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## William G. Gray

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## Education

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| <b>Ph. D., Chemical Engineering</b><br>1974 | <i>Princeton University</i>            |
| <b>M. A., Chemical Engineering</b><br>1971  | <i>Princeton University</i>            |
| <b>B. S., Chemical Engineering</b><br>1969  | <i>University of California, Davis</i> |

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## Experience

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|---|---|
| <b>Adjunct Professor</b><br><i>February, 2018 - Present</i>           | <i>School of Engineering<br/>University of Vermont</i>  |
| <b>Research Affiliate</b><br><i>May, 2016 - February, 2018</i>        | <i>School of Engineering<br/>University of Vermont</i>  |
| <b>Adjunct Professor</b><br><i>July, 2015 - Present</i>               | <i>Curriculum for the Environment and Ecology<br/>University of North Carolina at Chapel Hill</i>           |
| <b>Research Professor</b><br><i>August, 2014 - Present</i>            | <i>Department of Environmental Sciences and Engineering<br/>University of North Carolina at Chapel Hill</i> |
| <b>Professor</b><br><i>July, 2003 - August, 2014</i>                  | <i>Department of Environmental Sciences and Engineering<br/>University of North Carolina at Chapel Hill</i> |
| <b>Massman Professor</b><br><i>October, 1988 - June, 2003</i>         | <i>Department of Civil Engineering and Geological Sciences<br/>University of Notre Dame</i>                 |
| <b>Chair</b><br><i>July, 1991 - August, 1995</i>                      | <i>Department of Civil Engineering and Geological Sciences<br/>University of Notre Dame</i>                 |
| <b>Chair</b><br><i>September, 1984 - June, 1991</i>                   | <i>Department of Civil Engineering<br/>University of Notre Dame</i>   |
| <b>Professor</b><br><i>September, 1984 - October, 1988</i>            | <i>Department of Civil Engineering<br/>University of Notre Dame</i>   |
| <b>Associate Professor</b><br><i>July, 1980 - August, 1984</i>        | <i>Department of Civil Engineering<br/>Princeton University</i>   |
| <b>Director of Graduate Studies</b><br><i>July, 1977 - June, 1984</i> | <i>Department of Civil Engineering<br/>Princeton University</i>   |
| <b>Assistant Professor</b><br><i>July, 1975 - July, 1980</i>          | <i>Department of Civil Engineering<br/>Princeton University</i>   |

**Experience  
(continued)**

<b>Consulting Research Hydrologist</b> <i>September, 1974 - July, 1979</i>	<i>U. S. Geological Survey Water Resources Division Reston, Virginia</i>
<b>Lecturer</b> <i>September, 1974 - July, 1975</i>	<i>Department of Civil Engineering Princeton University</i>
<b>Research Hydrologist</b> <i>September, 1973 - September, 1974</i>	<i>U. S. Geological Survey, Water Resources Division Reston, Virginia</i>
<b>Visiting Fellow</b> <i>September, 1973 - September, 1974</i>	<i>Department of Civil Engineering Princeton University</i>

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**Awards**

National Academy of Engineering, Elected (2018)  
ALERT Invited Lecturer, Annual Meeting of the ALERT Geomaterials Association, Aussois, France (October, 2017).  
Langbein Lecturer, American Geophysical Union, Fall Meeting, San Francisco (December, 2010)  
Fulbright Research Scholar Award, to visit University of Bergen, Bergen, Norway (August 15 - November 15, 2010)  
Newton Underwood Award for Teaching Excellence, Environmental Sciences and Engineering, University of North Carolina, May, 2010.  
Visiting Scientist Fellowship, Department of Mathematics, University of Bergen, Norway (September, 2007; September, 2009).  
SAMSI University Fellow, Statistical and Applied Mathematical Sciences Institute, Research Triangle Park, NC and Visiting Professor, Department of Environmental Sciences and Engineering, University of North Carolina (January 15 - May 31, 2003).  
Kaneb Award for Excellence in Undergraduate Teaching, Department of Civil Engineering and Geological Sciences, University of Notre Dame (May, 2001)  
Visiting Scientist Fellowship, Department of Mathematics, University of Bergen, Norway (June, 1999)  
Gledden Visiting Scientist Fellowship, Water Resources Center, University of Western Australia (November, 1998 - March, 1999)  
Fellow, Texas Institute for Computational and Applied Mathematics (April, 1996; April, 1997)  
Fellow, American Geophysical Union (1995)  
1991 Distinguished Engineering Alumnus of the University of California at Davis  
Rheinstein Award to outstanding junior faculty member in the School of Engineering and Applied Science, Princeton University (1979-80)

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**Professional and  
Honorary Societies**

American Institute of Chemical Engineers  
Society of Sigma Xi (1969-2010)  
Phi Kappa Phi  
Tau Beta Pi  
International Association of Hydraulic Research  
American Geophysical Union  
Society of Industrial and Applied Mathematics

**Courses Taught**

*Undergraduate*

Mechanics of Fluids  
Introduction to Water Resources  
Surface and Subsurface Hydrology  
Introduction to Numerical Methods for the Solution of Differential Equations  
Groundwater Hydrology  
Fundamental Aspects of Environmental Modeling  
Hydraulics of Open Channel Flow  
Environmental Modeling

*Graduate*

Advanced Hydraulics  
Simulation Methods in Surface and Subsurface Hydrology  
Advanced Hydrology  
Finite Element Methods for Engineers  
Averaging Theory for Porous Media Flow  
Capillary Pressure Effects in Porous Media  
Environmental Thermodynamics  
Unifying Concepts  
Multiphase Transport Phenomena  
Environmental Physics

**University Committees**

*Princeton University*

Committee on Examinations and Standing  
Undergraduate Life Committee  
Graduate School Committee  
    Subcommittee on Curriculum  
    Subcommittee on Graduate Student Life  
    Subcommittee on Fellowships  
Engineering School Special Committee on the Future of Graduate  
    Education at Princeton  
Water Resources Program Committee

*University of Notre Dame*

College of Engineering Executive Committee  
Engineering College Council  
Graduate Studies Committee  
Undergraduate Studies Committee  
Engineering Dean Search Committee  
Architecture School Chairman Search Committee  
Executive Committee, Center for Bioengineering and Pollution Control  
College of Engineering Outstanding Teacher Selection Committee  
Subcommittee on Graduate Education of the University Committee on  
    Research, Scholarship and Infrastructure  
Clark Professor Selection Committee  
Departmental Committee on Appointments and Promotions

*University of North Carolina*

Graduate Admissions Committee, Environmental Sciences and Engineering (2011 -  
2012)  
+1 Masters Degree Coordinator (2009 - )  
School of Public Health, Faculty Mentor (2007 - 2008)  
Environmental Engineering Committee, Department of Environmental Sciences and  
    Engineering (2007 - )  
Faculty Advisory Committee, Carolina Environmental Institute (2007 - 2011)  
Appointments, Promotion, and Tenure Committee, School of Public Health  
    (2005 - 2008)  
Faculty Advisory Committee, Carolina Environmental Program (2004 - 2007)  
Academic Programs Committee, Department of Environmental Sciences and  
    Engineering (2007 - 2007)

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**Journal Editing**

Editor, Advances in Water Resources (June, 1985 - October, 1997)  
Editor, Water Resources Research (October, 2000 - December, 2004)  
Associate Editor, Journal of Hydraulic Research (January, 2017 - )

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**Journal Editorial  
Boards**

Advances in Engineering Software  
Microsoftware for Engineers  
Topics in Engineering Series (CMP)  
Advances in Water Resources (1997 - 2001, 2005 - 2014)  
Computer Applications in Engineering Education (1993 - )  
Journal of Porous Media (2000 - 2017)  
Special Topics and Reviews in Porous Media (2010 - )

