

Frank W. Schwartz

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Education

B.Sc. in Geology, Univ. Western Ontario, 1968
M.Sc. in Geology, Univ. Manitoba, 1970
Ph.D. in Geology, Univ. Illinois, 1972

Employment

Professor of Geology, Dept. of Geology, University of Alberta, 1972-1988
Ohio Eminent Scholar, Dept. of Geological Sciences, The Ohio State University, 1988-present

Background

Dr. Frank Schwartz joined The Ohio State University in 1988 as the Ohio Eminent Scholar in Hydrogeology. He was formerly a Professor of Geology at the University of Alberta. Frank is the author of more than 150 publications and is known internationally for his work on field and theoretical aspects of mass transport, contaminant hydrogeology, and ground-water geochemistry. In recognition of his contributions to hydrogeology, he was named as a co-recipient of the prestigious O.E. Meinzer Award in 1984, a co-recipient of the Excellence in Science and Engineering Award in 1991, and the King Hubbert Science Award in 1997. He was elected as a Fellow of the American Geophysical Union in 1992.

In addition to teaching and research, Frank acts as a consultant to government and industry, and in various advisory capacities. He has served on a variety of expert panels of the National Research Council and chaired the committee with reviewing the applicability of contaminant transport models to contemporary problems in hydrogeology. Following is a summary of honours and awards, industrial and government experience, and academic achievements.

Honors and Special Recognition

Distinguished Service Award in Hydrogeology, Geological Society of America, 2005
TD Canada Trust/Walter Bean Visiting Professor in the Environment, University Waterloo, 2005
Halbouty Visiting Chair in Geology and Geophysics, Texas A&M University, March 2003
Farvolden Lecturer, Department of Earth Sciences, University of Waterloo, November 2001
M. King Hubbert Science Award, National Ground Water Association, 1997
Fellow American Geophysical Union, 1992
Editor-in-Chief, Journal of Contaminant Hydrology, 1991-2003
Co-recipient, the Excellence in Science and Engineering Award, National Water Well Association, 1991
Moore Lecturer, University of Virginia, 1991
Oliver Lecturer in Hydrogeology, Univ. of Texas, 1986
Co-recipient O.E. Meinzer Award, Geological Society of America, 1984
John Birdsall Distinguished Lecturer in Hydrogeology, 1983
Graduate Fellow, Univ. of Illinois, 1969-1971
National Research Council of Canada, Postgraduate Fellowship, 1968-1969
Gold Medal in Geology, Univ. Western Ontario, 1968
Board of Governors Award, Univ. Western Ontario, 1967, 1968
Kennecott Copper Minerals Exploration Scholarship, Univ. of Western Ontario, 1967
G. Baines Memorial Award, Univ. Western Ontario, 1967

Professional Affiliations

Fellow, Geological Society of America
Fellow, American Geophysical Union
National Groundwater Association

Service (1989 – present)

Member, Joint Technical Program Committee, Geological Society of America, 1991-1992
1st Vice-Chairman, Hydrogeology Division, Geological Society of America, 1991-1992
Member, National Research Council Committee on Modeling Needs of the US Army, 1992
Chairman, Hydrogeology Division, Geological Society of America, 1992-1993
Member, National Research Council Committee on USGS Water Resources Research, 1992-1995.
Member, Water Science and Technology Board, National Research Council, 1995-1998.
Executive Committee – Consortium on Hydrologic Sciences, 2001-2003.
DOE SECURE Research Initiative Member, LBL and Idaho Nat'l Lab, 2003-present.
National Research Council Panel on Water Resources Research, 2003-2004.

Experience in Hydrogeological Practice

Frank Schwartz provides specialized consultative services in many aspects of ground-water geology. His expertise and practical experience extend to areas of

- peer review and contributions to expert panels
- expert advice in litigation and dispute resolution
- ground-water flow modeling (aquifer evaluation, regional flow, watershed systems, and contaminant transport).
- contaminant hydrogeology (field and experimental investigations, radioactive waste disposal, dispersion, tailings pond seepage evaluations).
- environmental impact analyses and groundwater resource evaluation.
- hydrogeological aspects of energy resources development (coal surface and subsurface mining, petroleum development).
- computer applications (software development, statistical analyses, data management, graphics).
- educational programs

The summary that follows provides an overview of project experience in these areas.

