Lipfert and Andrew Reeve, Ph.D., University of Maine
1:20 – 1:40 p.m.	**Development of a Conceptual Field Scale Flow Model in a Fractured Bedrock Aquifer** Bibhuti Panda, Ph.D., Amec Earth and Environmental
1:40 – 2:40 p.m.	**General Session** **Moderator:** Robert W. Masters, NGWA
1:40 – 2:00 p.m.	**NAPL Removal from Fractured Bedrock Using (SPTT™) Non-ionic surfactants successful Ground Water Remediation Cases** George A. Ivey, B.Sc., CES, CESA, Ivey International Inc.
2:00 – 2:20 p.m.	**Hydraulic Properties of Granitic Fracture Skins and Their Effect on Solute Transport** Terence T. Garner and John M. Sharp, Jr., The University of Texas

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2:20 – 2:40 p.m.	**The Approach to Understanding and Controlling Contaminant Fate and Transport on the U.S. Department of Energy's Oak Ridge Reservation, Tennessee (USA); A Review of Status and Future Challenges** Thomas O. Early and Phillip M. Jardine, Oak Ridge National Laboratory; Richard H. Ketelle, Bechtel Jacobs Co. LLC
2:40 – 3:00 p.m.	**Analysis of X-ray Computed Tomography Scans to Characterize and Measure the Surface Roughness of Natural Rock Fracture Samples** Clark Thompson, University of Texas at Austin
3:00 – 3:20 p.m.	**Team Injection into Fractured Limestone at Loring Air Force Base** Eva L. Davis, Ph.D., USEPA/ORD/NRMRL/GWERD; Gorm Heron and Steve Carroll, StreamTech Environmental Services
3:40 – 4:40 p.m.	**Student Career Mentoring Program** As a part of the conference, students should plan to attend the career mentoring program. Professionals will present their views on the opportunities in the ground water industry. Come with questions on ground water careers and have them answered by a variety of professionals.

Wednesday, September 15, 2004

7:30 a.m. – 2:00 p.m.	Registration
8:30 – 8:50 a.m.	**Successful Use of a Horizontal/Vertical Well Couplet in Fractured Bedrock Remediation** Dana Carlisle, GeoEngineers
8:50 – 9:10 a.m.	**Using Tracers to Understand Advection, Dispersion, and Diffusion in Fractured Rock** Matthew W. Becker, University at Buffalo, State University of New York
9:10 –9:30 a.m.	**Innovation Approach for Hydraulic Containment of PCB Contamination in Fractured Bedrock** Jack Guswa, Ph.D., GeoTrans
9:30 – 10:00 a.m.	Refreshment break

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10:00 – 11:40 a.m.	**Day Three, Track One** **Technical Impracticability** **Moderator:** Kathy Davies, U.S. EPA
10:00 – 10:20 a.m.	**Regulatory and Technical Perspectives on Technical Impracticability** Kathy Davies, U.S. EPA
10:20 – 10:40 a.m.	**Successful Application of Technical Impracticability for Achieving a Cost Effective Remedy for DNAPL in Deep Fractured Limestone/Dolostone at a Superfund Site** David W. Lay, C.P.G. and Michael J. Gefell, C.P.G, Blasland, Bouck, and Lee Inc.; Bernard H. Kueper, Ph.D. Queens University; William T. McCune, P.G.; Blasland, Bouck, and Lee; Curt Christensen, P.E., Schneider Electric North America
10:40 – 11:40 a.m.	**Technical Impracticability: Panel Discussion** Open microphone
11:40 a.m. – 1:00 p.m.	Lunch (on your own)
1:00 – 2:40 p.m.	**Bioremediation** **Moderator:** Nancy Kinner, Ph.D., University of New Hampshire
1:00 – 1:20 p.m.	**Evaluating Innovative Bioremediation Technologies and Successful Pilot Test Performance** Tess Rottero, AMEC; Craig Walmsley, U.S. Army Claims Service; Oliver Kohnen, AMEC
1:20 – 1:40 p.m.	**Ethanol Biostimulation and Bioaugmentation of VOC-Impacted Deep Bedrock Aquifer** Christopher J. Voci, P.G. and Michael S. Kozar, P.G., O'Brien and Gere Engineers Inc.; Roy S. Blickwedel, P.G., General Electric Co.
1:40 – 2:00 p.m.	**Fracture Characterization at a Bedrock Bioremediation Site in New Hampshire** Stanley S. Sadkowski, Wallace A. Bothner, Jean Benoît, Francis S. Birch and José Escamilla-Casas University of New Hampshire