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**Technical Reviewer**

**Journals**

Advances in Engineering Software  
Advances in Water Resources  
ASCE, Journal of the Hydraulics Division  
ASCE, Journal of Mechanics Division  
ASCE, Journal of the Environmental Engineering Division  
Anais de Academia Brasileira de Ciencia  
Applied Mathematical Modeling  
Applied Mathematics Letters  
Arabian Journal for Science and Engineering  
Catena  
Chemical Engineering Communications  
Chemical Engineering Research and Design  
Chemical Engineering Science  
Chemosphere  
Computational Geosciences  
Computer Applications in Engineering Education  
Computers and Fluids  
Continuum Mechanics and Thermodynamics  
Engineering Analysis  
Environmental Science and Technology  
Geoderma  
The Geophysical Journal of the Royal Astronomical Society  
Geophysical Research Letters  
Hydrology and Earth Systems Science Journal of the European Geosciences Union  
Industrial and Engineering Chemistry Research  
International Journal for Numerical Methods in Engineering  
International Journal for Numerical Methods in Fluids  
International Journal of Engineering Science  
International Journal of Heat and Mass Transfer  
International Journal of Multi-phase Flow  
Journal of Canadian Petroleum Technology  
Journal of Computational Physics  
Journal of Contaminant Hydrology  
Journal of Fluid Mechanics  
Journal of Hydraulic Research  
Journal of Hydro-environment Research  
Journal of Hydrology  
Journal of Porous Media  
Lab on a Chip

**Technical Reviewer  
(continued)**

**Journals (continued)** Mathematical Geology  
Mathematical Problems in Engineering  
Numerical Methods for Partial Differential Equations  
Transactions of the Canadian Society for Mechanical Engineering  
Transport in Porous Media  
Vadose Zone Journal  
Water Resources Research  
Zeitschrift für Angewandte Mathematik und Mechanik

**Publishers** Addison-Wesley Publishing Company  
Cambridge University Press  
Holt, Rinehart, and Winston  
PWS Publishing  
Springer Verlag

**Organizations and Agencies** Battelle Columbus  
Canadian Research Council  
Department of Defense  
Department of Energy  
France-Berkeley Fund  
Israel Science Foundation  
Lawrence Livermore National Laboratory Institute of Geophysics and Planetary  
Physics  
Michigan State University Water Resources Institute  
National Science Foundation  
Natural Sciences and Engineering Research Council of Canada  
Petroleum Research Fund  
Purdue University Water Resources Institute  
Qatar National Research Fund  
South Africa Foundation for Research and Development  
Swiss National Science Foundation  
Vermont Experimental Program to Stimulate Competitive Research

**Professional Service**

International Society for Computational Methods in Engineering  
Vice-President (July 1981-83)  
President (July, 1983 - July, 1985)  
Purdue University Water Resources Research Council  
Member (June, 1986 - May 1988)  
American Society of Civil Engineers Hydraulics Division  
Control Member Computational Hydraulics Committee  
(October, 1987 - September, 1991)  
American Geophysical Union  
Member MacElwane Medal Subcommittee (July, 1988 - July, 1990)  
National Science Foundation Panel on Graduate Fellowships in Engineering  
Member (1991 - 1995, 2007 - 2010)  
The Future of Environmental Studies at Princeton University  
External Review Panel Member (January, 1991)  
SIAM Activity Group on the Geosciences  
Group Leader in Subsurface Hydrology  
Educational Testing Service  
Engineering Advanced Test of the Graduate Record Examination  
Review Panel Member (1993 - 1994)  
National Defense Science and Engineering Graduate Fellowship  
Review Panel Member - Geosciences (February, 1996, 1997, 2002, 2003, 2004, 2013)  
Review Panel Chair - Geosciences (February, 1998, 2005)  
Review Panel Chair - Civil Engineering (February, 2006, 2007, 2008, 2009, 2010)  
National Research Council  
Review Panel Member - AFOSR Mechanics Proposals (October, 1996)  
New England Association of Schools and Colleges, Inc.  
Member of accreditation team (1997)  
American Geophysical Union  
Committee of Fellows (July, 1998 - June, 2000)  
American Geophysical Union  
Hydrology Section Executive Committee (January, 2001 - December, 2004)  
Carroll College Engineering Advisory Board  
Member (August, 1996 - August, 2017)  
Florida Gulf Coast University  
Member of Advisory Board for the School of Engineering (October, 2005 - October, 2007)  
American Geophysical Union  
Langbein Lecture Committee Chair (January, 2011 - January, 2014)  
Hydrology Section Executive Committee (January, 2011 - January, 2014)

**Conference  
Committees**

International Conference on Finite Elements in Water Resources  
Conference Series Co-founder and Permanent Organizing Committee Member  
Princeton, NJ (1976)  
London, England (1978)  
University, Mississippi (1980)  
Hannover, W. Germany (1982)  
Burlington, Vermont (1984)  
Lisbon, Portugal (1986)

International Conference on Computational Methods in Water Resources  
Conference Series Co-founder and Permanent Organizing Committee Member  
Boston, MA (1988)  
Venice, Italy (1990)  
Denver, CO (1992)  
Heidelberg, Germany (1994)  
Cancun, Mexico (1996)  
Crete, Greece (1998)  
Calgary, Canada (2000)  
Delft, The Netherlands (2002)  
Session Co-organizer and Co-chair: Computational Methods in Education  
Chapel Hill, NC (2004)  
Copenhagen, Denmark (2006)

Princeton University Workshop on Transport of Toxic Chemicals  
Co-organizer (1984)

AICHE Meeting, Philadelphia (August, 1984)  
Session Chairman & Organizer, Modeling at Toxic Waste Sites

International Groundwater Modeling Center  
Expert Meeting on New Developments in Groundwater Modeling, Delft  
Scientific Program Committee Member (September, 1988)

SIAM Conference on Mathematical and Computational Issues in Geophysical  
Fluid and Solid Mechanics, Houston (September, 1989)  
Minisymposium Organizer and Chairman, Novel Computational Procedures for  
Water Resources

International Conference on Computer Modelling of Seas and Coastal Regions  
Southampton (1992)  
International Scientific Advisory Committee Member

Fourth International Conference on Hydraulic Engineering Software, Hydrossoft '92  
Valencia (1992)  
International Advisory Committee Member

Coastal '95, Second International Conference  
Cancun, Mexico (1995)  
International Scientific Advisory Committee Member

CMWR '95, Third International Conference  
Beirut, Lebanon (1995)  
International Scientific Advisory Committee Member

Porous Media Processes - Linking the Pore and Continuum Scales Through Theory  
Direct Modeling, and Direct Experimentation  
Los Alamos, New Mexico (1997)  
Workshop Coordinator

Fourth SIAM Conference on Mathematical and Computational Issues in Geosciences  
Albuquerque, New Mexico (1997)  
Organizing Committee Member  
Minisymposium Organizer and Chairman, Effect of Microprocesses and  
Microstructure on Soil Properties and Fluid Flow in Porous Media



**Conference  
Committees  
(continued)**

CMWR '97, Fourth International Conference  
Beirut, Lebanon (1997)  
International Scientific Advisory Committee Member

Coastal Engineering 97  
La Coruna, Spain (1997)  
International Scientific Advisory Committee Member

3rd International Conference on Hydrosience and Engineering  
Cottbus/Berlin Germany (1998)  
Scientific Advisory Committee Member

3rd International Symposium on Environmental Hydraulics  
Tempe, Arizona (2001)  
Scientific Advisory Committee Member

American Geophysical Union Annual Fall Meeting  
Session Organizer and Chair, Thirty-five years of Groundwater Modeling:  
A Tribute to George F. Pinder  
San Francisco, California (2001)

SIAM Conference on Mathematical and Computational Issues in the Geosciences,  
, Austin, Texas (March, 2003)  
Minisymposium Organizer, Pore and Macro Scale Modeling and Experiments -  
Parts I and II

SAMSI Simulation and Optimization Workshop  
Research Tringle Park, North Carolina (April, 2003)  
Workshop Organizing Committee

SAMSI One-Day Workshop on Porous Media Processes  
Research Tringle Park, North Carolina (May, 2003)  
Workshop Co-organizer

Second International Conference on Porous Media and Its Applications in Science,  
Engineering and Industry  
Kauai, Hawai'i (June, 2007)

SIAM Conference on Mathematical & Computational Issues in the Geosciences  
Santa Fe, New Mexico (March, 2007)  
Minisymposium Co-organizer, Theoretical, Numerical, and Experimental Studies  
of Pore Scale Processes

SIAM Conference on Mathematical & Computational Issues in the Geosciences  
Leipzig, Germany (June, 2009)  
Organizing Committee, Member

ALERT Geomaterials Association  
Co-organizer, ALERT Workshop on Porous Media Mechanics from Geomaterials to  
Non-geological Media (October 2, 2017)