Peer Review and Contributions to Expert Panels

Technical Peer Review of Viscous Liquid Barrier Systems, for Institute for Regulatory Sciences, and DOE

Review of Lawrence Berkeley National Laboratory Geosciences Program, for Director LBNL

Followup Review of the Integrated Safety Management Evaluation at the Brookhaven National Laboratory, for Paragon and DOE-EH.

Review of hydrologic modeling studies at Lake Wabamun, Alberta, for Golder Associates, Calgary

Review of Ground-Water Modeling Studies at Brookhaven National Laboratory, for DOE, Chicago Operations

Review and Comments on Report Concerned with Alcohol Flushing, for Battelle Memorial Institute

Review of Modeling Studies Related to an Oil Refinery Spill, for Squires, Sanders and Dempsey, Columbus

Peer Review of the Thermo-hydrologic modeling and testing program of the Yucca Mountain site; for TRW Environmental Safety Systems, Inc. and DOE

Panel to demonstrate the feasibility of an early site assessment for the Yucca Mountain site in Nevada; for Electric Power Research Instit.

Cross-verification of fracture flow and transport codes, Stripa International Project, Stockholm.

Development and application of an expert system in contaminant hydrogeology; for National Hydrology Research Institute, Ottawa.

Review of Environmental Impact Study of the Regina Refinery, for M.M. Dillon, Winnipeg, Canada

Peer reviewer for U.S. EPA Region 5 land ban petitions for hazardous waste disposal; for EPA Region 5, Chicago.

Peer review group, Argonne National Laboratory; for DOE's Civilian Radioactive Waste Management Program, Argonne.

Performance Assessment Peer Review Panel, Sandia National Laboratory

Review Board on the Milwaukee Water Pollution Abatement Program; for Cook & Franke, Milwaukee.

Expert Advice in Litigation and Dispute Resolution

Brookhaven Ground-Water Panel – Neutral expert in the implementation of a Phase I litigation agreement. Work on this case has involved assessment of hydrogeological studies and identification of individuals impacted by contamination related to oil-field operations.

Metroplex Equipment Co., et al. v. Safety-Kleen -- Hydrogeology expert for Safety-Kleen. Work in this case involved evaluation of consultants reports, and deposition. Case settled out of Court

United States v. Conrail v. Gemeinhardt Co. et al. -- Hydrogeology expert for Gemeinhardt Co. Activities included evaluation of consultants' reports, and preparation of expert report. Case settled out of court.

Warner Brothers v. Travelers Indemnity, et al. -- Hydrogeology expert for Warner Brothers. Activities included evaluation of reports, preparation of trial exhibits, deposition and testimony in court.

Mead Corporation v. United States -- Hydrogeology expert for Mead Corporation. I was involved in a site visit and the preparation of an expert report. Case settled out of court.

Rose Chance v. BP Corporation -- Backup witness for BP. Met with lawyers to provide expert advice as needed.

Scientific Advisor, Illinois Low-level Radioactive Waste Disposal Facility Siting Commission -- Member of Judge Simons' staff to review and resolve issues related to the siting of a low-level waste repository at Martinsville, Illinois. Participated at public hearings and worked in preparing the final commission report, Rudnick & Wolfe, Chicago.

Administrative Hearing concerning waste injection by Aristec Chemicals -- Expert for Ohio EPA. Reviewed consultants reports and presented testimony at a hearing.

Ground Water -Resource Evaluation

Modeling of groundwater systems at Stony Plain, Alberta; study commissioned by the Water Resources Management Division of Alberta Environment, Edmonton, Alberta.

Analysis of the influence of a subsurface drain on groundwater conditions at Grand Centre, Alberta; Study undertaken for Hydrogeological Consultants Ltd., Edmonton, Alberta.

Evaluation of the maximum supply capability of a groundwater infiltration pond at Camrose, Alberta; study undertaken for Stanley Associates Engineering Ltd., Edmonton, Alberta.

Three-dimensional groundwater flow model analysis of pumping from an unconfined aquifer along the South Saskatchewan River, study undertaken for MLM Groundwater Engineering, Edmonton, Alberta.