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2:00 – 2:20 p.m.	**Enhanced Bioremediation of DNAPL in a Fractured Limestone Aquifer: Bench Test Results** Neal D. Durant and Eric D. Hood, GeoSyntec Consultants; Sandra M. Dworatzek and Jeff Roberts, SiREM; Keith B. Rapp, Terry Etter, and William H. Anthony, Unisys Corp.
2:20 – 4:40 p.m.	**Integrating and Prioritizing Characterization Methods** Moderator:Aaron Green, Connecticut Department of Environmental Protection
2:40 – 4:40 p.m.	**Combined Use of Borehole Geophysics and Packers to Site Potable Wells in a Contaminated Area** Aaron Green, Connecticut Department of Environmental Protection; John W. Lane, Jr., Carole D. Johnson, John H. Williams , Remo A. Mondazzi, Peter K. Joesten, U.S. Geological Survey
2:40 – 3:00 p.m.	**An Integrated View of Ground Water Flow Characterization and Modeling in Fractured Geologic Media** Mingyu Wang and Rob Earle, Shaw Environmental Inc.
3:00 – 3:20 p.m.	Refreshment break
3:20 – 3:40 p.m.	**Fracture Network Characterization for Studies of Retention Processes at the Äspö Hard Rock Laboratory** Thomas Doe and Jan Hermanson, Golder Associates Inc.; Peter Andersson, Geosigma AB; Anders Winberg, Conterra AB
3:40 – 4:00 p.m.	**Application of the Fractured Bedrock Toolbox at Multiple Sites in New England** R. Joseph Fiacco, Jr., Matthew H. Daly, and John C. Drobinski, Environmental Resources Management
4:00 – 4:20 p.m.	**Hydrogeological Characterization for Siting Geothermal Wells in Fractured Bedrock at Bronx Zoological Park, Bronx, New York** Dennis Askins and Alex Posner, New York City Department of Design and Construction

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4:20 – 4:40 p.m.	**The FLUTe Multilevel Ground Water Monitoring System Used for Study of a Contaminated Dolostone Aquifer** John Cherry, Ph.D. and Beth L. Parker, Ph.D. University of Waterloo; Christopher M. Turner, Haley and Aldrich Inc.; Leanne S. Burns and James H. Plett, University of Waterloo; Carl E. Keller, Flexible Liner Underground Technologies Limited
10:00 – 11:20 a.m.	**Day Three, Track Two** **Water Sampling** **Moderator:** Norman Brown
10:00 – 10:20 a.m.	**Ground Water Sampling Method Comparison: Low-Flow and Passive Diffusion Bag Sampling Results for Volatile Organic Compounds in Fractured Metamorphic Bedrock** Thomas R. Eschner and David Dinsmore, Woodard and Curran
10:00 – 10:20 a.m.	**From Low-Flow Sampling to Passive Diffusion Bag Samplers: The Evolution of Volatiles Characterization in a Triassic Shale Aquifer** Matthew P. Lesley, P.E., P.G., and Raymond E. Lees, P.E., Malcolm Pirnie Inc.
10:20 –10:40 a.m.	**How to Locate and Flow Test, Every Major Fracture in a Borehole in One Hour** Carl Keller, FLUTe Ltd.
10:40 – 11:00 a.m.	**Multipurpose Packer System** Gonzalo Pulido, HydroQual Inc., Thomas P. Ballestero and Nancy E. Kinner, University of New Hampshire
11:00 – 11:20 a.m.	**Unpredictable Pattern of Road Salt Contamination in Private Wells Demonstrates Crucial Role of Interconnections** Joshua Katz, MS, Maine Department of Transportation
11:20 – 11:40 a.m.	Open
11:40 a.m. – 1:00 p.m.	Lunch (on your own)
1:00 – 1:40 p.m.	**Drilling Techniques** **Moderator:** Vincent B. Dick, Haley & Aldrich Inc.