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**Refereed Publications**

- Gray, W. G., and M. D. Kostin, "Natural Convection Effects in a Catalytic Reactor," *The Chemical Engineering Journal*, Vol. 6 (Oct., 1973), pp. 157-164.
- Gray, W. G., and G. F. Pinder, "Galerkin Approximation of the Time Derivative in the Finite Element Analysis of Groundwater Flow," *Water Resources Research*, Vol. 10 (Aug., 1974), pp. 821-828.
- Gray, W. G., and M. D. Kostin, "Natural Convection, Diffusion and Chemical Reaction in A Catalytic Reactor: Numerical Results," *The Chemical Engineering Journal*, Vol. 8 (Aug., 1974), pp. 1-10.
- Gray, W. G., "A Derivation of the Equations for Multi-Phase Transport," *Chemical Engineering Science*, Vol. 30 (Feb., 1975), pp. 229-233.
- Segol, G., G. F. Pinder, and W. G. Gray, "A Galerkin-Finite Element Technique for Calculating the Transient Position of the Saltwater Front," *Water Resources Research*, Vol. 11, No. 2 (April, 1975), pp. 821-828.
- Gray, W. G., and M. D. Kostin, "Velocity, Temperature, and Concentration Profiles in a Vertical Flow Reactor," *Chemical Engineering Science*, Vol. 30, No. 8 (Aug., 1975), pp. 931-936.
- Pinder, G. F., and W. G. Gray, "Is There a Difference in the Finite Element Method?," *Water Resources Research*, Vol. 12, No. 1 (Feb., 1976), pp. 105-107.
- Gray, W. G., and K. O'Neill, "On the Development of Darcy's Law for the General Equations for Flow in Porous Media," *Water Resources Research*, Vol. 12, No. 1 (April, 1976), pp. 148-154.
- Gray, W. G., and G. F. Pinder, "An Analysis of the Numerical Solution of the Transport Equation," *Water Resources Research*, Vol. 12, No. 3 (June, 1976), pp. 547-555.
- Gray, W. G., and G. F. Pinder, "On the Relationship Between the Finite Element and Finite Difference Method," *International Journal for Numerical Methods in Engineering*, Vol. 10, No. 4 (July, 1976), pp. 893-923.
- Gray, W. G., and G. F. Pinder, "Reply" to "Comment on 'An Analysis of the Numerical Solution of the Transport Equation,'" by J.J. Leendertse, *Water Resources Research*, Vol. 13, No. 1 (Feb., 1977), p. 220.
- Gray, W. G., and K. O'Neill, "Comment on 'On the Species Transport Equation for Flow in Porous Media,' by Thomas R. Blake and Sabodh K. Garg," *Water Resources Research*, Vol. 13, No. 3 (June, 1977), pp. 695-696.
- Gray, W. G., and P. C. Y. Lee, "On the Theorems for Local Volume Averaging of Multi-phase Systems," *International Journal Multiphase Flow*, Vol. 3 (July, 1977), pp. 333-340.
- Gray, W. G., and D. R. Lynch, "Time-Stepping Schemes for Finite Element Tidal Model Computations," *Advances in Water Resources*, Vol. 1, No. 2 (December, 1977), pp. 83-95.
- van Genuchten, M. Th., and W. G. Gray, "Analysis of Some Dispersion Corrected Numerical Schemes for Solution of the Transport Equation," *International Journal for Numerical Methods in Engineering*, Vol. 12, No. 3 (March, 1978) pp. 387-404.
- Gray, W. G., and M. Th. van Genuchten, "Economical Alternatives to Gaussian Quadrature Over Isoparametric Quadrilaterals," *International Journal for Numerical Methods in Engineering*, Vol. 12, No. 9 (September, 1978), pp. 1478-1484.
- Gray, W. G., and H. H. Mellon, "Comment on 'Accurate Calculations of Transport in Two-Dimensions' by F.M. Holley, Jr. and A. Preissman," *ASCE J. Hydraulics Div.*, Vol. 104, No. HY10 (October, 1978), pp. 1468-1469.

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**Refereed Publications  
(continued)**

- Lynch, D. R., and W. G. Gray, "Analytic Solutions for Computer Flow Model Testing," *ASCE J. Hydraulics Div.*, Vol. 104, No. HY10 (October, 1978), pp. 1409-1428.
- Gray, W. G., and D. R. Lynch, "On the Control of Noise in Finite Element Tidal Computations," *Computers and Fluids*, Vol. 7, No. 1 (March, 1979), pp. 47-67.
- Lynch, D. R., and W. G. Gray, "A Wave Equation Model for Finite Element Tidal Computations," *Computers and Fluids*, Vol. 7, No. 3 (September, 1979), pp. 207-228.
- Hassanizadeh, M., and W. G. Gray, "General Conservation Equations for Multi-Phase Systems, I. Averaging Procedure," *Advances in Water Resources*, Vol. 2, No. 3 (September, 1979), pp. 131-144.
- Hassanizadeh, M., and W. G. Gray, "General Conservation Equations for Multi-Phase Systems, II. Mass, Momenta, Energy, and Entropy Equations," *Advances in Water Resources*, Vol. 2, No. 4 (December, 1979), pp. 191-203.
- Lynch, D. R., and W. G. Gray, "On the Analysis of Accuracy for Two-Equation Transient Problems," *International Journal for Numerical Methods in Engineering*, Vol. 15, No. 1 (January, 1980), pp. 55-62.
- Hassanizadeh, M., and W. G. Gray, "General Conservation Equations for Multi-Phase Systems, III. Constitutive Theory for Porous Media Flow," *Advances in Water Resources*, Vol. 3, No. 1 (March, 1980), pp. 25-40.
- Lynch, D. R., and W. G. Gray, "Finite Element Simulation of Flow in Deforming Regions," *J. of Computational Physics*, Vol. 36, No. 2 (July, 1980), pp. 135-153.
- Gray, W. G., "Response to comments of T.N. Narasimhan on 'General conservation equations for Multiphase systems: I,'" *Advances in Water Resources*, Vol. 3, No. 3 (September, 1980), pp. 143-144.
- Celia, M. A., G. F. Pinder, and W. G. Gray, "Velocity Calculation from Randomly Located Hydraulic Heads," *Groundwater*, Vol. 19, No. 3 (May-June, 1981), pp. 262-264.
- Gray, W. G., "On the Need for Consistent Manipulation in Volume Averaging," *Chemical Engineering Science*, Vol. 37, No. 1 (January, 1982), pp. 121-122.
- Gray, W. G., "Comment on 'The Statistical Mechanical Theory of Groundwater Flow' by G. Sposito and S. Y. Chu," *Water Resources Research*, Vol. 18, No. 3 (June, 1982), pp. 668-669.
- Nguyen, V. V., W. G. Gray, G. F. Pinder, J. F. Botha, and D. A. Crerar, "A Theoretical Investigation on the Transport of Chemicals in Reactive Porous Media," *Water Resources Research*, Vol. 18, No. 4 (August, 1982), pp. 1149-1156.
- Gray, W. G., "Some Inadequacies of Finite Element Models as Simulators of Two-Dimensional Circulation," *Advances in Water Resources*, Vol. 5, No. 3 (September, 1982), pp. 171-177.
- Gray, W. G., "Derivation of Vertically Averaged Equations Describing Multiphase Flow in Porous Media," *Water Resources Research*, Vol. 18, No. 6 (December, 1982), pp. 1705-1712.
- Gray, W. G., and J. L. Hoffman, "A Numerical Model Study of Groundwater Contamination from Price's Landfill, New Jersey, I: Data Base and Flow Simulation," *Groundwater*, Vol. 19, No. 1 (January-February, 1983), pp. 7-14.
- Gray, W. G., and J. L. Hoffman, "A Numerical Model Study of Groundwater Contamination from Price's Landfill, New Jersey, II: Sensitivity Analysis and Contaminant Plume Simulation," *Groundwater*, Vol. 19, No. 1 (January-February, 1983), pp. 51-61.