Evaluation of the groundwater supply and recharge potential at Two Hills, Alberta; study undertaken for Geoscience Consultants Ltd., Edmonton, Alberta.

Evaluation of the feasibility of a river bed infiltration gallery as an industrial groundwater supply source; investigation for Stanley Associates Engineering Ltd, Edmonton, Alberta.

Three-dimensional groundwater flow model analysis for a proposed fish hatchery site in southwestern Alberta; study undertaken for Hydrogeological Consultants Ltd., Edmonton, Alberta.

A computer model study of the potential of utilizing groundwater to supplement the water supply system for the Town of Banff, Alberta; model analysis for Hydrogeological Consultants Ltd., Edmonton, Alberta.

Model study of the operation of a proposed high-rate infiltration system and associated collection wells at Tumbler Ridge, British Columbia; undertaken for Stanley Associates Engineering Ltd., Edmonton, Alberta.

Evaluation of the feasibility of pumping scenarios for the Cardium Sand, Alberta; study for MLM Groundwater Ltd., Edmonton, Alberta and Petro-Canada Ltd.

Environmental Impact Assessment and Contaminant Hydrogeology

Ground Water Modeling and Environmental Impact Analysis of the Nova Chemicals Plant, for Golder Associates

Scenario development and evaluation related to the risk assessment of high level radioactive waste repositories; study undertaken for CGS Inc. and the U.S. Nuclear Regulatory Commission, Urbana, Illinois.

Definition of a reference repository system for risk analysis in the disposal of radioactive wastes; study for CGS Inc., Urbana, Illinois.

Groundwater field investigation of a proposed brine storage pond in Southern Alberta; study undertaken for Golder Associates Ltd., Calgary, Alberta.

Determination of the contribution of groundwater to the hydrologic balance of Ethel Lake, Alberta; field and office study commissioned by the Earth Sciences Division of Alberta Environment, Edmonton, Alberta.

Model study of the impact of gravel extraction on water levels in the Villeneuve aquifer, Alberta; study for MLM Groundwater Engineering Ltd., Edmonton, Alberta.

Model analysis of the Pine Lake, Alberta, watershed; study undertaken for the Alberta Research Council, Edmonton, Alberta.

Model Study of the Contaminant Recovery System Installed at the Uniroyal Chemical Ltd, Clover Bar Plant, Edmonton.

Field and model study of the impact on the groundwater system as a result of the irrigation of part of the Blood Indian Reserve, Alberta; study undertaken for the Planning Division of Alberta Environment, Lethbridge Alberta.

Review of modeling and geochemical reports in conjunction with the Slave River Dam Project, Alberta; study for Stanley Associates Engineering Ltd., Edmonton, Alberta.

Computer-based assessment of the impact of coal strip mining on the hydrology of a small lake; study contracted by MLM Engineering Ltd., Edmonton, Alberta.

Hydrological and chemical model study of the groundwater regime at Wabamun Lake, Alberta; study undertaken for the Pollution Control Division of Alberta Environment, Edmonton, Alberta.

Computer analysis of the factors influencing groundwater flow and mass transport in a system disturbed by strip mining; model analyses for the Alberta Research Council, Edmonton, Alberta.

Hydrogeological Aspects of Energy Resources Development

Evaluation of the potential of groundwater to supplement surface water for cooling of a thermal-electric generating station in southern Saskatchewan; model developed for the Saskatchewan Power Corporation and Stanley Associates Engineering Ltd., Regina, Saskatchewan.

Model analysis of the dewatering requirements for a proposed coal strip mine at Cadomin, Alberta; study commissioned by MLM Groundwater Engineering Ltd., Edmonton, Alberta.

Predictions of the groundwater inflow to a proposed underground coal mine; for MLM Groundwater Engineering, Edmonton, Alberta.

Modeling of a groundwater supply system associated with the Gregg River Coal Mine, Alberta; modeling for MLM Groundwater Engineering, Edmonton, Alberta.

Model study of the impact of a proposed injection well system on groundwater inflow to surface waters; prepared for CDC Oil and Gas Ltd, Calgary Alberta.