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1:00 – 1:20 p.m.
Use of Angled Drilling Techniques to Characterize Fractured Crystalline Bedrock and Minimize Migration of Suspected Non-aqueous Phase Liquids (NAPL)
David Finney, P.G., Jeffrey Hershberger, P.G., and Peter Nangeroni, P.E., ESS Group Inc.

1:20 – 1:40 p.m.
Using Minimal Impact Deep Drilling Techniques in a DNAPL Impacted, Fractured Rock Aquifer
Matthew B. Best and Brian S. Murray, Science Applications International corp.

1:40 – 4:20 p.m.
Numerical Modeling
Moderator: Gloria Sosa, U.S. EPA

1:40 – 2:00 p.m.
Investigation of the Impact of Fracture Intersection on Solute Transport in Fractured Carbonate
Catherine Ledoux and René Therrien, Université Laval; Kent Novakowski, Queen's University; Donna Kirkwood, Université Laval

2:00 – 2:20 p.m.
Large-scale Solute Transport Modeling in Discretely-Fractured Porous Media
Guillaume Kenny, René Therrien, and André Fortin, Université Laval; Kent Novakowski, Queen's University

2:20 – 2:40 p.m.
Multiscale Site Characterization for the Numerical Mapping of NAPL Migration Pathways in Contaminated Fractured Igneous Rocks: A Case Study in Northern Spain
Knud Erik S. Klint, Ph.D., Peter Gravesen, Ph.D., Geological Survey of Denmark and Greenland; Catherine Laroche, Ph.D., Laurent Trenty, Ph.D., Pierre LeThiez, Ph.D., Institut Francais du Petrole; Christos Tsakiroglou, PH.D., FORTH/ICE-HT

2:40 – 3:00 p.m.
Ground Water Flow Simulation of a Glacial Aquifer and its Implication for the Management of University of Connecticut Water Supply System During Drought Periods
Farhad Nadim, The University of Connecticut; Jeffrey J. Starn, U.S. Geological Survey; Amvrossios C. Bagtzoglou, The University of Connecticut

3:00 – 3:20 p.m.
Discrete Analytic Domains: A New AEM Formulation for Modeling Anisotropy and Heterogeneity
Charles Fitts, University of Southern Maine

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3:20 – 3:40 p.m.	**Statistical Modeling of a Non-Parametric Data Distribution to Determine an Exposure Point Concentration during Risk Assessment** Adam P. Chen and Joan V. Gonzalez, Burns and McDonnell Engineering Inc.
3:40 – 4:00 p.m.	**Discrete Fracture Network Modeling: Current Status and Future Trends** William S. Dershowitz, Paul R. Lapointe, and Thomas W. Doe, Golder Associates Inc.
4:00 – 4:20 p.m.	**Ground Water Flow and Contaminant Transport Modeling of Fractured Bedrock Aquifer with Solution Channels at a Southeastern Pennsylvania Superfund Site** Henry He and Andrew H. Thalheimer, P.E., Environmental Resources Management Inc.
10:00 a.m. – 2:40 p.m.	**Day Three, Track Three** **Moderator:** Gloria Sosa, U.S. EPA
10:00 –10:20 a.m.	**A Simple Analytical Model for Heat Flow in Fractures – Application to Steam Enhanced Remediation Conducted in Fractured Rock** K.S. Novakowski, Queen's University; K.M. Stephenson, Golder Associates Ltd.; E.L. David and S. Carroll, R.S. Kerr Environmental Research Center; G. Heron, Steamtech Environmental Services Inc.; K. Udell, University of California
10:20 – 11:40 a.m.	**Workshop: Demonstration of the Westbay MP Multilevel Groundwater Monitoring System**

Delineating the extent of a ground water contaminant plume in geologic materials requires a three-dimensional array of sampling points. Multilevel monitoring can provide increased data density and therefore an improved understanding of site conditions. This demonstration will show how the Westbay MP System, one type of multilevel monitoring well, is installed and operated. Also discussed will be field quality control procedures, potential applications, case studies, and the advantages of more (and better) data for optimizing project management.

