

VINCE R. VERMEUL

Senior Research Engineer

Environmental Systems Group, Earth Systems Science Division

Energy and Environment Directorate, Pacific Northwest National Laboratory

Education

B.S. Agricultural Engineering, Oregon State University, Corvallis, Oregon, 1988

M.S. Civil Engineering (Environmental), Oregon State University, Corvallis, Oregon, 1990

Experience

Mr. Vermeul has 20 years of experience in hydrologic and geochemical characterization, designing, instrumenting, conducting, and managing field tests, interpreting hydrologic test data, and developing/demonstrating groundwater remediation technologies. Since joining Pacific Northwest National Laboratory in 1990, Mr. Vermeul has gained the following experience:

- Key contributor on several interdisciplinary teams developing innovative groundwater remediation technologies including: 1) manipulation of in situ redox conditions to create a permeable reactive barrier (PRB) to prevent migration of groundwater contaminants, 2) injection of colloidal-scale ZVI for source area treatment and PRB installation, 3) emplacement of injectable apatite to create a PRB for containment of strontium-90 contaminated groundwater, 4) In situ uranium stabilization through phosphate amendment injection/infiltration, 5) In situ biostimulation for the creation of a reducing barrier, and 6) the use of shear-thinning fluids for improved delivery or retention of remedial amendments. Primary technical contribution to these technology development projects has been hydrologic and geochemical characterization of the field test sites, design/integration of systems required to deploy and monitor the technologies at the field-scale, performance assessment of the in situ treatment technologies, management of field operations, and technology transfer.
- Key contributor on DOE-SC Integrated Field Research challenge project focused on providing improved understanding of mass transfer processes.
- MVA program lead for FutureGen2 Carbon Capture and Storage (CCS) project
- Conducted numerous remedial investigations at Department of Energy, Department of Defense, and Environmental Protection Agency sites.
- Hydrology subject matter expert for environmental and safety reviews of combined construction and operating license applications for new commercial nuclear plants (Levy Nuclear Plant).
- Experienced in the development and interpretation of regional and local-scale groundwater flow and contaminant transport models, including both forward and inverse modeling approaches.
- Project management experience in remedial investigation, technology development, and predictive simulation projects.

Professional and Educational History

2000 - Pres. Senior Research Engineer II, Environmental Systems Group, Earth Systems Science Division, PNNL, Richland WA.

1996 - 2000 Senior Research Engineer I, Field Hydrology & Chemistry Group, Environmental Technology Directorate, PNNL, Richland WA.

1992 – 1996 Research Engineer, Geosciences Department, Environmental Technology Division, PNNL, Richland WA.

1990 – 1992 Engineer, Hydrology Section, Geosciences Department, PNNL, Richland WA.

1988 – 1990 Graduate studies in Environmental Engineering. Emphasis: Groundwater hydrology – Numerical modeling of groundwater flow and solute transport - Water quality/hazardous waste – Information management with geographical information systems.

1984 – 1988 Undergraduate studies in Agricultural Engineering. Emphasis: Surface and groundwater hydrology - Water resource management and development - Fluid mechanics and hydraulic design.

Awards and Professional Affiliations

Trained in Hazardous Waste Operations, HAZWOPER Supervisor, and Medic First Aid

R&D 100 Award, 1998, Development of the In Situ Redox Manipulation Technology

PNNL Outstanding Performance Award, ISRM technology field demonstration

PNNL Outstanding Performance Award, Transient inverse groundwater modeling

PNNL Outstanding Performance Award, Proposal Generation/Business Development with EPA

BHI Gold Award, ISRM deployment for remediation of Cr(VI) contaminated groundwater

U. S. Patent 6,438,501; Flow Through Electrode with Automated Calibration

Certified by the Oregon State Board of Engineering Examiners as an Engineer-in-Training.

Selected Publications

Cole, C. R., R. M. Cooper, J. F. Fletcher, B. P. Hay, B. P. McGrail, I.C. Nelson, L.H. Sawyer, R. J. Serne, S. M. Short, V. R. Vermeul. 1992. *Final Report, Rokkasho Shallow-Land Low-Level Waste Disposal Study, Volumes 1-3*. Prepared for Radioactive Waste Management Center Under Contract 17943 by Battelle Pacific Northwest Laboratory.