A model study of the impact of a proposed coal mine at Genesse, Alberta, on surrounding groundwater levels; study undertaken for Fording Coal Ltd. and Stanley Associates Engineering Ltd., Edmonton, Alberta.

Model analysis of dewatering requirements at the Syncrude mine for several proposed mining schemes; for ESSO Resources Canada Ltd., Calgary, Alberta.

Computer Applications in Hydrogeology

Review of the EPACMOW Modeling Package and Manuals, for HydroGeologic, Inc., Reston, Virginia

Development of a Discrete-Fracture Model Related to Yucca Mountain Conditions, Groundwater Simulations Group, Waterloo Canada

Formulation of a probabilistic - deterministic mass transport model for the study of contaminant transport in regional groundwater systems; computer program and user's guide prepared for CGS Inc. and the U.S. Nuclear Regulatory Commission, Urbana, Illinois.

Preparation of a data management system for handling data from an automatic water well monitoring system; system developed for Hydrogeological Consultants Ltd., Edmonton, Alberta.

Preparation of the computer code and a users' guide for a model to simulate changes to groundwater flow systems and the transport of contaminants from spoil in the vicinity of strip mines; prepared for the Alberta Research Council, Edmonton, Alberta.

Preparation of a self - teaching guide for deterministic and stochastic mass transport models; prepared for CGS. Inc., Urbana, Illinois.

Development and application of an expert system in contaminant hydrogeology; study funded by the Department of Supply and Services, and Environment Canada, Ottawa, Ontario.

Assistance in the operation of a three-dimensional groundwater flow model of the Cold Lake area, Alberta; model reviewed for ESSO Resources Canada Ltd., Calgary, Alberta.

Educational Programs

Principles of Ground Water and Contaminant Hydrogeology, 3-day course, B.P. Oil, Lima OH

Existing and Emerging Technologies in Ground-Water Remediation, 1-day course, AIPG,
Columbus, OH

Contaminant Hydrogeology from Field Investigation to Remedial Design, 5-day course, San
Diego, Reston, Pine Mountain

University Grants and Contracts (1988-present)

Contaminant Transport in Groundwater, Natural Sciences and Engineering Research Council, Period: 1987-90. Principal Investigator: Schwartz

Unstable Mixed Flow in Variable Density Systems, US Department of the Interior, Period: 1990-93, Principal Investigator: Schwartz

In-Situ Remediation of Metal-Contaminated Landfill Materials, US Environmental Protection Agency, Period: 1990-93, Principal Investigators: Logan, Schwartz, Traina

Solute Transport with Convective Instability in Groundwater, National Science Foundation, Period: 1990-93, Principal Investigators: Schwartz and Bair

Co-solvent Processes in Aquifer Remediation, US Department Interior; Period: 1991-93, Principal Investigators: Schwartz and Chin

In Situ Treatment of Metals and Leachates in Ground Water, CECOS/BFI; Period 1994-1996; Principal Investigator: Schwartz

Reactive Contaminant Transport in Variable-Density Flow Systems, US Environmental Protection Agency; 1994-97, Principal Investigator: Schwartz

DOD Environmental Scholarships and Training Program, US Department of Defense; Period: 1994-1997, Principal Investigator: Schwartz

An Experimental Study of Reaction-coupled Flow and Mass Transport in Porous Media, National Science Foundation; 1995-1998, Principal Investigator: Schwartz

Discovering Ohio's Hydrogeology Through Computer-Based Multimedia Programs, Ohio Environmental Education Fund; 1995-1997, Principal Investigators: McKenzie and Schwartz

In-situ destruction of solvents by permanaganate oxidation, U.S. Geological Survey; 1998-2001, Principal Investigator: Schwartz

Anisotropic dispersion and variable-density flow in fractured porous media, National Science Foundation, 1998-2001, Principal Investigators: Schwartz and Ibaraki

Permanganate Treatment of DNAPLs in Reactive Barriers and Source-Zone Flooding Schemes, Department of Energy, 2000-2003, Principal Investigators: Schwartz and Zhang; \$379K.

Methodology for estimating total maximum daily load in watersheds with considerable ground-water surface –water interaction: U.S. Geol. Survey, 2000-2003, Principal Investigators; Schwartz and Hussein; \$94,764 (Federal share).

