Classical Papers in Hydrogeology
Featuring papers from the GSA Meinzer Award

GEOL 5200
2 Credits
Fall, 2009

Dept. of Geology & Geophysics
University of Wyoming
Instructor: Ye Zhang

Grading: S/U

Location: TBA (a room with PowerPoint projection)
Time: TBA (1:40 block time)
Office hour: M (4:00~5:30 pm), F (3:00~4:30 pm), GE 220
Email: yzhang9@uwyo.edu
Phone: 307-766-2981

Overview:
Hydrogeology studies the movement of underground water, transport of dissolved solutes in water, transfer of heat, and geochemical reactions taking place in the subsurface geological media. It emerges from an early engineering root (development of water resources) to become, in recent decades, a full-fledged environmental, engineering and geological science. The mathematical and physical principles of hydrogeology are intimately linked to other fields, e.g., soil physics, petroleum and agricultural engineering, where flow, transport, and reaction through porous media play a fundamental role. In this seminar, a series of classical papers published in the hydrogeology literature in the last five decades is presented to provide an overview of the field throughout the latter half of the 20th century. In addition to the physical and chemical studies in traditional aquifers, representative papers from well hydraulics, groundwater contamination, groundwater/surface water interaction, sedimentary basin hydrogeology, and the more recent, "stochastic revolution", will be presented. In light of this body of work, we'll also discuss important new ideas in hydrogeology and future research directions.

Note: due to time constraint, not all important hydrogeological topics can be discussed, e.g., flow and transport in fractured media, reactive transport, flow in low permeability environment, hydrogeophysics, inverse methods in parameter estimation, groundwater management, policy and law are not covered.

The Meinzer Award:
With some exceptions, most of the papers are authored or co-authored by a Meinzer Awardee (http://gsahydrodiv.unl.edu/OEMeinzer.htm). The Meinzer Award is given annually by the Hydrogeology Division of the Geological Society of America in recognition of an outstanding paper or collection of papers published within the previous five years. The award is named after Oscar E. Meinzer who is generally regarded as the "father of hydrogeology" in North America.

Prerequisite:
GEOL4444/5444 Geohydrology
Or an equivalent intro-level groundwater hydrology course

Note: this class is a graduate-level seminar providing a forum for in-depth discussions on important research topics, thus each student should already be familiar with the basic hydrogeological concepts, parameters and approaches.

Course Web Page:
A course website will be used (via Wyoweb) where the papers and relevant materials will be posted. Many are pdf files, though the earlier Water Resources Research papers exist as scanned images bundled into a zip file. Several USGS papers are in DjVu format. Please install the DjVu viewer on your computer (http://pubs.er.usgs.gov/usgspubs/wsp/wsp1800).

Course requirements:
Students are expected to attend the lectures, complete the assigned literature readings, and develop their presentations independently.

Attendance Policy:
Each student is expected to attend the class to fulfill the above requirements. For participation in a University-sponsored activity or for unusual circumstances (personal hardship), an authorized absence may be issued to the student by the Director of Student Life or the Director's authorized representative. This proof of absence must be presented to the instructor.

Exam, Grade, Grade of Incomplete
In place of a final exam, this seminar will adopt a final class presentation of a research topic or a research project chosen by each individual student. The class grade will be based on the student's attendance and classroom participation throughout the semester as well as the final presentation performance.

Grade of incomplete:
During the semester, if a student has suffered severe problems (e.g., physical or mental incapacitation) and cannot complete the course as a result, he/she may be issued an "I" (incomplete) grade. The UW policy on how to make up for this grade is:
http://uwadmnweb.uwyo.edu/legal/Uniregs/ur720.htm

Academic dishonesty:
As defined by UW, academic dishonesty is:
An act attempted or performed which misrepresents one's involvement in an academic task in any way, or permits another student to misrepresent the latter's involvement in an academic task by assisting the misrepresentation.

UW has a time-tested procedure to judge such cases, and serious penalties may be assessed. Please refer to UW Regulation 6-802 for details:
http://www.uwyo.edu/generalcounselsupport/clean%20uw%20regulations/UW%20Reg%206-802.pdf

So, do not cheat and do not help others cheat! In this class, if a student is caught cheating, he or she will not only lose the full point of the assignment/test, but may also be assigned a "F" for the course. Plagiarism is considered a form of cheating. Both students will lose the full points on the particular homework or lab assignments. However, when writing papers, a student may cite other's work, but proper attribution must be given.

Students with disability:
Please refer to the University Disability Support Service: http://uwadmnweb.uwyo.edu/UDSS/

Disclaimer:
The syllabus is subject to changes as deemed necessary by the instructor. If a significant change were to be made, all students will be informed of it and given appropriate reasons for such a change.

Course Calendar:

To allow in-depth discussions of each topic, in a given class, a single topic based on one or a series of related papers will be presented by one student. A rotation scheme is then used throughout the semester so everyone has a chance to give talks on the topics of his/her interest.