Freedman, Vicky L., Scott R. Waichler, Charles R. Cole, Vince R. Vermeul, and Marcel P. Bergeron. 2005. Identifying the Potential Loss of Monitoring Wells Using an Uncertainty Analysis. *Ground Water*, Vol 43, No 6: 916-925.

Fruchter, J.S., F.A. Spane, J.K. Fredrickson, C.R. Cole, J.E. Amonette, J.C. Templeton, T.O. Stevens, D.J. Holford, L.E. Eary, B.N. Bjornstad, G.D. Black, J.M. Zachara and V.R. Vermeul. (1994) Manipulation of Natural Subsurface Processes: Field Research and Validation. Final report, *Subsurface Science Program*, Office of Health and Environmental Research and the In Situ Remediation Technology Development Integrated Program, Office of Technology Development, U.S. Department of Energy, Washington, D.C. PNL-10123/UC-402,802.

Fruchter, J.S., J.E. Amonette, C.R. Cole, Y.A. Gorby, M.D. Humphrey, J.D. Istok, F.A. Spane, J.E. Szecsody, S.S. Teel, V.R. Vermeul, M.D. Williams and S.B. Yabusaki (1996) *In Situ Redox Manipulation Field Injection Test Report - Hanford 100H Area*, Subsurface Contaminant Focus Area, Office of Technology Development, U.S. Department of Energy, Washington, D.C. PNNL-11372

Fruchter JS, CR Cole, MD Williams, VR Vermeul, JE Amonette, JE Szecsody, JD Istok, and MD Humphrey. 2000. Creation of a Subsurface Permeable Treatment Barrier using In Situ Redox Manipulation. *Groundwater Monitoring and Remediation Review*. Spring 2000.

Fruchter, J.S., V.R. Vermeul, M.D. Williams and J.E. Szecsody, "Remediation of Cr(VI) and TCE in Groundwater Using an In Situ Redox Manipulation Barrier", in *Innovative Approaches to the On-Site Assessment and Remediation of Contaminated Sites*, D. Reible and K. Demnorrava, Eds., NATO Science Series, IV Earth and Environmental Sciences- Vol.15, Kluwer Academic Publishers, Dordrecht, Netherlands, pp 201-216.