Semi-passive, chemical oxidation schemes for the long-term treatment of contaminants, Department of Energy, 2002-2005, \$389,000, PI. Schwartz, co-PIs Ibaraki, and Lee.

Effects of hydrologic pulses on the effectiveness of wetlands to control agricultural runoff of nitrogen-Biogeochemical and economic modeling, OARDC, 2002-2004, \$145,223, PI Mitch, co-PI Schwartz.

Importance of hydrologic pulsing on the water quality function of wetlands in Midwestern USA, US Dept. Agriculture, 2004-2006, \$270,000, PI Mitsch, co-PI Schwartz

Climate variability and its impact on hydrology of small mid-continent lakes and wetlands, NSF, 2005-2008, \$375,000, PI Schwartz, co-PIs Shum, Braun

Publications

Books

Domenico, P.A. and F.W. Schwartz, 1990. Physical and Chemical Hydrogeology. John Wiley & Sons, Inc., New York, First Edition, 824 pages.

Domenico, P.A. and F.W. Schwartz, 1998. Physical and Chemical Hydrogeology. John Wiley & Sons, Inc., New York, Second Edition, 506 pages.

F.W. Schwartz, and H. Zhang, 2003. Fundamentals of Ground Water. John Wiley & Sons, Inc., New York, First Edition, 583 pages.

Committee on Ground Water Modeling Assessment, F.W. Schwartz Chairman, 1990. Ground Water Models Scientific and Regulatory Applications. National Academy Press, Washington, D.C., 303 pages.

Smith, L. and F.W. Schwartz, 1993. Solute Transport Through Fracture Networks. in Flow and Contaminant Transport in Fractured Rock, Bear, Tsang, de Marsily eds., Academic Press, 129-167.

Bedient, P.B., F.W. Schwartz, H.S. Rifai, (1993). Hydrologic Design for Groundwater Pollution Control. in Handbook of Hydrology, D.R. Maidment ed., McGraw Hill, 29.1-29.47.

Articles

1. Schwartz, F.W. and P.A. Domenico., 1973. Simulation of hydrochemical patterns in regional groundwater flow. *Water Resources Res.*, 9(3), p. 707-720.
2. Schwartz, F.W. and D.W. Chorley., 1973. Hydrogeologic investigation of the ESTC site, Defense Research Establishment Suffield, Suffield Memorandum, No. 57/73, 23 p.

3. Schwartz, F.W., 1974. The origin of chemical variations in groundwater from a small watershed in Southwestern Ontario. *Can. Jour. Earth Sci.*, 11 (7), p. 893-904.
4. Schwartz, F.W., 1974. Subsurface hydrology at the radioactive waste management site, Defense Research Establishment Suffield - A preliminary description, Suffield Memorandum, No. 56/73, 17 p.
5. Schwartz, F.W., 1974. Hydrogeologic investigation of a radioactive waste management site in Southern Alberta. *Proc. 27th Can. Geotechnical Conf.*, No. 7-9. p. 17-23.
6. Schwartz, F.W., 1975. On radioactive waste management: An analysis of the parameters controlling subsurface contaminant transfer. *Jour. Hydrology*, 27, p. 51-71.
7. Schwartz, F.W., 1975. Hydrogeologic investigation of a waste management site in Southern Alberta. *Can. Geotechnical Jour.*, 12(3), p. 349-361.
8. Schwartz, F.W., 1975. Response testing of piezometers in fractured porous media. *Can. Geotechnical Jour.*, 12(3), p. 408-412.
9. Schwartz, F.W., 1975. A probabilistic mass transfer model, in *Proceedings of the Canadian Hydrology Symposium*, Aug. 1975, p. 407-412.
10. Schwartz, F.W., 1975. Reply to Discussion. *Can. Geotechnical Jour.*, 12(3), p. 446.
11. Schwartz, F.W., 1977. On radioactive waste management: Model analysis of a proposed site. *Jour. Hydrology*, 32, p. 257-277.
12. Schwartz, F.W. and G.L. McClymont, 1977. Applications of surface resistivity methods. *Groundwater*, 15(3), p. 197-202.
13. Schwartz, F.W., 1977. Macroscopic dispersion in porous media: The controlling factors. *Water Resources Res.*, 13 (4), p. 743-752.
14. Schwartz, F.W. and D. Gallup., 1978. Some factors controlling the major ion chemistry of small lakes: Examples from the Prairie Parkland of Canada. *Hydrobiologica*, 58(1), p. 65-81.
15. Schwartz, F.W., 1978. Applications of probabilistic deterministic modeling to problems of mass transfer in groundwater systems, in *Third International Hydrology Symposium*, Ft. Collins, p. 281-296.
16. May, R.W. and F.W. Schwartz, 1978. Evaluating features of lake water balance from water chemistry data. *Proc. 7th Symposium, The Water Studies Institute on Applied Prairie Hydrology*, p. 155-161.
17. Schwartz, F.W. and K. Muehlenbachs, 1979. Isotope and ion geochemistry of groundwaters in the Milk River Aquifer, Alberta. *Water Resources Res.*, 15(2), p. 259-268.
18. Schwartz, F.W. and K. Muehlenbachs, 1979. Geochemistry of groundwaters in the Milk River aquifer, Alberta, in *Proc. National Hydrogeological Conference - IAH*, p. 142-150.
19. May, R.W. and F.W. Schwartz, 1979. Evaluation of geologic controls on the chemistry of groundwaters, in *Proc. National Hydrogeological Conference - IAH*, p. 152-163.
20. Schwartz, F.W., 1979. Interim report on a hydrogeological investigation of the Muskeg River basin, Alberta. *Alberta Oil Sands Environmental Research Program, Report 48*, 104 p.
21. Schwartz, F.W., 1980. Final report on a hydrogeological investigation of the Muskeg River basin. *Alberta Oil Sands Environmental Research Program, Report 87*, 97 p.