Week 1 **Aug 26** **Aug 28**	Review of syllabus. Class organization. Pointers on (1) prepare a good PowerPoint; (2) critically analyze each topic and relevant papers. Students select preferred topics. * Student A prepares for Week-2 talk.		
	Topic	**Presenter**	**Papers**
Week 2 **Sep 2** **Sep 4**	Groundwater resources in the USA	Student A	McGuinness (1963) (p1-119 only)
Week 3 **Sep 9** **Sep 11**	Regional flow analysis	Student B	Toth (1962), (1963) OR Freeze & Witherspoon (1966), (1967), (1968)
Week 4 **Sep 16** **Sep 18**	Multiphase flows in the unsaturated zone	Student C	Stallman (1964)
Week 5 **Sep 23** **Sep 25**	Well hydraulics	Student D	Theis (1935), Hantush & Jacob (1955), Neuman (1975)
Week 6 **Sep 30** **Oct 2**	Groundwater chemistry OR geochemical modeling	Student E	Back & Handsaw (1970) OR Plummer et al (1990)
Week 7 **Oct 7** **Oct 9**	No Class (GSA Annual Meeting)	-	-
Week 8 **Oct 14** **Oct 16**	Groundwater chemistry & isotopes	Student A	Winograd and Robertson (1982), Winograd et al (1983), Phillips (1995) (supplemental review)
Week 9 **Oct 21** **Oct 23**	Sedimentary Basin Hydrogeology	Student B	Bethke et al (1988), Bethke et al (1999) OR Garven et al (1993)
Week 10 **Oct 28** **Oct 30**	Groundwater-Surface Water Interaction	Student C	Freeze (1972)a, (1972)b OR Anderson & Cheng (1993), Cheng & Anderson (1994) OR Winter et al (1998), Winter (2000)
Week 11 **Nov 4**	Groundwater Contamination	Student D	Nelson (1978)a, (1978)b, (1978)c, (1978)d OR MacFarlane et al (1983), Cherry et al (1983), Egboka et al (1983), Sudicky et al (1983)

Nov 6			
Week 12 **Nov 11** **Nov 13**	Heterogeneity (Stochastic Hydrogeology)	Student E	Schwartz & Smith (1980), (1981)a, (1981)b, Tang et al (1982) OR Wagner and Gorelick (1989), Tiedeman and Gorelick (1993)
Week 13 **Nov 18** **Nov 20**	Heterogeneity (Parameter Estimation)	Ye Zhang	Zhang et al (2005), (2006), (2007), Zhang & Gable (2008)
Week 14 **Nov 25** **Nov 27**	Topics of Interest	Final presentation	Papers or research project of interest (Student A, B) ***Thanksgiving: No class on Thursday***
Week 15 **Dec 2** **Dec 4**	Topics of Interest	Final presentation	Papers or research project of interest (Student C, D, E)

*The topic selection for the whole semester is done on Day One, so each student has ample time to study up on the topic(s) of his/her interest ahead of time.

Concerning Presentations
Seven points are emphasized:

(1) Each normal presentation should be ~1 hour and 10 minutes to allow 30 minutes for questions and discussions. The final class presentation is 40 minutes to allow 10 minutes for questions and discussions.

(2) The presenter is expected to study the relevant paper(s) carefully, as in-depth discussions around each topic will be carried out. The other students are also expected to read the paper(s): classroom participation is judged based on the quality of the questions each student asks.

(3) Be professional in presenting the talk. Make it well organized, clear, and logical. It is important to give attribution to the proper literature sources.

(4) Nobody is an expert on everything! As we discuss each topic, a list of unresolved questions that transpire during this discussion will be compiled by the instructor. It will be handed out to all students periodically. If we have time/interest, we'll then do research, consult experts, and generally try to resolve these questions (it is likely that new researches have already addressed some of these questions).

(5) For certain topics (i.e., chemistry) for which the instructor has minimal expertise, we may invite an outside expert to participate in the class.

(6) The instructor will provide general guidelines on (a) how to give a professional PowerPoint presentation; (b) how to critically analyze each topic and the relevant papers. These guidelines will be posted on the course website.

(7) To clip images from the electronic files (pdf, jpeg, or DjVu), try downloading and installing the free software: MWSnap. Before you clip any image, zoom in a good deal. This usually results in better resolution in the image which is then pasted into the Powerpoint file (in MWSnap, after clipping, go to *Edit*, then *Copy*).

Bibliography:
Ordered around each topic

Groundwater Resources of the USA
McGuinness C L (1963) The role of ground water in the national water situation, *USGS Water-Supply Paper* 1800.

Regional Flow Analysis
Toth J (1962) A theory of groundwater motion in small drainage basins in central Alberta, *Journal of Geophysical Research*, vol. 67, n. 11, p. 4375-4387.

Toth J (1963) A theoretical analysis of groundwater flow in small drainage basins, *Journal of Geophysical Research*, vol. 68, n. 16, p. 4795-4812.

Freeze R A and P A Witherspoon (1966) Theoretical analysis of regional groundwater flow: analytical and numerical solutions to the mathematical model, *Water Resources Research*, vol. 2, n. 4, p. 641-656.
Freeze R A and P A Witherspoon (1967) Theoretical analysis of regional groundwater flow: effect of water-table configuration and subsurface permeability variation, *Water Resources Research*, vol. 3, p. 623-634.