- Fruchter, J.S., V.R Vermeul, P.D. Thorne, and T.R. Wood. 2008. *Hydrogeochemical Conceptual Model and Framework for the Chevron Research, Development, and Demonstration Site, Piceance Basin, Colorado*. PNNL-17376, Pacific Northwest National Laboratory, Richland, WA.
- Istok JD, Amonette JE, Cole CR, Fruchter JS, Humphrey MD, Szecsody JE, Teel SS, Vermeul VR, Williams MD, and Yabusaki SB. 1999. In Situ Redox Manipulation by Dithionite Injection: Intermediate-Scale Laboratory Experiments. *Ground Water*. 37:884-889.
- Luttrell, S. P., D. R. Newcomer, S. S. Teel, and V. R. Vermeul. 1992. *Hydrogeologic Controls on Ground-Water and Contaminant Discharge to the Columbia River Near the Hanford Townsite*. PNL-8167, Prepared for the Department of Energy, Richland, Washington.
- Newcomer, D. R., L. A. Doremus, S. H. Hall, M. J. Truex, V.R. Vermeul, and R. E. Engelman. 1995. *Geology, Hydrology, Chemistry, and Microbiology of the In Situ Bioremediation Demonstration Site*. PNL-10422, Pacific Northwest Laboratory, Richland, Washington.
- Newcomer, D. R., Hall, S. H., and V. R. Vermeul. 1996. Use of Improved Hydrologic Testing and Borehole Geophysical Logging Methods for Aquifer Characterization. *Ground Water Monitoring and Remediation*. Vol 16, No 1: 67-72.
- Newcomer DR, BN Bjornstad, and VR Vermeul. 2010. "Vertical Wellbore Flow Monitoring for Assessing Spatial and Temporal Flow Relationships with a Dynamic River Boundary." *Ground Water Monitoring and Remediation*. doi:10.1111/j1745-6592.2010.01304.x. Vol 30, No 4: 123-135.
- Oostrom M, TW Wietsma, MA Covert, and VR Vermeul. 2007. Zero-valent Iron Emplacement in Permeable Porous Media Using Polymer additions. *Groundwater Monitoring and Remediation* 27: 122-130.
- Oostrom M, TW Wietsma, MA Covert, and VR Vermeul. 2005. *An Experimental Study of Micron-Size Zero-Valent Iron Emplacement in Permeable Porous Media Using Polymer-Enhanced Fluids*. PNNL-15573, Pacific Northwest National Laboratory, Richland, WA.
- Spane, F. A. and V. R. Vermeul. 1994. *Summary and Evaluation of Hydraulic Property Data Available for the Hanford Site Upper Basalt Confined Aquifer*. PNL-10158, Pacific Northwest Laboratory, Richland, Washington.
- Szecsody, J., Fruchter, J. Vermeul, V.R., Williams, M., Devary, B., 2003 In Situ Reduction of Aquifer Sediments to Create a Permeable Reactive Barrier to Remediate Chromate: Bench-Scale Tests to Determine Barrier Longevity, book chapter, J. Jacobs, ed., Groundwater Remediation of Chromate, CRC Press.
- Szecsody, J. , Fruchter J., Williams, M., V Vermeul, D. Sklarew, In Situ Reduction of Aquifer Sediments: Enhancement of Reactive Iron Phases and TCE Dechlorination. *Environmental Science and Technology*, Vol. 38, No. 17, 2004.
- Szecsody, J., J. Phillips, V. Vermeul, J. Fruchter, and M. Williams. 2005. *Influence of nitrate on the Hanford 100D area In Situ Redox Manipulation barrier longevity*. PNNL-15262, Pacific Northwest National Laboratory.
- Szecsody, JE, VR Vermeul, JS Fruchter, MD Williams, BJ Devary, JL Phillips, ML Rockhold, and Y Liu. 2005. *Effect of Geochemical and Physical Heterogeneity on the Hanford 100D Area In Situ Redox Manipulation Barrier Longevity*. PNNL-15499, Pacific Northwest National Laboratory.

Szecsody, J., C. Burns, R. Moore, J. Fruchter, V. Vermeul, M. Williams, D. Girvin, J. McKinley, M. Truex, J. Phillips, 2007. *Hanford 100-N Area Apatite Emplacement: Laboratory Results of Ca-Citrate-PO₄ Solution Injection and Sr-90 Immobilization in 100-N Sediments*. PNNL-16891, Pacific Northwest National Laboratory, Richland, WA.

Szecsody JE, ML Rockhold, M Oostrom, RC Moore, CA Burns, MD Williams, L Zhong, JS Fruchter, JP McKinley, VR Vermeul, MA Covert, TW Wietsma, AT Breshears, and BJ Garcia. 2009. Sequestration of Sr-90 Subsurface Contamination in the Hanford 100N Area by Surface Infiltration of a Ca-Citrate-PO₄ Solution . PNNL-18303, Pacific Northwest National Laboratory, Richland, WA.

Szecsody JE, VR Vermeul, JS Fruchter, MD Williams, ML Rockhold, N Qafoku, and JL Phillips. 2010. Hanford 100-N Area In Situ Apatite and Phosphate Emplacement by Groundwater and Jet Injection: Geochemical and Physical Core Analysis . PNNL-19524, Pacific Northwest National Laboratory, Richland, WA.

Thorne, P. D., M. A. Chamness, F. A. Spane, V. R. Vermeul, and W. D. Webber. 1993. *Three-Dimensional Conceptual Model for the Hanford Site Unconfined Aquifer System, FY 1993 Status Report*. PNL-8971, Prepared for the Department of Energy, Richland, Washington.