22. Smith, L. and F.W. Schwartz., 1980. Mass transport 1: A stochastic analysis of macroscopic dispersion. *Water Resources Res.*, 16(2), p. 303-313.
23. Schwartz, F.W. and F.A. Donath, 1980. Scenario development and evaluation related to the risk assessment of high level radioactive waste repositories. U.S. Nuclear Regulatory Comm., NUREG/CR-1608, 68 p.
24. Schwartz, F.W. and A. Crowe, 1980. A deterministic probabilistic model for contaminant transport. U.S. Nuclear Regulatory Comm., NUREG/CR- 1609, 158 p.
25. Schwartz, F.W., with four panel members, 1980. The report of the ad hoc panel convened by the National Research Council of Canada to review the spill of Polychlorinated Biphenyls at the Federal Pioneer site in Regina, Saskatchewan (Prepared for the Government of Saskatchewan 30 January 1980), National Research Council, NRCC 17586, I-1 to I-12.
26. Roberts, J.R., F.W. Schwartz and J.A. Cherry, 1980. History, Distribution and Surface translocation. National Research Council, NRCC 17586, II-1 to II-31.
27. Schwartz, F.W., J.A. Cherry and J.R. Roberts., 1980. Hydrogeological conditions and contaminant migration, National Research Council, NRCC 17586, III- 1 to III-30.
28. Cherry, J.A., J.R. Roberts and F .W. Schwartz., 1980. Options for remedial actions. National Research Council, NRCC 17586, IV-1 to IV-15.
29. Schwartz, F.W. and K. Muehlenbachs, 1980. Chemical evolution of formation waters in a sedimentary basin. *Proc. 3rd International Symposium on Water-Rock Interaction*, p. 24- 26.
30. Smith, L., and F.W. Schwartz., 1981. Mass Transport 2: Analysis of uncertainty in prediction. *Water Resources Res.*, 17(2), p. 351-369.
31. Crowe, A.S. and F.W. Schwartz., 1981. Simulation of lake-watershed systems: 1) Description and sensitivity analysis of the model. *Journal of Hydrology*, Vol. 52, p. 71-105.
32. Crowe, A.S., and F.W. Schwartz., 1981. Simulation of lake-watershed systems: 2) Application to Baptiste Lake. Alberta, *Journal of Hydrology*, Vol. 52, p. 107-125.
33. Smith, L., and F.W. Schwartz., 1981. Mass Transport 3: Role of hydraulic conductivity data in prediction. *Water Resources Res.*, 17(5), p. 1463-1479.
34. Schwartz, F.W., K. Muehlenbachs and D.W. Chorley., 1981. Flow-system controls of the chemical evolution of groundwater. *Journal of Hydrology*, Vol. 54, p. 225-243.
35. Schwartz, F.W. and L. Smith., 1981. An evaluation of the ability to predict radionuclide transport in groundwater flow systems. *Proc. Materials Research Society, Symposium on the Scientific Basis of Nuclear Waste Management*, Boston, Vol. 3, Plenum Press.
36. Smith, L. and F.W. Schwartz., 1981. The role of hydraulic conductivity data in reducing uncertainty in radionuclide transport modeling. *Proc. Sym. on Uncertainties Associated with the Regulation of the Geologic Disposal of High -Level Radioactive Waste*, Gatlinburg, Tennessee, March 1981, Oak Ridge National Lab.
37. Schwartz, F.W., and W.A. Milne-Home, 1982. Watershed in muskeg terrain: 1. The chemistry of water systems. *Journal of Hydrology*, 57, p. 267-290.