Freeze R A and P A Witherspoon (1968) Theoretical analysis of regional groundwater flow: quantitative interpretations, *Water Resources Research*, vol. 4, p. 581-590.

Multiphase Flows in the Unsaturated Zone
Stallman R W (1964) Multiphase fluids in porous media – a review of theories pertinent to hydrologic studies, *USGS Professional Paper* 411-E.

Well Hydraulics

Theis C V (1935) The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using groundwater storage, *Transactions of the American Geophysical Union*, vol. 2, p. 519-524.

Hantush M S and C E Jacob (1955) Non-steady radial flow in an infinite leaky aquifer, *Transactions of the American Geophysical Union*, vol. 36, p. 95-100.

Neuman S P (1975) Analysis of pumping test data from anisotropic unconfined aquifers considering delayed gravity response, *Water Resources Research*, vol. 11, p. 329-342.

Groundwater Chemistry OR Geochemical Modeling
Back W and B B Hanshaw (1970) Comparison of chemical hydrogeology of the carbonate peninsulas of Florida and Yucatan, *Journal of Hydrology*, Vol. 10, p. 330-368.

Plummer L N, J F Busby, R W Lee and B B Hanshaw (1990) Geochemical modeling of the Madison aquifer in parts of Montana, Wyoming, and South Dakota, *Water Resources Research*, vol. 26, p. 1981-2014.

Groundwater Chemistry & Isotopes
Winograd I Jand F N Robertson (1982) Deep oxygenated ground water: anomaly or common occurrence, *Nature*, vol. 216, p. 1227-1230.

Winograd I J, B J Szabo, T B Coplen, A C Riggs and P T Kolesar (1983) Two-million-year record of deuterium depletion in Great Basin ground waters, *Nature*, vol. 227, p. 519-522.

Phillips F M (1995) the use of isotopes and environmental tracers in subsurface hydrology, *Review of Geophysics*, vol. 33 (supplement), p. 1029-1033.

Sedimentary Basin Hydrogeology
Bethke C M, W J Harrison, C Upson and S P Altaner (1988) Supercomputer analysis of sedimentary basin, *Nature*, vol. 239, p. 261-267.

Bethke C M, X Zhao and T Torgersen (1999) Groundwater flow and the ^{4}He distribution in the Great Artesian Basin of Australia, *Journal of Geophysical Research*, vol. 104, p.12,999–13,011.

Garven G, S Ge, M A Person, D A Sverjensky (1993) Genesis of stratabound ore deposits in the midcontinent basins of North America. 1. The role of regional groundwater flow, *American Journal of Science*, vol. 293, p. 497-568.

Groundwater-Surface Water Interaction
Freeze A R (1972)a Role of subsurface flow in generating surface runoff, 1, base flow contributions to channel flow, *Water Resources Research*, vol. 8, p. 609-623.

Freeze A R (1972)b Role of subsurface flow in generating surface runoff, 2, upstream source areas, *Water Resources Research*, vol. 8, p. 1272-1283.

Anderson M P and X Cheng (1993) Long- and short-term transience in a groundwater/lake system in Wisconsin, USA, *Journal of Hydrology*, vol. 145, p. 1-18.

Cheng X and M P Anderson (1994) Simulating the influence of lake position on groundwater fluxes, *Water Resources Research*, vol. 30, p. 2041-2049.

Winter T C, J W Harvey, O L Franke and W M Alley (1998) Ground water and surface water – A single resource, *USGS Circular* 1139, p. 88.

Winter T C (2000) The vulnerability of wetlands to climate change: a hydrologic landscape perspective, *Journal of the American Water Resources Association*, vol. 36, p. 305-311.

Groundwater Contamination
Nelson W R (1978)a Evaluating the environmental consequences of ground-water contamination, 1, An overview of contaminant arrival distributions as general evaluation requirements, *Water Resources Research*, vol. 14, p. 409-415.

Nelson W R (1978)b Evaluating the environmental consequences of ground-water contamination, 2, Obtaining location/arrival time and location/outflow quantity distributions for steady flow systems, *Water Resources Research*, vol. 14, p. 416-428.

Nelson W R (1978)c Evaluating the environmental consequences of ground-water contamination, 3, Obtaining contaminant arrival distributions for steady flow in heterogeneous systems, *Water Resources Research*, vol. 14, p. 429-440.

Nelson W R (1978)d Evaluating the environmental consequences of ground-water contamination, 4, Obtaining and utilizing contaminant arrival distributions in transient flow systems, *Water Resources Research*, vol. 14, p. 441-450.

MacFarlane D S, Cherry J A, Gillham R W, and E A Sudicky (1983), Migration of contaminants in groundwater at a landfill: a case study, 1, Groundwater flow and plume delineation, *Journal of Hydrology*, vol. 63, p. 1-29.

Cherry J A , Gillham R W, Anderson E G, and P E Johnson (1983), Migration of contaminants in groundwater at a landfill: a case study, 2, Groundwater monitoring devices, *Journal of Hydrology*, v. 63, p. 31-49.

Egboka B C E, Cherry, J A, Farvolden R N, and E O Frind (1983), Migration of contaminants in groundwater at a landfill: a case study, 3, Tritium as an indicator of dispersion and recharge, *Journal of Hydrology*, v. 63, p. 51-80.