11:40 a.m. – 1:00 p.m.	Lunch (on your own)

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1:00 – 1:20 p.m.	**Determining the Average Fracture Spacing Between Fractures and Planning of the Best Paths for the Wells in a Field Located in the Middle Magdalena Basin-Colombia** Roa Leonardo, Ing., Flamino Oil S.A.; and Penaloza Jorge E., Ing, Meta Petroleum Limited
1:20 – 1:40 p.m.	**Natural Attenuation of Dissolved Petroleum Components in Fractures Crystalline Rock: Results from Field Experiments at Äspö Hard Rock Laboratory, Sweden** Ola Landin and Sten Berglund, WSP Environmental; Lotta Hallbeck and Sara Eriksson, Goteborg University; Katrina Abrahamsson and Tobias Ankner, Chalmers University of Technology; Lars-Gunnar Karlsson, Geological Survey of Sweden
1:40 – 2:40 p.m.	**Workshop: Strategies for Monitoring the Performance of DNAPL Source Zone Remedies** Eric Hausamann, New York State Department of Environmental Conservation; Naji Alkadiss, Maine Department of Environmental Protection; Thomas Early, Oak Ridge National Laboratory; Linda Fielder, U.S. EPA; Laurie Haines, U.S Army Environmental Center; Konstantinos Kastarelos, Polytechnic University; Hans Meinardus, Intera; and Michael Smith, Vermont Department of Environmental Conservation
2:40 – 4:00 p.m.	**Performance Assessment: Measuring Success in Remediation Panel Discussion** Co-Chairs: Kathy Davies, U.S. EPA, Beth Moore, U.S. Department of Energy

Special Events

Field Trip to Bedrock Bioremediation Center
Sunday, September 12, 2004
8:00 a.m. – 5:00 p.m.

Characterization Methods for Contaminated Fractured Rock
Members of national organizations, federal agencies, universities, and private industry are collaborating to provide field demonstrations of methods to characterize fracture patterns, hydraulic properties, the potential for *in situ* bioremediation, and ground-water flow in a contaminated fractured-rock aquifer. Field demonstrations will include drilling techniques; hydraulic testing and discrete-interval monitoring; methods to sample microbes and monitor *in situ* bioremediation; and borehole imaging, flowmeter, and fluid-property logging. Data collection and the results of related ongoing site-specific research will be discussed in terms of the challenges and the complexities of characterizing contaminant transport and remediation with a particular focus on fractured-rock aquifers. Lunch will be provided.

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Registrations will be taken on a first come, first served basis and NGWA reserves the right to limit the number of participants.

Information about the site: The Bedrock Bioremediation Center (BBC) Research Site at Former Pease AFB (Site 32) has been the focus of multi-disciplined research on bioremediation of organically-contaminated bedrock aquifers. This demonstration site is the location of a former industrial shop (known as Building 113 at Site 32). From 1955 to 1968, a 1200-gallon concrete underground storage tank with an overflow pipe received TCE from degreasing operations. It was estimated that 5200 gallons of TCE were released at the site. A contaminant plume of TCE and its degradation products has been identified approximately 0.5 km beyond the identified source area. The plume has migrated with the ground water into the bedrock. It is 55 miles south and about one hour way from Portland, Maine.

Transportation to the site: NGWA will provide bus transportation from the conference hotel in Portland Maine to the Site. The bus will depart from Portland at 8:00 am and arrive at the field site at about 9:00. People can opt to meet directly at the field site, but must notify NGWA at time of registration and be ready to start the field trip at 9:00.
Cost: $50

Peak's Island "Down East Lobster Bake"
Tuesday, September 14, 2004
4:45- 9:00 p.m.

Buses leave at 4:45 and 5:15 p.m. for the waterfront. Guests will board the boat and enjoy a scenic, 20-minute ride to Peak's Island where they will enjoy an authentic "Down East Lobster Bake" with all the trimmings at the Lion's Club theatre, which was built in 1866. Guests can substitute steak, chicken, or vegetarian lasagna for lobster. A cash bar will be available along with volleyball, beach combing, and plenty of fun. A boat leaves for the shore at 8:30 p.m., and guests will be back at the hotel by 9:00 p.m. Enjoy the fun that Maine offers!
Cost: $60

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