38. Schwartz, F.W. and W.A. Milne-Home., 1982. Watersheds in muskeg terrain 2. Evaluations based on water chemistry. *Journal of Hydrology*, 57, p. 291-305.
39. Schwartz, F.W., and F.A. Donath., 1982. Influence of faulting on groundwater flow and contaminant transport. in *Predictive Geology*, ed. G. de Marsily and D.F. Merriam, Pergamon Press, p. 117-136.
40. Tang, D.H., F.W. Schwartz and L. Smith., 1982. Stochastic modeling of mass transport in a random velocity field. *Water Resources Res.*, 18(2), p. 231-244.
41. Schwartz, F.W., A.S. Crowe and S.R. Moran., 1982. Model studies of the impact of mining on groundwater flow systems. in *Proc. Second National Hydrogeological Conference*, Winnipeg, p. 69-80.
42. Crowe, A.S. and F.W. Schwartz., 1982. Responses of regional flow systems to changing hydrogeological conditions. in *Proc. Second National Hydrogeological Conference*, Winnipeg, p. 35-47.
43. Schwartz, F.W., L. Smith and A.S. Crowe., 1982. Stochastic analysis of groundwater flow and contaminant transport in a fractured rock system. *Proc. Material Research Soc., Sym. on the Scientific Basis of Nuclear Waste Management*, Vol. 4, Plenum Press.
44. Roberts, J.R., J.A. Cherry and F.W. Schwartz., 1982. A case study of a chemical spill: Polychlorinated Biphenyls (PCB's) 1. History, distribution and translocation, *Water Resources Res.*, 18(3), p. 525-534.
45. Schwartz, F.W., J.A. Cherry and J.R. Roberts., 1982. A case study of a chemical spill: Polychlorinated Biphenyls (PCB's) 2. Hydrogeological conditions and contaminant migration. *Water Resources Res.*, 18(3), p. 535-545.
46. Chorley, D.W., F.W. Schwartz and A.S. Crowe., 1982. Inventory and potential application of groundwater flow and chemistry models. *Research Management Division, Alberta Environment, RMD 82/7*, 73 p.
47. Hendry, M.J. and F.W. Schwartz., 1982. Hydrogeology of saline seeps, in *First Annual Western Provincial Conference on Rationalization of Water and Soil Research and Management*, p. 25-40.
48. Schwartz, F.W., L. Smith and A.S. Crowe., 1982. A theoretical analysis of mass transport in fractured media. *Proc. of an International Conference on Radioactive Waste Management*, Winnipeg, p. 636-640.
49. Smith, L. and F.W. Schwartz., 1983. Megascopic controls on radionuclide transport in groundwater flow systems. *Proc. Materials Res. Society Symposium on the Scientific Basis of Nuclear Waste Management*, Vol. 5, Elsevier, p. 355-362.
50. Schwartz, F.W., L. Smith and A.S. Crowe., 1983. A stochastic analysis of macroscopic dispersion in fractured media. *Water Resources Research*, 19(5), p. 1253-1265.
51. Schwartz, F.W. and L. Smith., 1983. Reply to Discussion. *Water Resources Research*, 19(4), p. 1053- 1054.
52. Schwartz, F.W. and A.S. Crowe., 1984. Simulation of changes in groundwater levels associated with strip mining. *Bulletin Geological Soc. of America*, Vol. 96, p. 253-262.
53. Smith, L. and F.W. Schwartz., 1984. An analysis of the influence of fracture geometry on mass transport in fractured media. *Water Resources Research*, 20(9), p. 1241-1252.
54. Smith, L., and F.W. Schwartz., 1984. Macroscopic dispersion in a fractured rock mass. *Proc. International Groundwater Symposium on Groundwater Resources Utilization and Contaminant Hydrogeology*. ed., R. Pearson, International Assoc. of Hydrogeologists, May 1984, Montreal, p. 539-548.
55. Schwartz, F.W. and L. Smith., 1984. Reply to Discussion. *Water Resources Research*, 20(3), p. 411.