Sudicky E A, Cherry J A, and E O Frind (1983) Migration of contaminants in groundwater at a landfill: a case study, 4, A natural-gradient dispersion test, *Journal of Hydrology*, v. 63, p. 81-108.

Heterogeneity (Stochastic Hydrogeology)

Schwartz F W and Smith L J (1980) Mass transport, 1, A stochastic analysis of macroscopic dispersion, *Water Resources Research*, vol. 16, p. 303-313.

Schwartz F W and Smith L J (1981)a Mass transport, 2, Analysis of uncertainty in prediction, *Water Resources Research*, vol. 17, p. 351-369.

Schwartz F W and Smith L J (1981)b Mass transport, 3, Role of hydraulic conductivity data in prediction, *Water Resources Research*, vol. 17, p. 1463-1479.

Tang D H, Schwartz F W, and Smith L J (1982) Stochastic modeling of mass transport in a random velocity field, *Water Resources Research*, vol. 18, p. 231-244.

Wagner B J and Gorelick S M (1989) Reliable aquifer remediation in the presence of spatially variable hydraulic conductivity: From data to design, *Water Resources Research*, vol. 25, p. 2211-2225.

Tiedeman C and Gorelick S M (1993) Analysis of uncertainty in optimal groundwater contaminant capture design, *Water Resources Research*, vol. 29, p. 2139-2153.

Heterogeneity (Parameter Estimation)

Zhang Y, M Person, C Paola, C W Gable, X-H Wen, J M Davis (2005) Geostatistical Analysis of an Experimental Stratigraphy, vol. 41, W11416, *Water Resources Research*, doi:10.1029/2004WR003756

Zhang Y, C W Gable, M Person (2006) Equivalent hydraulic conductivity of an experimental stratigraphy: Implications for basin-scale flow simulations, *Water Resources Research*, vol. 42, W05404, doi:10.1029/2005WR004720.

Zhang Y, M Person and C W Gable (2007) Representative Hydraulic Conductivity of Hydrogeologic Units: Insights from an Experimental Stratigraphy, *Journal of Hydrology*, vol. 339, p. 65-78, doi: 10.1016/j.jhydrol.2007.03.007.

Zhang Y and C W Gable (2008) Two-scale modeling of solute transport in an experimental stratigraphy, *Journal of Hydrology*, vol. 348, p. 395-411.

A complete listing of Meinzer award winner and the classic papers:

Year	1965
Winner	Tóth, József
Paper	Tóth, József, 1963, A theoretical analysis of groundwater flow in small drainage basins: Journal of Geophysical Research, v. 68, no. 16, p. 4795-4812.

Year	1966
Winner	McGuinness, C. L.
Paper	McGuinness, C. L., 1963, The role of groundwater in the national water situation: U.S. Geological Survey Water-Supply Paper 1800, 1121 p.

Year	1967
Winner	Stallman, Robert W.
Paper	Stallman, Robert W., 1964, Multiphase fluids in porous media - a review of theories pertinent to hydrologic studies: U.S. Geological Survey Professional Paper 411, p. E1-E51.

Year	1968
Winner	Hantush, Madhi S.
Paper	Hantush, Madhi S., 1964, Hydraulics of wells, in Advances in Hydroscience, V. T. Chow (ed.): New York, Academic Press, v. 1, p. 281-432.

Year	1969
Winner	Cooper, Hilton H., Jr.
Paper	Cooper, Hilton H., Jr., 1966, The equation of ground-water flow in fixed and deforming coordinates: Journal of Geophysical Research, v. 71, no. 20, p. 4785-4790.

Year	1970
Winner	Stringfield, Victor T.
Paper	Stringfield, Victor T., 1966, Artesian water in Tertiary limestone in the southeastern states: U.S. Geological Survey Professional Paper 517, 226 p.

Year	1971
Winner	Maxey, George B.
Paper	Maxey, George B., 1968, Hydrogeology of desert basins: Ground Water, v. 6, no. 5, p. 10-22.

Year	1972
Winner	Poland, Joseph F. and Davis, George H.
Paper	Poland, Joseph F. and Davis, George H., 1969, Land subsidence due to withdrawal of fluids: Geological Society of America, Reviews in Engineering Geology, v. 2, p. 187-269.

Year	1973
Winner	Back, William and Hanshaw, Bruce B.
Paper	Back, William and Hanshaw, Bruce B., 1970, Comparison of chemical hydrogeology of the Carbonate Peninsulas of Florida and Yucatan: Journal of Hydrology, v. 10, no. 4, p. 330- 368.

Year	1974
Winner	Freeze, R. Allen
Paper	Freeze, R. Allen, 1972, Role of subsurface flow in generating surface runoff, 1, base flow contributions to channel flow: Water Resources Research v. 8, no. 3, p. 609-623.
Paper	Freeze, R. Allen, 1972, Role of subsurface flow in generating surface runoff, 2, upstream source areas: Water Resources Research v. 8, no. 5, p. 1272-1283.
Year	1975
Winner	Bredehoeft, John D. and Pinder, George F.
Paper	Bredehoeft, John D. and Pinder, George F., 1973, Mass transport in flowing groundwater: Water Resources Research, v. 9, no. 1, p. 194-210.