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**Refereed Publications  
(continued)**

- Gray, W. G., and I. P. E. Kinnmark, "QUIET: A Reduced Noise Finite Element Model for Tidal Circulation," *Advances in Engineering Software*, Vol. 5, No. 3 (July, 1983), pp. 130-136.
- Gray, W. G., "General Conservation Equations for Multi-Phase Systems, 4: Constitutive Theory Including Phase Change," *Advances in Water Resources*, Vol. 6, No. 3 (September, 1983), pp. 130-140.
- Gray, W. G., "Local Volume Averaging of Multiphase Systems Using a Non-Constant Averaging Volume," *International Journal for Multi-phase Flow*, Vol. 9, No. 6 (November, 1983), pp. 755-76.
- Nguyen, V. V., G. F. Pinder, W. G. Gray, and J. F. Botha, "Numerical Simulation of Uranium In-Situ Mining," *Chemical Engineering Science*, Vol. 38, No. 11 (November, 1983), pp. 1855-1862.
- Gray, W. G., "Constitutive Theory for Vertically Averaged Equations Describing Steam-Water Flow in Porous Media," *Water Resources Research*, Vol. 19, No. 6 (December, 1983), pp. 1501-1510.
- Gray, W. G., "On Normal Flow Boundary Conditions in Finite Element Codes for Two-Dimensional Shallow Water Flow," *International Journal for Numerical Methods in Fluids*, Vol. 4 (January, 1984), pp. 99-104.
- Kinnmark, I. P. E., and W. G. Gray, "A Two-Dimensional Analysis of the Wave Equation Model for Finite Element Tidal Computations," *International Journal for Numerical Methods in Engineering*, Vol. 20, No. 2 (February, 1984), pp. 369-383.
- Kinnmark, I. P. E., and W. G. Gray, "One Step Integration Methods with Maximum Stability Regions," *Mathematics and Computers in Simulation*, Vol. 26 (June, 1984), pp. 87-92.
- Kinnmark, I. P. E., and W. G. Gray, "One Step Integration Methods of Third-Fourth Order Accuracy with Large Hyperbolic Stability Limits," *Mathematics and Computers in Simulation*, Vol. 26 (July, 1984), pp. 181-188.
- Celia, M.A., and W. G. Gray, "An Improved Isoparametric Transformation for Finite Element Analysis," *International Journal for Numerical Methods in Engineering*, Vol. 20, No. 9 (September, 1984), pp. 1443-1459.
- Kinnmark, I. P. E., and W. G. Gray, "An Exposition of the Distribution Function Used in Proving the Averaging Theorems for Multi-phase Flow," *Advances in Water Resources*, Vol. 7, No. 3 (September, 1984), pp. 113-115.
- Gray, W. G., and L. M. Abriola, "On the Role and Use of an Averaging Volume in Obtaining Equations for Porous Media Flow," *Revista de la Academia Nacional de Ingenieria, Mexico*, Vol. 3, No. 2 (June, 1984), pp. 105-125.
- Soll, W. E., and W. G. Gray, "Proportional Isoparametric Transformations for Quadratic Lagrangian Finite Elements," *Engineering Analysis*, Vol. 2, No. 2 (June, 1985), pp. 61-66.
- Kinnmark, I. P. E., and W. G. Gray, "An Implicit Wave Equation Model for the Shallow Water Equations," *Advances in Water Resources*, Vol. 7, No. 4 (December, 1984), pp. 168-171.
- Kinnmark, I. P. E., and W. G. Gray, "Stability and Accuracy of Spatial Approximations for Wave Equation Tidal Models," *Journal of Computational Physics*, Vol. 60, No. 3 (September, 1985), pp. 447-466.
- Abriola, L. M., and W. G. Gray, "On the Explicit Incorporation of Surface Effects into the Multiphase Mixture Balance Laws," *International Journal for Multi-phase Flow*, Vol. 11, No. 6 (November, 1985) pp. 837-852.
- Kinnmark, I. P. E. and W. G. Gray, "The  $2\Delta x$ -Test: A Tool for Analyzing Spurious Oscillations," *Advances in Water Resources*, Vol. 8, No. 3 (September, 1985), pp. 129-135.

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**Refereed Publications  
(continued)**

- Kinnmark, I. P. E., and W. G. Gray, "Fourth Order Accurate One Step Integration Methods with Large Imaginary Stability Limits," *Numerical Methods for Partial Differential Equations*, Vol. 2, No. 1 (Spring, 1986) pp. 63-70.
- Tompson, A. F. B., and W. G. Gray, "A Second Order Approach for the Modeling of Dispersion Transport in Porous Media: 1. Theoretical Development," *Water Resources Research*, Vol. 22, No. 5 (May, 1986) pp. 591-600.
- Tompson, A. F. B., and W. G. Gray, "A Second Order Approach for the Modeling of Dispersion Transport in Porous Media: 2. Application to Solute Motion in Pipes and Capillary Tubes," *Water Resources Research*, Vol. 22, No. 5 (May, 1986) pp. 601-614.
- Celia, M. A., and W. G. Gray, "Improved Coordinate Transformations for Finite Elements: The Lagrange Cubic Case," *International Journal for Numerical Methods in Engineering*, Vol. 23, No. 8 (August, 1986) pp. 1529-1545.
- Tompson, A. F. B., and W. G. Gray, "A Second Order Approach for the Modeling of Dispersive Transport in Porous Media: 3. Application of Two Porous Media Problems," *Water Resources Research*, Vol. 22, No. 13 (December, 1986) pp. 1959-1972.
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- Ghidaoui, M. S., and W. G. Gray, "A Boltzmann Approach to Shallow Water Flows," in *Computational Methods in Water Resources XV, Volume 2* (edited by C. T. Miller, M. W. Farthing, W. G. Gray, and G. F. Pinder), Elsevier, Amsterdam (2004), pp. 1715-1730.
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**Invited Lectures and  
Addresses**

- “A Comparison of Numerical Solution Techniques for the Convective-Diffusion Equation,” Penrose Conference on Flow Through Porous Media, Aspen, Colorado (September, 1974) 1 lecture.
- “The Finite Element Method in Groundwater Transport,” American Water Resources Association Symposium on Groundwater Hydrology, Chicago, Illinois (September, 1976) 1 lecture.
- “Finite Element Simulation of Tidal Flows,” Department of Chemical Engineering, University of California at Davis (1978) 1 lecture.
- “Numerical Solution Techniques for the Convective-Dispersive Equation,” American Nuclear Society Annual Meeting, Atlanta, Georgia (June, 1979) 1 lecture.
- “The Finite Element Method in the Simulation of Tidal Flows,” Royal Institute of Technology, Stockholm, Sweden (August, 1979) 20 hrs. of Lectures over a two week period.
- “Finite Element Modeling of Tidal Flows,” American Geophysical Union Fall Meeting, San Francisco, California (December, 1980) 1 lecture.
- “Groundwater Contamination Due to Price’s Landfill,” Department of Chemical Engineering, University of California at Davis (December, 1981) 1 lecture.
- “Comparison of Finite Difference and Finite Element Methods,” NATO Advanced Studies Institute on Mechanics of Fluids in Porous Media, Newark, Delaware (June, 1982) one 3 hr. lecture.
- “Groundwater Issues of Price’s Landfill,” Department of Civil Engineering, Duke University (November, 1983) 1 lecture.
- “Averaging of Porous Media Equations,” Courant Institute of Mathematics, New York University (March, 1984) 1 lecture.
- “The Importance of the Interface in Modeling Multi-phase Flow,” AGU Spring Meeting, Cincinnati, Ohio (May, 1984).
- “A Higher Order Model for Dispersion in Porous Media,” AGU Spring Meeting, Baltimore (May, 1985).
- “Implications of Averaging Theory for Groundwater Flow and Transport,” Pacific Northwest Laboratories, Richland, Washington (August, 1985) 1 lecture.
- “Evolution of Two-Dimensional FE Wave Equation Models,” VI International Conference on Finite Elements in Water Resources, Lisbon, Portugal (June, 1986) 1 hr. General lecture.
- “Volume Averaging for Porous Medium Flow” Argonne National Laboratory, Materials and Components Technology Division, Chicago, Illinois (June 1987) 1 hr. lecture.
- “Adaptive Meshes for Finite Element Simulations,” National Institute of Public Health and Environmental Hygiene, Bilthoven, The Netherlands (June, 1987) 1 hr. lecture.
- “Finite Element Surface Flow Simulation,” XXII Congress of the International Association for Hydraulic Research, Lausanne, Switzerland (September, 1987) and coauthored with Ingemar P. E. Kinnmark.
- “Incorporation of Surface Effects into the Multiphase Mixture Balance Laws,” 1987 Society of Engineering Science Meeting, Salt Lake City (September, 1987) coauthored and presented by Linda M. Abriola.
- “A Framework for the Derivation of Multiphase Flow Equations,” Department of Civil Engineering, University of Michigan (November, 1987) 1 hr. lecture.
- “Experience with Finite Element Wave Equation Models,” IAHR Section on Computational Hydraulics Meeting on Refined Modeling of Turbulent Flows in Coastal Waters, Chatou, France (February, 1988).