Thorne, P. D., M. A. Chamness, V. R. Vermeul, Q. C. Macdonald, S. E. Schubert. 1994. *Three-Dimensional Conceptual Model for the Hanford Site Unconfined Aquifer System: FY 1994 Status Report*. PNL-10195, Pacific Northwest Laboratory, Richland, Washington.

Truex, M. J., V. R. Vermeul, P. E. Long, F. J. Brockman, M. Oostrom, S. Hubbard, R. C. Borden, J. S. Fruchter. 2007. *Treatability Test Plan for an In Situ Biostimulation Reducing Barrier*. PNNL-16424, Pacific Northwest National Laboratory, Richland, WA.

Truex MJ, VR Vermeul, BG Fritz, RD Mackley, DP Mendoza, RP Elmore, AV Mitroshkov, DS Sklarew, CD Johnson, M Oostrom, DR Newcomer, FJ Brockman, CL Bilskis, and SS Hubbard. 2009. Hanford 100-D Area Biostimulation Treatability Test Results . PNNL-18784, Pacific Northwest National Laboratory, Richland, WA.

Truex, MJ, VR Vermeul, DP Mendoza, BG Fritz, RD Mackley, M Oostrom, TW Wietsma, and TW Macbeth. 2010. Injection of Zero Valent Iron into an Unconfined Aquifer Using Shear-Thinning Fluids. *Ground Water Monitoring and Remediation*. doi: 10.1111/j1745-6592.2010.001319.x. Vol 31, No 1: 50-58.

Vermeul, V. R., J. D. Istok, A. L. Flint, and J. L. Pikul, Jr. 1993. An Improved Method for Quantifying Soil Macroporosity. *Soil Sci. Soc. Am. J.* 57:809-816

Vermeul, V. R., S. S. Teel, J. E. Amonette, C. R. Cole, J. S. Fruchter, Y.A. Gorby, F. A. Spane, J. E. Szecsody, M. D. Williams, S. B. Yabusaki. 1995. *Geologic, Geochemical, Microbiologic, and Hydrologic Characterization at the In Situ Redox Manipulation Test Site*, PNL-10633, Pacific Northwest Laboratory, Richland, Washington.

Vermeul, V. R., M. D. Williams, J. C. Evans, J. E. Szecsody, B. N. Bjornstad, and T. L. Liikala, 2000, *In Situ Redox Manipulation Proof-of-Principle Test at the Fort Lewis Logistics Center: Final Report*, PNNL-13357, Pacific Northwest National Laboratory, Richland, Washington.

Vermeul VR, Cole CR, Bergeron MP, Thorne PD and Wurster SK. 2001. *Transient Inverse Calibration of Site-Wide Groundwater Model to Hanford Operational Impacts from 1943 to 1996--Alternative Conceptual Model Considering Interaction with Uppermost Basalt Confined Aquifer*. PNNL-13623. Pacific Northwest National Laboratory, Richland, WA.

Vermeul VR, Williams MD, Szecsody JE, Fruchter JS, Cole CR and Amonette JE. 2002. *"Creation of a Subsurface Permeable Reactive Barrier Using In Situ Redox Manipulation"*. in *Groundwater*

Remediation of Metals, Radionuclides, and Nutrients with Permeable Reactive Barriers. (book):163. Academic Press, San Diego, CA. PNNL-SA-35122

Vermeul VR, MP Bergeron, CR Cole, CJ Murray, WE Nichols, TD Scheibe, PD Thorne, SR Waichler, and Y Xie. 2003. *Transient Inverse Calibration of the Site-Wide Groundwater Flow Model (ACM-2): FY03 Progress Report* . PNNL-14398, Pacific Northwest National Laboratory, Richland, WA.

Vermeul, V.R., B.N. Bjornstad, C.J. Murray, D.R. Newcomer, M.L. Rockhold,, J.E. Szecsody, M.D. Williams, and Y. Xie. 2004. *In Situ Redox Manipulation Permeable Reactive Barrier Emplacement: Final Report, Frontier Hard Chrome Superfund Site, Vancouver, WA.* PNWD-3361, Pacific Northwest National Laboratory, Richland, WA.