Year	1976
Winner	Neuman, Shlomo P. and Witherspoon, Paul A.
Paper	Neuman, Shlomo P. and Witherspoon, Paul A., 1972, Field determination of the hydraulic properties of leaky multiple aquifer systems: Water Resources Research, v. 8, no. 5, p. 1284-1298.

Year	1977
Winner	Rubin, Jacob and James, Ronald V.
Paper	Rubin, Jacob and James, Ronald V., 1973, Dispersion-affected transport of reacting solutes in saturated porous media; galerkin method applied to equilibrium-controlled exchange in unidirectional steady water flow: Water Resources Research, v. 9, no. 5, p.

	1332-1356.

Year	1978
Winner	Nelson, William R.
Paper	Nelson, William R., 1978, Evaluating the environmental consequences of ground-water contamination, 1, An overview of contaminant arrival distributions as general evaluation requirements: Water Resources Research, v. 14, no. 3, p. 409-415.
Paper	Nelson, William R., 1978, Evaluating the environmental consequences of ground-water contamination, 2, Obtaining location/arrival time and location/outflow quantity distributions for steady flow systems: Water Resources Research, v. 14, no. 3, p. 416-428.
Paper	Nelson, William R., 1978, Evaluating the environmental consequences of ground-water contamination, 3, Obtaining contaminant arrival distributions for steady flow in heterogeneous systems: Water Resources Research, v. 14, no. 3, p. 429-440.
Paper	Nelson, William R., 1978, Evaluating the environmental consequences of ground-water contamination, 4, Obtaining and utilizing contaminant arrival distributions in transient flow systems: Water Resources Research, v. 14, no. 3, p. 441-450.

Year	1979
Winner	Sharp, John. M., Jr., and Domenico, P. A.
Paper	Sharp, John. M., Jr., and P. A. Domenico, 1976, Energy transport in thick sequences of compacting sediment: Geological Society of America Bulletin, v. 87, no. 3, p. 390-400.

Year	1980
Winner	Cooley, Richard. L.
Paper	Cooley, Richard. L., 1977, A method of estimating parameters and assessing reliability for models of steady state groundwater flow, 1, Theory and numerical properties: Water Resources Research, v. 13, no. 2, p. 318-324.

Year	1981
Winner	Bennett, Gordon D.
Paper	Bennett, Gordon D., 1976, Introduction to ground-water hydraulics, a programmed text for self-instruction: U.S. Geological Survey, Techniques of Water-Resources Investigations, Book 3, Chapter B2, 172 p.

Year	1983
Winner	Weeks, Edwin P.
Paper	Weeks, Edward. P., 1978, Field determination of vertical permeability to air in the unsaturated zone: U.S. Geological Survey, Professional Paper 1051, 41 p.

Year	1984
Winner	Schwartz, Franklin W. and Smith, Leslie. J.
Paper	Schwartz, Franklin W. and Smith, Leslie. J., 1980, Mass transport, 1, A stochastic analysis of macroscopic dispersion: Water Resources Research v. 16, no. 2, p. 303-313.

Paper	Schwartz, Franklin W. and Smith, Leslie. J., 1981, Mass transport, 2, Analysis of uncertainty in prediction: Water Resources Research v. 17, no. 2, p. 351-369.
Paper	Schwartz, Franklin W. and Smith, Leslie. J., 1981, Mass transport, 3, Role of hydraulic conductivity data in prediction: Water Resources Research v. 17, no. 5, p. 1463-1479.
Paper	Tang, D. H., Schwartz, Franklin W., and Smith, Leslie. J., 1982, Stochastic modeling of mass transport in a random velocity field: Water Resources Research v. 18, no. 2, p. 231-244.
Paper	Schwartz, Franklin W., Smith, Leslie. J., and A. S. Crowe, 1983, A stochastic analysis of macroscopic dispersion in fractured media: Water Resources Research v. 19, no. 5, p. 1253-1265.
Year	1985
Winner	Cherry, John A.
Paper	Cherry, John A., Gillham, R.W., and Sudicky, E. A., 1983, Migration of contaminants in groundwater at a landfill: a case study, 1, Groundwater flow and plume delineation: Journal of Hydrology, v. 63, no. 1/2, p. 1-29.
Paper	Cherry, John A. , Gillham, R.W., Anderson, E. G., and Johnson, P. E., 1983, Migration of contaminants in groundwater at a landfill: a case study, 2, Groundwater monitoring devices: Journal of Hydrology, v. 63, no. 1/2, p. 31-49.
Paper	Egboka, B. C. E., Cherry, John A., Farvolden, R. N., and Frind, E. O., 1983, Migration of contaminants in groundwater at a landfill: a case study, 3, Tritium as an indicator of dispersion and recharge: Journal of Hydrology, v. 63, no. 1/2, p. 51-80.
Paper	Sudicky, E. A., Cherry, John A., and E. O. Frind, 1983, Migration of contaminants in groundwater at a landfill: a case study, 4, A natural-gradient dispersion test: Journal of Hydrology, v. 63, no. 1/2, p. 81-108.
Paper	Nicholson, R. V., Cherry, John A., and Reardon, E. J., 1983, Migration of contaminants in groundwater at a landfill: a case study, 6, Hydrogeochemistry: Journal of Hydrology, v. 63, no. 1/2, p. 136-176.