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**Invited Lectures and  
Addresses (continued)**

- “Finite Element Modeling of Two-Dimensional Tidal Flows,” Department of Civil Engineering, Virginia Polytechnic and State University (March, 1988) 1 hr. lecture.
- “The Development of Finite Element Models for Shallow Water Flow,” Computational Mechanics Institute, Southampton, England (July, 1988) 1 hr. lecture.
- “Averaging Theory for Multiphase Problem Definition,” Lawrence Livermore National Laboratory (August, 1988) 1 hr. lecture.
- “A Framework for the Mathematical Description of Multiphase Processes,” Department of Mathematics, University of Houston (August, 1988), 1 hr. lecture.
- “Introduction to Density-Dependent Solute Transport Modeling,” Expert Meeting on New Developments in Groundwater Modeling, Delft (September, 1988) 30 min. lecture.
- “A Complete Averaging Framework for Multiphase Flow and Transport,” International Workshop on Mathematical Modeling for Flow and Transport Through Porous Media, Irsee, Bavaria (May, 1989) 45 min. lecture.
- “Averaging of Multiphase Flow Equations Including Interfaces,” Department of Chemical Engineering, University of Akron (October, 1989) 1 hr. lecture.
- “Mathematical Description of Porous Media Flow: Averaged Equations, Thermodynamics, and Constitutive Assumptions,” Department of Mathematics, Purdue University (October, 1989) 1 hr. lecture.
- “On the Equations for Multiphase Flow,” Department of Mathematics, University of the German Armed Forces, Neubiberg, Germany (June, 1990) 1.5 hr. lecture.
- “Tidal Modeling by the Finite Element Method,” IBM Scientific Center, Heidelberg, Germany (July, 1990) 1 hr. lecture.
- “Multiphase Flow and the Second Law of Thermodynamics,” Earth Sciences Department, Lawrence Livermore National Laboratory (October, 1990) 1.5 hr. lecture.
- “Infiltration Theory, Averaging, and the Second Law of Thermodynamics,” Joint Seminar of the Departments of Chemical Engineering, Civil Engineering, and Land Air and Water Resources, University of California at Davis (October, 1990) 1 hr. lecture.
- “Finite Element Modeling of Groundwater Contamination,” Department of Mathematics, Carroll College (October, 1990) 1 hr. lecture.
- “On the Equations for Describing Unsaturated Flow,” Department of Hydraulics, Soil Physics, and Hydrology, Agricultural University of Wageningen (November, 1990) 1 hr. lecture.
- “On Multiphase Flow Theory,” Los Alamos National Laboratory (February, 1992) 1 hr. lecture.
- “The Impact of Interfacial Physics on Multiphase Flow Theory,” Institute for Mathematics and its Applications Summer Program on Environmental Studies: Mathematical Computational, and Statistical Analysis, University of Minnesota (July, 1992) 1 hr. lecture.
- “Modeling,” Hazardous Waste Conference, University of Notre Dame Center for Bioengineering and Pollution Control and Miles Inc., University of Notre Dame (September, 1992) 30 min. lecture.
- “Modeling, Muddling, and Meddling: Three Approaches to Scientific Inquiry,” Department of Civil Engineering and Geological Sciences, University of Notre Dame (December, 1992) 1 hr. lecture.

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**Invited Lectures and  
Addresses (continued)**

- “On the Description of Multiphase Systems at the Macroscale,” Conference on Porous Media and the Environment, University of Manitoba (May, 1993) 1 hr. lecture.
- “On the Inclusion of Phase Interfaces in Describing Multiphase Porous Media Flows,” Phoebe Apperson Hearst Distinguished Lecture, Department of Materials Science and Mineral Engineering, University of California, Berkeley (October, 1993) 1 hr. lecture.
- “Theoretical Aspects of the Inclusion of Phase Interfaces in the Description of Multiphase Subsurface Flows,” Dunwalke Workshop on Multiphase Fluid Flow, Princeton University (October, 1993) 2.5 hr. lecture.
- “On Modeling and Measuring Phase Interfaces in Multiphase Subsurface Flows,” Department of Environmental Sciences and Engineering, University of North Carolina at Chapel Hill (April, 1994) 1 hr. lecture.
- “Interfaces and Averaging,” Gordon Research Conference on Modeling of Flow in Permeable Media, Andover, New Hampshire (August, 1994) 1 hr. lecture.
- “Development of Multi-value Time-stepping Algorithms for Surface Water Modeling,” Recent Developments in Finite Element Analysis - A Conference Dedicated to Robert L. Taylor, Stanford, California (September, 1994) 0.5 hr. lecture.
- “Photoluminescent Volumetric Imaging: An Experimental Method for the Visualization of Interface Behavior in Porous Media,” Department of Chemical and Petroleum Engineering, University of Kansas, Lawrence (November, 1994) 1 hr. lecture.
- “A Theoretical Framework for the Study of Multiphase Flow in Porous Media,” Department of Civil Engineering and Surveying, University of Newcastle, Australia (March, 1995) 1 hr. lecture.
- “On the Incorporation of Interphase Physics into Multi-phase Flow Analysis,” CSIRO, Canberra, Australia (March, 1995) 1 hr. lecture.
- “On the Importance of Fluid-fluid Interfaces in Multiphase Subsurface Flows,” CSIRO, Perth, Australia (March, 1995) 1 hr. lecture.
- “Issues Requiring Attention in Modeling Multiphase Porous Media Flow,” Dunwalke Workshop on Flow in Porous Media, Princeton University (April, 1995) 1.5 hr. lecture.
- “The Fluid Mechanics of Multiphase Porous Media Flow,” Matematisk Institutt, Universitetet i Bergen, Norway (July, 1995) 1.5 hr. lecture.
- “Incorporation of Interfacial Areas in Models of Two-Phase Flow,” Kearney Foundation of Soil Science International Conference ‘Vadose Zone Hydrology: Cutting Across Disciplines, University of California at Davis (September, 1995) 45 min. keynote address (with M. A. Celia).
- “The Importance of Interfacial Areas in Infiltration Problems,” Department of Earth Sciences, University of Waterloo, Canada (September, 1995) 1 hr. lecture.
- “Modeling, Muddling, and Meddling: Three Approaches to Scientific Inquiry,” Department of Mathematics and Engineering, Carroll College, Helena, Montana (October, 1995) 1 hr. lecture.
- “Interfacial Areas in Two-Phase Flow,” Department of Mathematics and Engineering, Carroll College, Helena, Montana (October, 1995) 1 hr. lecture.
- “On the Dependence of Constitutive Equations for Two-Phase Flow on Saturation and Interfacial Area,” Workshop on Multiphase Flow in Porous Media Including Interfacial Phenomena, Department of Mathematics, Delft University of Technology, The Netherlands (November, 1995) 45 min. lecture.