56. Schwartz, F.W., 1984. Modeling of groundwater flow and composition. Proc. First Canadian American Conference on Hydrogeology, ed., B. Hitchon and E .I. Wallick, Banff, p. 178-188.
57. Crowe, A.S. and F.W. Schwartz., 1985. Application of a lake-watershed model for the determination of water balance. J. of Hydrology, 81, p. 1-26.
58. Schwartz, F.W. and L. Smith., 1985. A new continuum approach for modeling dispersion in fractured media. Proc. of Conference of Hydrogeology of Rocks of Low Permeability, ed. N. Buras, S. Neuman, E .S. Simpson, Tucson, p. 538-546.
59. Smith, L., C.W. Mase, F.W. Schwartz and D. Chorley., 1985. Dispersion in three dimensional fracture networks. Proc. of Conference on Hydrogeology of Rocks of Low Permeability, ed. N. Buras, S .Neuman, E.S. Simpson, p. 666-675.
60. Smith, L., C.W. Mase and F.W. Schwartz, 1985. A stochastic model for transport in networks of planar fractures, in Proceedings Symposium on the Stochastic Approach to Subsurface Flow, ed., G. de Marsily, Montvillargenne, p. 523-536.
61. Schwartz, F.W., G.W. McClymont, and L. Smith, 1985. On the role of mass transport modeling. Proc. Second Canadian/American Conference on Hydrogeology, National Water Well Association, Banff, p. 2-12.
62. Schwartz, F.W., and L. Smith, 1987. Stochastic modeling of dispersion in fractured rock. in Advances in Transport Phenomena in Porous Media, ed. J. Bear and M.Y. Corapciouglu, NATO ASI Series, Martinus Nijhoff, p. 727-750.
63. Schwartz, F.W., A.S. Crowe, M.J. Hendry, and D .W. Chorley, 1987. A case study to assess the potential for saline soil development due to irrigation. Journal of Hydrology, 91, p. 1-27.
64. Schwartz, F.W. and A.S. Crowe, 1986. Model study of some factors influencing the resaturation of spoil following mining and reclamation. Journal of Hydrology 92, p. 121-147.
65. Smith, L., C.W. Mase, and F.W. Schwartz, 1987. Estimation of fracture aperture using hydraulic and tracer tests. Proc. 28th U.S. Symposium on Rock Mechanics, ed. I.W. Farmer et al., Tucson, p. 453-463.
66. Smith, L., F.W. Schwartz, and C.W. Mase, 1988. Application of stochastic methods for the simulation of solute transport in discrete and continuum models of fractured rock systems. Proc. DOE/AECL Symposium on Geostatistical Sensitivity and Uncertainty Methods for Groundwater Flow and Radionuclide Transport Modeling, ed. B. Buxton, Battelle Press, p. 425-440.
67. Schwartz, F.W. and L. Smith, 1988. A continuum approach for modeling mass transport in fractured media. Water Resour. Research, 24(8), p. 1360-1372.
68. Schwartz, F.W., 1988. Contaminant hydrogeology-dollars and sense. J. of Hydrology, 100, p. 453-470.
69. Hendry, M.J., and F.W. Schwartz, 1988. An alternative view on the origin of chemical and isotopic patterns in groundwater from the Milk River aquifer. Water Resour. Research, 24(10), p. 1747-1764.
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