Year	1986
Winner	Narasimhan, T. N.
Paper	Narasimhan, T. N., 1982, Multidimensional numerical simulation of fluid flow in fractured porous media: Water Resources Research, v. 18, no. 4, p. 1235-1247.

Year	1987
Winner	Gelhar, Lynn W.
Paper	Gelhar, Lynn W., 1986, Stochastic subsurface hydrology from theory to application, in Trends and directions in hydrology, Burges, S. J. (ed.): Water Resources Research v. 22, no. 9, p. 135s-145s.
Paper	Gelhar, Lynn W., 1983, Stochastic analysis of flow in heterogeneous porous media, in Fundamentals of transportation phenomena in porous media, Jacob Bear and M. Y. Corotcioglu (eds.): Dordrecht, The Netherlands, Martinus Nijhoff Publishers, p. 673-720.
Paper	Gelhar, Lynn W., and Axness, C. L., 1983, Three-dimensional stochastic analysis of macrodispersion in aquifers: Water Resources Research v. 19, no. 1, p. 161-180.

Year	1988
Winner	Winograd, Isaac J.

Paper	Winograd, Isaac J., 1986, Archeology and public perception of a transscientific problem - disposal of toxic wastes in the unsaturated zone: U.S. Geological Survey Circular 990, 9 p.
Paper	Winograd, Isaac J., Szabo, B. J., Coplen, T. B. Riggs, A. C. and Kolesar, P. T. 1985, Two- million-year record of deuterium depletion in Great Basin ground waters: Science v. 227, no. 4686, p. 519-522.
Paper	Winograd, Isaac J. and Robertson, F. N., 1982, Deep oxygenated ground water: anomaly or common occurrence: Science v. 216, no. 4551, p. 1227-1230.
Paper	Winograd, Isaac J., 1981, Radioactive waste disposal in thick unsaturated zones: Science v. 212, no. 4502, p. 1457-1464.

Year	1989
Winner	Davis, Stanley N.
Paper	Davis, Stanley N., Campbell, D., Bentley, H. W., and Flynn, T., 1985, Ground water tracers: Worthington, Ohio, National Water Well Association Press, 200 p.
Paper	Davis, Stanley N., and Murphy, E., 1987, Dating ground water and the evaluation of repositories for radioactive waste: U.S. Nuclear Regulatory Commission, Report no. NUREG/CR-4912, 181 p.

Year	1990
Winner	Hem, John D.
Paper	Hem, John D., 1985, Study and interpretation of the chemical characteristics of natural water: U.S. Geological Survey Water-Supply Paper 1473, 269 p., (also 1959 and 1970 editions).

Year	1991
Winner	Neuzil, Christopher E.
Paper	Neuzil, Christopher E., 1986, Ground water flow in low-permeability environments: Water Resources Research, v. 22,p. 1163-1195.

Year	1992
Winner	Bethke, Craig M.
Paper	Bethke, Craig M., 1989, Modeling subsurface flow in sedimentary basins: Geologische Rundschau, v. 78, no. 1,p. 129-154.
Paper	Bethke, Craig M., Harrison, W. J., Upson, C., and Altaner, S. P., 1988, Supercomputer analysis of sedimentary basins: Science, v. 239, p. 261-267.

Year	1993
Winner	Plummer, L. Niel
Paper	Plummer, L. Niel, Busby, J. F., Lee, R. W., and Hanshaw, B. B., 1990, Geochemical modeling of the Madison aquifer in parts of Montana, Wyoming, and South Dakota: Water Resources Research v. 26, no. 9, p. 1981-2014.
Paper	Buesenberg, E., and Plummer, L. N., 1992, Use of chlorofluorocarbons (CCl3F2 CCL2 F2) as hydrologic tracers and age-dating tools: The alluvium and terrace system of central Oklahoma: Water Resources Research v. 28, no. 9, p. 2257-2283.

Year	1994
Winner	Gorelick, Steven M.
Paper	Wagner, B.J., and Gorelick, S.M., 1989, Reliable aquifer remediation in the presence of spatially variable hydraulic conductivity: From data to design, Water Resources Research, v. 25, no. 10, p. 2211-2225.
Paper	Gailey, R.M., and Gorelick, S.M., 1993, Design of optimal reliable plume capture systems: Application to the Gloucester landfill groundwater contamination problem, Ground Water, v. 31, no. 1, p. 107-114.
Paper	Tiedeman, C. and Gorelick, S.M., 1993, Analysis of uncertainty in optimal groundwater contaminant capture design, Water Resources Research, no. 29, no. 7, p. 2139-2153.

Year	1995
Winner	Garven, Grant
Paper	Garven, Grant, Ge, S., Person, M. A., and Sverjensky, D. A., 1993, Genesis of stratabound ore deposits in the Midcontinent basins of North America: 1. The role of regional groundwater flow: American Journal of Science, v. 293, p. 497-568.
Paper	Ge, S., and Garven, G., 1992, Hydromechanical modeling of tectonically driven groundwater flow with application to the Arkoma foreland basin: Journal of Geophysical Research, v. 97, p. 9119-9144.
Paper	Person, M., and Garven, G., 1994, A sensitivity study of the driving forces on fluid flow during continental-rift basin evolution: Geological Society of America Bulletin, v. 106, p. 461-475.