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**Invited Lectures and  
Addresses (continued)**

- “Incorporation of Interfacial Areas in a Complete Model of Multi-phase Flow,” Center for Applied Mathematics, Department of Mathematics, Purdue University (December, 1995) 2 hr. lecture.
- “Considerations in the Development of a Complete Theory of the Physics of Unsaturated Flow,” Hydrologic Science Program, Department of Land, Air, and Water Resources, University of California at Davis (January, 1996) 1 hr. lecture.
- “Inclusion of Interfacial Phenomena in Multiphase Porous Media Flow: Theoretical Advances,” Civil Engineering and Environmental Sciences, University of Oklahoma (January, 1996) 1.5 hr. lecture.
- “Inclusion of Interfacial Phenomena in Multiphase Porous Media Flow: Implications for Modeling and Experiments,” Civil Engineering and Environmental Sciences, University of Oklahoma (January, 1996) 1.5 hr. lecture.
- “Modeling, Muddling, and Meddling: Three Approaches to Scientific Inquiry,” Civil Engineering and Environmental Sciences, University of Oklahoma (February, 1996) 1 hr. lecture.
- “The Averaging Approach to Modeling Multiphase Flow,” Department of Mechanical Engineering, University of Toronto (May, 1996) 1 hr. lecture.
- “A Continuum Approach to Describing Multiphase Flow,” Department of Civil Engineering, Mechanics, and Metallurgy, University of Illinois at Chicago (June, 1996) 1 hr. lecture.
- “Averaging Theory for Multiphase Flow,” Department of Civil Engineering, University of Vermont (July, 1996) 1 hr. lecture.
- “The Averaging Approach to Modeling Multiphase Flow,” 31st Polish Solid Mechanics Conference - SolMec’96, Mierki (September, 1996) 1 hr. lecture.
- “A Systematic Approach to Modeling Multiphase Flow in Porous Media,” Department of Environmental Sciences, University of Virginia (November, 1996) 1 hr. lecture.
- “Football and Education: A Multiphase Flow Approach,” Program in Interdisciplinary Research in Contaminant Hydrogeology (PIRCH), University of Virginia (November, 1996) 30 minute lecture.
- “The Challenges of Incorporating Internal Structure into Models of Subsurface Flow and Transport,” Symposium on Advanced Simulation of Subsurface Flow and Contaminant Transport, sponsored by Cray Computing at the North Carolina Supercomputing Center (December, 1996) 30 minute lecture.
- “Theoretical Considerations in the Development of Models of Multiphase Flow in Porous Media,” First Ever Workshop on Porous Media Processes - Linking the Pore and Continuum Scales Through Theory, Direct Modeling, and Direct Experimentation, Los Alamos (April, 1997) 1 hr. lecture.
- “Thermodynamic Considerations in Multiphase Flow,” Fourth SIAM Conference on Mathematical and Computational Issues in the Geosciences, Albuquerque (June, 1997) 30 minute lecture.
- “After Dinner (Fluid) Film Festival,” Dunwalke International Workshop on Multiphase Flow in Porous Media, Princeton University (October, 1997) 1.5 hr. lecture.
- “Framework for Systematic Description of Multiphase Flow Physics,” Department of Geography and Environmental Engineering, The Johns Hopkins University (November, 1997) 1 hr. lecture.
- “Framework for the Systematic Description of the Physics of Multiphase Flow in Porous Media,” Department of Mathematics, University of North Carolina (February, 1998) 2 hr. lecture.



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**Invited Lectures and  
Addresses (continued)**

- “Theoretical Aspects for Consideration of Multiphase Flow in Porous Media,” Geanalysis Group, Los Alamos National Laboratory (May, 1998) 1.5 hr. lecture.
- “Macroscopic and Microscopic Description of Porous Material Flow and Transport,” Centre International des Sciences Mécaniques (CISM), Udine, Italy (July, 1998) 6 hrs. of lectures.
- “Evolving Models of Multiphase Flow with Mass Transfer Implications” Miller, C.T. (presenter), M. Hilpert, V. R. Raghu, W. G. Gray, R. Glantz, and C. T. Kelley, Gordon Research Conference on Modeling of Flow in Permeable Media, Andover, New Hampshire (August, 1998) 1 hr. lecture.
- “On the Derivation of Equations for Single Phase Flow in Porous Media,” Workshop on Nonlinear Flow and Transport Processes in Porous Media, Delft University of Technology, Delft, The Netherlands (November, 1998) 2 hr. lecture.
- “On the Geometric Closure Conditions for Multiphase Flow in Porous Media,” Tutorial Lectures on Nonlinear Flow and Transport Processes in Porous Media, Delft University of Technology, Faculty of Civil Engineering and Geosciences, Delft, The Netherlands (November, 1998) 1 hr. lecture.
- “Incorporation of Interfacial Areas in Models of Two-phase Flow in Porous Media,” Department of Civil Engineering and Structures, Hong Kong University of Science and Technology, Hong Kong (December, 1998) 2.5 hrs. of lectures.
- “The Importance of Interfacial Areas to Multiphase Flows,” Centre for Water Research, University of Western Australia, Nedlands, Australia (February, 1999) 1 hour lecture.
- “On the Incorporation of Interface Physics into the Analysis of Multiphase Flow in Porous Media,” CSIRO Land and Water Seminar Series, Perth Laboratory, Australia (March, 1999) 1 hr. lecture.
- “A Continuum Approach to Multiphase Flow in Porous Media,” Tutorial Lecture Series, Centre for Water Research, University of Western Australia, Nedlands, Australia (February - March, 1999) 5 hrs. of lectures.
- “On Closure of the Flow Equations for Two-Phase Flow in Porous Media,” Workshop on Flow and Transport in Porous Media, organized by Department of Mathematics, University of Bergen, held in Lindas, Norway (June, 1999) 1 hr. lecture.
- “On the Need for a Consistent Approach to Modeling Multiphase Flow in Porous Media,” Matematisk Institutt, Universitetet i Bergen, Norway (June, 1999) 1 hr. lecture.
- “An Extended Description of Two-Phase Flow in Porous Media,” Norsk Hydro, Bergen, Norway (June, 1999) 1 hr. lecture.
- “Elements of Multiphase Flow Dynamics,” Computational and Applied Mathematics Department, Rice University, Houston, TX (April, 2000), 1 hr. lecture.
- “Scaling Issues in Multiphase Flow Modeling,” Department of Mathematics, Texas A&M University, College Station, TX (April, 2000) 1 hr. lecture.
- “On the Exploitation of the Second Law of Thermodynamics in Modeling Multiphase Flow,” Department of Mathematics, University of Colorado, Denver, CO (October, 2000) 1 hr. lecture.
- “On the Definition of Pressure in Multiphase Porous Media Flows,” International Workshop and Tutorial Lectures on Subsurface Flow and Transport Phenomena, GeoDelft, Delft, The Netherlands (October, 2000) 50 minute lecture.
- “On the Employment of Conservation Principles in Environmental Modeling,” Department of Environmental Sciences and Engineering, University of North Carolina, Chapel Hill, NC (November, 2000) 1 hr. lecture.

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**Invited Lectures and  
Addresses (continued)**

- “A Simple View of the Entropy Inequality: The WGG\* vs. the MAC\* Approach,” Workshop on Multiphase Flow, Department of Civil and Environmental Engineering, Princeton University, Princeton, NJ (May, 2001) 30 minute lecture.
- “On the Significance of Interfacial Area in the Equations of Multiphase Flow,” Tompson, A. F. B. T. (presenter), Soll, W. E., and Gray, W. G., SIAM Conference on Mathematical and Computational Issues in the Geosciences, Boulder, CO (June, 2001) 25 minute lecture.
- “What Have We Learned from the Thermodynamically Constrained Averaging Theory Approach,” SIAM Conference on Mathematical and Computational Issues in the Geosciences, Boulder, CO (June, 2001) 60 minute plenary lecture.
- “Interfacial Processes in Multiphase Subsurface Flow and Transport,” 3rd International Symposium on Environmental Hydraulics, Tempe, AZ (December, 2001) 30 minute plenary lecture.
- “Closure of Thermodynamically Constrained Models of Multiphase Flow,” Hilpert, M. (presenter), Miller, C.T., and Gray, W. G., Water Resources Research Institute of the University of North Carolina 2002 Annual Conference (April, 2002) 25 minute lecture.
- “Phase Interfaces in Multiphase Subsurface Flow and Transport,” Department of Civil and Environmental Engineering, Princeton University, Princeton, NJ (January, 2002) 1 hr. lecture.
- “Interphase Processes in Multiphase Subsurface Flow and Transport,” Department of Civil and Environmental Engineering, University of Illinois, Urbana-Champaign, IL (April, 2002) 1 hour lecture.
- “Phenomena and Processes in Multiphase Subsurface Flow and Transport Modeling, First National Scientific Soil Symposium ‘Bodem Diep.’ Zeist, The Netherlands (June, 2002) 45 minute keynote address.
- “Theoretical and Conceptual Considerations in Multiphase Subsurface Flow and Transport,” Department of Environment and Resources, Danish Technical University, Lyngby, Denmark (June, 2002) 1 hour lecture.
- “Multiphase Transport Phenomena in Porous Medium Systems,” International Doctoral Program Environment Water, Universität Stuttgart, Stuttgart, Germany, co-taught with C. T. Miller (October, 2002) 22 hours of lecture.
- “Phase Interface Considerations in Multiphase Subsurface Flow and Transport,” Environnement Naturel, Architectural et Construit, École Polytechnique Fédérale de Lausanne, Lausanne, Switzerland (October, 2002) 1 hr. lecture.
- “Practical Considerations in the Use of Averaging Procedures in Porous Media Flow Studies,” Statistical and Applied Mathematical Sciences Institute Workshop on Multiscale Modeling of Environmental Systems, Research Triangle Park, NC (February, 2003) 90 minute plenary lecture.
- “Theoretical and Conceptual Issues for Accurate Modeling of Multiphase Subsurface Flow and Transport,” Department of Environmental Engineering Sciences, University of Florida, Gainesville, FL (February, 2003) 1 hr. lecture.
- “On the Consistent Description of Multiphase Porous Medium Flow Physics,” Statistical and Applied Mathematical Sciences Institute, Research Triangle Park, NC (March, 2003) 1 hr. SAMSI Distinguished Lecture.
- “On the Thermodynamic Description of Multiphase Flow,” SIAM Conference on Mathematical and Computational Issues in the Geosciences, Austin, Texas (March, 2003) 25 minute minisymposium lecture.
- “On the Governing Equations of Flow in Porous Media,” SAMSI Simulation and Optimization Workshop, Research Triangle Park, NC (April, 2003) 45 minute plenary lecture.