Vermeul VR, Bergeron MP, Dresel P, Freeman EJ, Peterson RE and Thorne PD. 2005. *Evaluation of the Fate and Transport of Tritium Contaminated Groundwater from the 618-11 Burial Ground.* PNNL-15293, Pacific Northwest National Laboratory.

Vermeul, V.R., J.E. Szecsody, M.J. Truex, C.A. Burns, D.C. Girvin, J.L. Phillips, B.J. Devary, A.E. Fischer, and S.W. Li. 2006. *Treatability Study of In Situ Technologies for Remediation of Hexavalent Chromium in Groundwater at the Puchack Well Field Superfund Site, New Jersey.* PNNL-16194, Pacific Northwest National Laboratory, Richland, WA.

Vermeul VR, MD Williams, BG Fritz, R Mackley, DP Mendoza, DR Newcomer, ML Rockhold, BA Williams, and DM Wellman. 2007. *Treatability Test Plan for 300 Area Uranium Stabilization through Polyphosphate Injection* . PNNL-16571, Pacific Northwest National Laboratory, Richland, WA.

Vermeul VR, BN Bjornstad, BG Fritz, JS Fruchter, RD Mackley, DR Newcomer, DP Mendoza, ML Rockhold, DM Wellman, and MD Williams. 2009. *300 Area Uranium Stabilization Through Polyphosphate Injection: Final Report* . PNNL-18529, Pacific Northwest National Laboratory, Richland, WA.

Vermeul VR, BG Fritz, JS Fruchter, JE Szecsody, and MD Williams. 2010. *100-NR-2 Apatite Treatability Test: High-Concentration Calcium-Citrate-Phosphate Solution Injection for In Situ Strontium-90 Immobilization* . PNNL-19572, Pacific Northwest National Laboratory, Richland, WA.

Vermeul VR, JP McKinley, DR Newcomer, RD Mackley, and JM Zachara. 2010. "River-Induced Wellbore Flow Dynamics in Long-Screen Wells and their Impact on Aqueous Sampling Results." *Groundwater* doi: 10.1111/j.1745-6584.2010.00769.x. Vol. 49, No. 4 – GROUNDWATER – July-August 2011.

Williams MD, Vermeul VR, Szecsody JE, and Fruchter JS. 2000. *100-D Area in Situ Redox Treatability Test for Chromate-Contaminated Groundwater:* PNNL-13349.

Williams MD, Vermeul VR, Oostrom M, Evans JC, Fruchter JS, Istok JD, Humphrey MD, Lanigan DC, Szecsody JE, White MD, Wietsma TW and Cole CR. 1999. *Anoxic Plume Attenuation in a Fluctuating Water Table System: Impact of 100-D Area In Situ Redox Manipulation on Downgradient Dissolved Oxygen Concentrations.* PNNL-12192.

Williams MD, BG Fritz, DP Mendoza, ML Rockhold, PD Thorne, YL Xie, BN Bjornstad, RD Mackley, JE Szecsody, and VR Vermeul. 2008. *100-NR-2 Apatite Treatability Test: Low Concentration Calcium Citrate-Phosphate Solution Injection for In Situ Strontium-90 Immobilization* . PNNL-17429, Pacific Northwest National Laboratory, Richland, WA.

Williams MD, VR Vermeul, PW Reimus, D Newell, and TB Watson. 2010. *Development of Models to Simulate Tracer Behavior in Enhanced Geothermal Systems* . PNNL-19523, Pacific Northwest National Laboratory, Richland, WA.

Zachara JM, BN Bjornstad, JN Christensen, ME Conrad, JK Fredrickson, MD Freshley, R Haggerty, G Hammon, DB Kent, A Konopka, PC Lichtner, C Liu, JP McKinley, CJ Murray, ML Rockhold, Y Rubin, VR Vermeul, RJ Versteeg, AL Ward, and C Zheng. 2010. Multi-Scale Mass Transfer Processes Controlling Natural Attenuation and Engineered Remediation: An IFRC Focused on Hanford's 300 Area Uranium Plume . PNNL-19209, Pacific Northwest National Laboratory, Richland, WA.