Year	1996
Winner	Wilson, John L.
Paper	Wilson, J. L., Wan, Jiamin, and Wilson, J. L., 1994, Visualization of the role of the gas-water interface on the fate and transport of colloids in porous media: Water Resources Research, v. 30, no. 1, p. 11-23.
Paper	Wilson, J. L., 1993, Induced infiltration in aquifers with ambient flow: Water Resources Research, v. 29, no. 10, p. 3503-3512.
Paper	Soll, W. E., and Wilson, J. L., 1993, Micromodel studies of three- fluid porous media systems: pore-scale processes relating to capillary pressure saturation relationships: Water Resources Research, v. 29, no. 9, p. 2963-2974.
Paper	Conrad, S. H., Wilson, J. L., Mason, W. R., and Peplinski, W. J., 1992, Visualization of residual organic liquid trapped in aquifers: Water Resources Research, v. 28, no. 2, p. 467-478.

Year	1997
Winner	Konikow, Leonard F.
Paper	Konikow, L.F., Goode, D.J. and Hornberger, G.Z., 1996, A three-dimensional method-of-characteristics solute-transport model (MOC3D): U.S. Geological Survey Water-Resources Investigation Report 96-4267, 87 p.
Paper	Konikow, L.F., 1995, The value of postaudits in ground water model applications, in El-Dadi (ed.) Groundwater models for resource analysis and management: Boca Raton, Florida, CRC-Lewis Publisher, p.59-78.

Paper	Konikow, L.F., and Bredehoeft, J.D., 1992, Ground-water models cannot be validated: Advances in Water Resources, v. 15, p.75-83.

Year	1998
Winner	Anderson, Mary P.
Paper	Webb,E.K. and M.P. Anderson, 1996, Simulation of preferential flow in three dimensional, heterogeneous fields with realistic internal structure, Water Resources Research, vol. 32, no. 3, pp. 533-545.
Paper	Anderson, M.P. and X. Cheng, 1993, Long- and short-term transience in a groundwater/lake system in Wisconsin, USA, Journal of Hydrology, vol. 145, pp. 1-18.
Paper	Cheng, X. and M.P. Anderson, 1994, Simulating the influence of lake position on groundwater fluxes, Water Resources Research, vol. 30, no. 7, pp. 2041-2049.
Paper	Hunt, R.J., D.P. Krabbenhoft, and M.P. Anderson, 1996, Groundwater inflow measurements in wetlands systems, Water Resources Research, vol. 32, no. 3, pp. 495-507.

Year	1999
Winner	Sudicky, Edward A.
Paper	Burr, D.T., Sudicky, E.A. and Naff, R.L., 1994, Nonreactive and reactive solute transport in three-dimensional heterogeneous porous media: Mean displacement, plume spreading, and uncertainty. Water Resources Research, 30(3):791-815.
Paper	Ibaraki, M. and Sudicky, E.A., 1995, Colloid-facilitated contaminant transport in discretely fractured porous media, 1. Numerical formulation and sensitivity analysis. Water Resources Research, 31(12):2945-2960.
Paper	Therrien, R. and Sudicky, E.A., 1996, Three-dimensional analysis of variably-saturated flow and transport in discretely-fractured porous media: Model development and illustrative examples. Journal of Contaminant Hydrology, 23(1-2):1-44.

Year	2000
Winner	Chapelle, Francis H.
Paper	Chapelle, F.H., McMahon, P.B., Dubrovsky, N.M., Fuji, R.F., Oaksford, E.T., and Vroblesky, D.A., 1995, Deducing the distribution of terminal electron-accepting processes in hydrologically diverse groundwater systems: Water Resources Research, 31(2): 359-371.
Paper	Lovley, D.R., and Chapelle, F.H., 1995, Deep subsurface microbial processes: Reviews in Geophysics, 33(3): 365-381.
Paper	Chapelle, F.H., Bradley, P.M., Lovley, D.R., and Vroblesky, D.A., 1996, Measuring rates of biodegradation in a contaminated aquifer using field and laboratory methods: Ground Water, 34(4): 691-698.
Paper	Bradley, P.M., Chapelle, F.H., and Wilson, J.T., 1998, Field and laboratory evidence for intrinsic biodegradation of vinyl chloride contamination in a Fe(III)-reducing aquifer: Journal of Contaminant Hydrology, 31: 111-127.