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**Invited Lectures and  
Addresses (continued)**

- “Microscale, Macroscale, and Beyond: Large Scale Implications of Pore Scale Experiments,” Culligan, K. A. (presenter), D. Wildenschild, and W. G. Gray, European Geosciences Union First General Assembly, Nice, France (April, 2004), 30 minute lecture.
- “Modeling Flow in Porous Media: Faith or Science?,” Workshop on Multiphase Flow in Porous Media, Department of Environmental Sciences and Engineering, Princeton University, Princeton, NJ (October, 2004) 45 minute lecture.
- “On the TCAT Approach for Obtaining Multiphase Subsurface Conservation Equations,” Computational Science and Mathematics Research, Sandia National Laboratory, Livermore, CA (June, 2005) 1 hr. lecture.
- “On the Inclusion of the Interfacial Area Between Fluids in Models of Multiphase Porous Media Flows,” Department of Marine, Earth, and Atmospheric Sciences, North Carolina State University, Raleigh, NC (August, 2005) 1 hr. lecture.
- “On the Importance of the Surface Area Between Phases in Multiphase Porous Media Flows,” Department of Mechanics and Physics of Fluids, Polish Academy of Sciences, Warsaw, Poland (June, 2006) 1 hr. lecture.
- “Darcy’s Law, the Capillary Pressure - Saturation Relation, and the Solid Phase Stress Tensor: A Revisitation of the Sacred Cows of Porous Media Flow Theory,” Department of Civil Engineering, University of Vermont (April, 2007) 1 hr. lecture.
- “Darcy’s Law and Its Elements of (In)compatibility with the Capillary Pressure Saturation Relation,” Center for Integrated Petroleum Research (CIPR), University of Bergen, Bergen, Norway (September, 2007) 1 hr. lecture.
- “Short Course on the Thermodynamically Constrained Averaging Theory,” Institute for Water, Universität Stuttgart, Stuttgart, Germany, co-taught with C. T. Miller (March, 2008) 16 hours of lectures.
- “Introduction to Conservation Principles for Environmental Analysis,” Department of Mathematics, University of Bergen, Bergen, Norway (September, 2009) 12 hours of lectures.
- “On the Importance of Model Consistency Across Scales,” Gray W. G. (presenter) and C. T. Miller, International Conference on Computational Methods in Water Resources, Barcelona, Spain, (June, 2010) 1 hr. plenary lecture.
- “The Thermodynamically Constrained Averaging Theory (TCAT) Approach to Obtaining Model Consistency Across Scales in Porous Media Analysis,” Department of Civil Engineering, University of Padova, Padova, Italy (October, 2010) 1 hr. lecture.
- “On the Use of Conservation Principles for Environmental Analysis,” Department of Mathematics, University of Bergen, Bergen, Norway (October, 2010) 12 hours of lectures.
- “Opportunities for Impacting the Trajectory of Hydrologic Model Development,” Langbein Lecture at the Fall Meeting of the American Geophysical Union, San Francisco (December, 2010) 1 hr. lecture.(Available online at: [www.agu.org/meetings/fm10/lectures/videos.php](http://www.agu.org/meetings/fm10/lectures/videos.php)),
- “George Pinder?!!” International Conference on Computational Methods in Water Resources, University of Illinois at Champaign-Urbana (June, 2012) 25 minute lecture.
- “Multiphase Porous Media Flows,” 2014 Gerhard Jirka Summer School sponsored by IAHR, Hong Kong University of Science and Technology (December, 2014) 3 hours of lectures.
- “Physics-based Models of Multiphase Flow in Porous Media,” Department of Civil Engineering, University of Vermont (June, 2015) 1 hour lecture.

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**Invited Lectures and  
Addresses (continued)**

“Multiphase Porous Media Flow and Transport,” ALERT Doctoral School 2015 on Coupled and Multiphysics Phenomena, Aussois, France (October, 2015) 4 hours of lectures.

“Process Modeling in Fluid Mechanics,” Department of Civil Engineering, Hong Kong University of Science and Technology (March, 2016) 18 hours of lectures.

“Elements of Analysis of Porous Media Flows” Department of Civil Engineering, Hong Kong University of Science and Technology (March, 2017) 3 hour lecture.

“Systematic Description of Multiphase Flow in Porous Media,” ALERT Lecture, Annual Meeting of the ALERT Geomaterials Association (October, 2017) 1 hour lecture.

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**Recent Presentations  
with Published Ab-  
stracts**

- “Lattice Boltzmann Simulation of Non-Darcy Flow in Porous Media,” McClure, J. E. (presenter), C. Pan, W. G. Gray, and C. T. Miller, AGU Fall Meeting, San Francisco (December, 2006) 15 minute lecture.
- “Lattice Boltzmann Modeling and Image Analysis for Multiphase Porous Medium Systems,” McClure, J. E. (presenter), A. Sallerson, W. G. Gray, and C. T. Miller, SIAM Conference on Mathematical & Computational Issues in the Geosciences, Santa Fe (March, 2007) 25 minute lecture.
- “Thermodynamically Constrained Averaging Theory Formulation of Two-Phase Flow in Porous Medium Systems,” Sallerson, A. (presenter), W. G. Gray, C. T. Miller, and J. E. McClure, SIAM Conference on Mathematical & Computational Issues in the Geosciences, Santa Fe (March, 2007) 25 minute lecture.
- “Modeling of Two-Fluid-Phase Flow in Porous Medium Using the Thermodynamically Constrained Averaging Theory Approach,” Sallerson, A. (presenter), W. G. Gray, and C. T. Miller, AGU Fall Meeting, San Francisco (December, 2007) poster.
- “Stress Measures in Partially Saturated Porous Media Mechanics,” Schrefler, B. A. (presenter), F. Pesavento, and W. G. Gray, ALERT Workshop 2008, Aussois, France (October, 2008) 30 minute lecture.
- “Dispersion of Dense Brine Solutions in Porous Medium Systems,” Pedit, J. A. (presenter), P. S. Birak, Y. C. Chang, S. E. Gasda, D. J. Wright, W. G. Gray, and C. T. Miller, AGU Fall Meeting, San Francisco (December, 2008) poster.
- “Examining the Influence of Solid Morphology for Non-Darcy Porous Medium Flows,” McClure, J. E. (presenter), W. G. Gray, and C. T. Miller, AGU Fall Meeting, San Francisco (December, 2009) poster.
- “The Impact of Aquifer Cap Rock on Long Term CO<sub>2</sub> Migration,” Herrera, P. (presenter), H. K. Dahle, W. G. Gray, and C. Haug, EGU General Assembly, (April, 2011), 15 minute lecture.
- “Interfacial Area Measurements for Robust Models of Multiphase Flow in Porous Media,” Brown, K. I. (presenter), D. Wildenschild, W. G. Gray, and C. T. Miller, Goldschmidt 2011 (August, 2011) poster.
- “Measuring Interfacial Areas and Curvatures for Three Immiscible Fluid Phases in a Porous Medium,” Brown, K. I. (poster presenter), D. Wildenschild, W. G. Gray, and C. T. Miller, AGU Fall Meeting, San Francisco (December, 2011) poster.
- “Analysis of Capillary Pressure in a Two-fluid-phase Porous Medium System,” Dye, A. L. (presenter), J. E. McClure, L. J. Pyrak-Nolte, D. Adalsteinsson, W. G. Gray, and C. T. Miller, International Conference on Computational Methods in Water Resources, U. of Illinois, Champaign Urbana (June, 2012) 20 minute lecture.
- “3-Phase Flow in Tumor Microenvironment: Constitutive Relationships for the Closure of a General Model,” Sciumè, G., W. G. Gray, P. Decuzzi, and B. A. Schrefler, First NEMB Venice Workshop on Cancer Nanotechnology, Venice, Italy (October 11-12, 2012) poster.
- “Description of Non-Darcy Flow in Anisotropic Porous Media,” McClure, J. E. (presenter), A. L. Dye, C. T. Miller, and W. G. Gray, Abstract H52C-02, AGU Fall Meeting, San Francisco (December, 2012) 20 minute lecture.
- “Pore-scale Analysis of Capillary Pressure at Equilibrium in a Two-fluid-phase Porous Medium System,” Dye, A. L. (presenter) J. E. McClure, E. Schaberg, M. Talley, W. G. Gray, and C. T. Miller, Abstract H51G-1426, AGU Fall Meeting, San Francisco (December, 2012) poster.
- “Capillary Pressure Dynamics in a Two-Fluid-Phase Porous Medium System,” Dye, A. L. (presenter), J. E. McClure, W. G. Gray and C. T. Miller, Abstract H53M-05, AGU Fall Meeting, San Francisco (December, 2013) 20 minute lecture.