Year	2001
Winner	Philips, Fred M.
Paper	Phillips, , F.M., 1995, The Use of Isotopes and Environmental Tracers in Subsurface

	Hydrology: Rev. Geophys. 30 1029-1033 (Supplement, July 1995, U.S. Nat. Rept. To Int. Union Geod. Geophys. 1991-1994).
Paper	Phillips, F.M., 1998, Groundwater Dating and Isotope Chemistry, In" Hydrologic Sciences; Taking Stock and Looking Ahead. National Academy Press, Washington, D.C., United States, 87-100.
Paper	Plummer, M.A., F.M. Phillips, J.T. Fabryka-Martin, H.J. Turin, P.E. Wigand and P. Sharma, 1997, Chlorine-36 in Fossil Rat Urin; An Archive of Cosmogenic Nuclide Deposition During the Past 40,000 Years, Science 277, No. 5325 (19970725): 538-541.
Paper	Phillips, F.M., D.B. Rogers, S.J. Dreiss, N.O. Jannik and D. Elmore, 1995, Chlorine 36 in Great Basin Waters; Revisited, Special Section; Shirley J. Dreiss Memorial, Water Resources Research, 31, No. 12 (199512); 3195-3204.
Paper	Wolvoord, M.A., P. Pegram, F.M. Phillips, M. Person, T.L. Kieft, J.K. Fredrickson, J.P. McKinley and J.B. Svenson, 1999, Groundwater Flow and Geochemistry in the Southeastern San Juan Basin; Implications for Microbial Transport and Activity. Water Resources Research, 35, No. 5 (199905); 1409-1424.

Year	2002
Winner	Winter, Thomas C.
Paper	Winter, T.C., Harvey, J.C., Franke, O.L., and Alley, W.M., 1998. Ground water and surface water, a single resource: U.S. Geological Survey Circular 1139, 79p.
Paper	Winter, T.C., 1999. Relation of streams, lakes, and wetlands to groundwater flow systems. Hydrogeology Journal 7 (1): 28-45.
Paper	Winter, T.C., 2000. The vulnerability of wetlands to climate change: a hydrologic landscape perspective: Journal of the American Water Resources Association 36 (2): 305-311.
Paper	Winter, T.C., 2001. The concept of hydrologic landscapes. Journal of the American Water Resources Association 37 (2): 335-349.

Year	2003
Winner	Ingebritsen, Steven E.
Paper	Hayba, D.O., and Ingebritsen, S.E., 1997, Multiphase groundwater flow near cooling plutons: Journal of Geophysical Research, v. 102, p. 12,235-12,252.
Paper	Ingebritsen, S.E., and Jones, D.R., 1999, Santa Clara Valley, California A case of arrested subsidence in Galloway, D. L., Jones, D. R., and Ingebritsen, S. E., eds., Land subsidence in the United States: U.S. Geological Survey Circular 1182, p. 15-22.
Paper	Ingebritsen, S.E., and Manning, C.E., 1999, Geological implications of a permeability-depth curve for the continental crust: Geology, v. 27, p. 1,107-1,110.
Paper	Ingebritsen, S.E., and Manning, C.E., 2002, Diffuse fluid flux through orogenic belts: Implications for the world ocean: Proceedings of the National Academy of Sciences, USA, v. 99, p. 9,113-9,116.
Paper	Ingebritsen S.E., and Sanford, W.E., 1998, Groundwater in Geologic Processes: New York, Cambridge University Press, 341 p.
Paper	Manning, C.E., and Ingebritsen, S.E., 1999, Permeability of the continental crust: Implications of geothermal data and metamorphic systems: Reviews of Geophysics, v. 37, 127-150.

Year	2004

Winner	de Marsily, Ghislain
Paper	Matheron, G. and Ghislain de Marsily, 1980, Is transport in porous media always diffusive? A counter example, Water Resources Research, Vol. 16, Issue 5, p. 901-917
Paper	De Marsily, Ghislain, 1986, Quantitative Hydrogeology, Academic Press, New York, New York, 440 p.

Year	2005
Winner	Siegel, Donald I.
Paper	Siegel, D.I. and Mandle, R.J., 1984, Isotopic evidence for glacial meltwater recharge to the Cambrian-Ordovician aquifer, north central United States, Quaternary Research, vol. 22, p. 328-335.
Paper	Siegel, D.I., 1990, Sulfur isotopic evidence for regional recharge of saline water during continental glaciation, north-central United States, Geology, vol. 18, p. 1054-1056.
Paper	Siegel, D.I., 1983, Groundwater and the evolution of patterned mires, Glacial Lake Agassiz Peatlands, Northern Minnesota: Journal of Ecology, vol. 71, p. 913-921.
Paper	Siegel, D.I., and Glaser, P.H., 1987, Groundwater flow in a bog-fen complex, Lost River Peatland, Northern Minnesota, Journal of Ecology, vol. 75, p. 743-754.
Paper	Siegel, D.I., Reeve, A., Glaser, P.H. and E. Romanowicz, 1995, Climate-driven flushing of pore water from humified peat: geochemical and ecological ramifications, Nature, vol. 374, p. 531-533.

	2006
Winner	Pruess, Karsten
Paper	Pruess, K., J.S.Y. Wang, and Y.W. Tsang. On Thermohydrological Conditions Near High-Level Nuclear Wastes Emplaced in Partially Saturated Fractured Tuff. Part 1. Simulation Studies With Explicit Consideration of Fracture Effects, Water Resources. Res., 26(6), 1235-1248, 1990.
Paper	Pruess, K. The TOUGH Codes-A Family of Simulation Tools for Multiphase Flow and Transport Processes in Permeable Media, Vadose Zone J., 3,738-746,2004.