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**Recent Presentations  
with Published Ab-  
stracts**

- “Analysis of Capillary Pressure in a Two-Fluid-Phase Porous Medium System Using Micro-model Experiments and Pore-Scale Modeling,” Carter, B., A. L. Dye (presenter), S. C. Hauswirth, J. E. McClure, L. J. Pyrak-Nolte, W. G. Gray, and C. T. Miller, Abstract H42D-06, AGU Fall Meeting, San Francisco (December, 2013) 20 minute lecture.
- “Calibration of a density-dependent TCAT model with the method of lines and implicit filtering,” Giffen, D. H. (presenter), C. T. Kelley, C. T. Miller, W. G. Gray, and P. Schultz, CMWR XIV, Stuttgart, Germany (June 10, 2014).20 minute lecture.
- “Interfacial dynamics in a two-fluid-phase porous medium system,” Dye, A. L. (presenter), J. E. McClure, W. G. Gray, and C. T. Miller, CMWR XIV, Stuttgart, Germany (June 12, 2014) 20 minute lecture.
- “Analysis of capillary pressure in a two-fluid-phase porous medium system using micro-model experiments and pore-scale modeling,” Dye, A. L. (presenter), S. C. Hauswirth, J. E. McClure, L. J. Pyrak-Nolte, W. G. Gray, and C. T. Miller, CMWR XIV, Stuttgart, Germany (June 12, 2014) 20 minute lecture.
- “Simulation of two-phase flow based on a thermodynamically constrained averaging theory flow model,” Weigand, T.(presenter), A. L. Dye, J. E. McClure, W. G. Gray, and C. T. Miller, CMWR XIV, Stuttgart, Germany (June 11, 2014) poster.
- “Pore-Scale Simulation and Analysis of Two-Fluid Flow in Porous Medium Systems,” McClure, J. E. (presenter), A. L. Dye, J. F. Prins, C. T. Miller, and W. G. Gray, Gordon Research Conference on Flow & Transport in Permeable Media, Lewiston, Maine (July 6--11, 2014) poster.
- “Vertically Integrated Models for CO<sub>2</sub> Storage with Coupled Thermal Processes,” Gasda, S. E. (presenter), W. G. Gray, and H. K. Dahle, Abstract H11K-03, AGU Fall Meeting, San Francisco (December, 2014) 20 minute lecture.
- “Simulation of Two-Phase Flow Based on a Thermodynamically Constrained Averaging Theory Flow Model,” Weigand, T.. (presenter), A. L. Dye, J. E. McClure, M. Farthing, W. G. Gray, and C.T. Miller, Abstract H13P-07, AGU Fall Meeting, San Francisco (December, 2014) 20 minute lecture.
- “Two-Dimensional Lattice Boltzmann Scheme for Analyzing Equilibrium States in a Two-Fluid-Phase Porous Medium System,” A. L. Dye. (presenter), J. E. McClure, D. Adalsteinsson, W. G. Gray, and C. T. Miller Abstract H21C-0755A, AGU Fall Meeting, San Francisco (December, 2014) poster.
- “Multiscale Analysis of Two-Fluid-Phase Flow in Porous Media,” C. T. Miller (presenter), A. L. Dye, T. M. Weigand, J. E. McClure, and W. G. Gray, Interpore Conference, Padova, Italy (May, 2015) 25 minute lecture.
- “Integrated Models for Coupled Thermal Processes in CO<sub>2</sub> Injection,” S. E. Gasda (presenter) and W. G. Gray, Interpore Conference, Padova, Italy (May, 2015) 25 minute lecture.
- “Connecting Pore Scale Dynamics to Macroscopic Models for Two-Fluid Phase Flow,” J. E. McClure (presenter), A. L. Dye, C. T. Miller, and W. G. Gray, Abstract H43L-04, AGU Fall Meeting, San Francisco (December, 2015) 15 minute lecture.
- “Development, Application, and Validation of Thermodynamically Constrained Averaging Theory Models of Porous Medium Systems,” C. T. Miller (presenter), W. G. Gray, J. E. McClure, A. L. Dye, T. Weigand, S. Hauswirth, and P. Schultz, Abstract H11J-01, AGU Fall Meeting, San Francisco (December, 2015) 15 minute lecture.

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**Recent Presentations  
with Published Ab-  
stracts**

- “Thermodynamically Constrained Averaging Theory (TCAT) Two-Phase Flow Model: Derivation, Closure, and Simulation Results,” T. Weigand (presenter), C. T. Miller, A. L. Dye, W. G. Gray, J. E. McClure, and I. Rybak Abstract H41D-1347, AGU Fall Meeting, San Francisco (December, 2015) poster.
- “Visualization of Two-Fluid-Phase Flow Dynamics Using Micro-models,” A. L. Dye (presenter), J. E. McClure, W. G. Gray, L. J. Pyrak-Nolte, and C. T. Miller, Abstract H41D-1346, AGU Fall Meeting, San Francisco (December, 2015) poster.
- “A Hierarchy of Thermodynamically Constrained Averaging Theory Models for Two-Fluid-Phase Flow in Porous Medium Systems,” C. T. Miller (presenter) and W. G. Gray, Interpore Conference, Cincinnati, Ohio (May, 2016) 20 minute lecture.
- “Analyzing Two-Fluid-Phase Flow Dynamics Using Micro-models,” A. L. Dye (presenter), J. E. McClure, W. G. Gray, L. J. Pyrak-Nolte, and C. T. Miller, Interpore Conference, Cincinnati, Ohio (May, 2016) poster.
- “Formulation, Evaluation, and Validation of a Thermodynamically Constrained Averaging Theory Model for Two-Fluid-Phase Flow in Porous Media” C. T. Miller (presenter), J. E. McClure, A. L. Dye, and W. G. Gray, Computational Methods in Water Resources 2016, Toronto, Canada (June, 2016) poster.
- “Modeling of Density-Dependent Flow Based on the Thermodynamically Constrained Averaging Theory,” T. M. Weigand (presenter), P. B. Schultz, C. T. Kelley, C. T. Miller, and W. G. Gray, Abstract H13H-1501, AGU Fall Meeting, San Francisco (December, 2016) poster.
- “The Effect of Topology on Two-Fluid Flow in Porous Media,” J. E. McClure (presenter), R. T. Armstrong, M. Rucker, S. Berg, S. Schlüter, C. T. Miller, and W. G. Gray, Abstract H53M-06, AGU Fall Meeting, San Francisco (December, 2016) 15 minute lecture.