John Robert Nimmo *Curriculum vitae 2 April 2013*

United States Geological Survey

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Professional Position

Research Physicist, National Research Program, United States Geological Survey, 1981-present
Since 1988: Chief, Unsaturated-Zone Flow Project
Since 2003: GS-15
Since 2011: Lead Scientist, Unsaturated Flow Processes

Academic Degrees

University of Redlands:	
Physics	B.S. 6/75
Mathematics	B.S. 6/75
University of Wisconsin-Madison:	
Physics	M.S. 12/76
Physics (major) /Soil Science (minor)	Ph.D. 6/83

Honors and Awards

Summa cum laude at graduation (B.S.) 6/1975
USDI Monetary award for achievement 11/1986
USGS Monetary award for achievement 12/1989, 9/1998, 12/1999, 11/2012
Certificate of Achievement in Recognition of Environmental Efforts 4/1990
Guest Professorship, China University of Geosciences 10/2004
AGU Research Spotlight 4/2012

Membership

American Geophysical Union (AGU), 1984-present, life member.
Geological Society of America (GSA), 1999-present, member.
International Association of Hydrogeologists (IAH), 2002-present, member.
International Union of Soil Science (IUSS), 1996-present, member.
Sigma Xi, 1980-present, life member.
Soil Science Society of America (SSSA), 1978-present, member.
Unsaturated-Zone Interest Group (UZIG), 1988-present, member.

Research

Preferential flow in the unsaturated zone. The source-responsive preferential flow (SRPF) model (Nimmo, 2007; 2010) is the most recent subject in a series of papers—early ones emphasizing generalizations based on the collective set of observations, and later papers

presenting physical theory and practical predictive models. This model is based largely in findings of (1) remarkably little variation in preferential transport rates across diverse scales, media, and moisture conditions; (2) strong dependence on the presence or absence of a water source (rainfall, irrigation, etc.); and (3) the importance of film-flow, as a supplement to capillary-tube and general diffusive concepts, derived largely from experimental and theoretical developments with Grace Su and others since the late 1990s. The SRPF fits numerous observations of preferential flow that goes faster and farther than accepted theory (Darcy-Buckingham law, Richards' equation) can predict with reasonable hydraulic property values, and fits nonclassical phenomena such as nonsequential wetting with soil depth. The SRPF approach has been added by Rick Healy to the VS2DT code to model the preferential component of flow. Incorporation into the RZQWM and MODFLOW models are in their initial stages.

Aquifer recharge and related fluxes. Advanced estimation and understanding of recharge through concurrent development and interpretive application of multiple methods, with additional synthesis through comparison of widely diverse settings. Numerous successful recharge studies in the Palouse region of WA, the Middle Rio Grande Basin, NM, the Snake River Plain, ID, the WE-38 Watershed, PA, the North China Plain, the Mojave Basin, CA, and multiple other sites.

Soil-plant-water relations. Using measured infiltration, geophysical techniques, and soil moisture probes in the Mojave Desert, showed that greater pedologic development led to greater root zone retention as opposed to recharge (Nimmo et al., 2009). The associated pronounced enhancement of structural complexity is of crucial importance to individual plant species and their relationships. Demonstrated the effective role of plants in a tropical dryland reforestation project in alteration of soil hydraulic properties in ways beneficial to the health and survival of those plants (Perkins et al., 2012).

Hydraulic properties of unsaturated media. Developed, from beginning (Nimmo et al., 1987) to advanced stages, the steady-state centrifuge (SSC) method for characterization of properties and sites. Developed theory and models for quantitative representation of unsaturated hydraulic properties (e.g. Rossi and Nimmo, 1994), and for predicting those properties from more easily-measured ones (e.g. Nimmo et al., 2007).

Temperature effects on soil-water processes. Made critical measurements and used them to develop the now widely-used Gain-factor model for systematically predicting and correcting for the influence of temperature variations (Nimmo and Miller, 1986).

Historical research. Expanded knowledge and interest in the history of soil physics with several journal articles (e.g. Nimmo and Landa, 2005) and presentations, including an invited talk at the 2006 AGU symposium commemorating Edgar Buckingham.

Teaching

Short courses and workshops at the USGS National Training Center on various topics of unsaturated flow, numerous times since 1995.

Invited short courses and lecture series in Perugia, Italy in 1993 and 1994; Wuhan, China in 2002 and 2004 (Guest Professorship); Bari, Italy in 2005; and Copenhagen, Denmark in

2010 (International Research School in Water Resources at the University of Copenhagen, 5-day course "New Understanding of Water Flow in the Unsaturated Zone").

> The main subject of these courses has been state-of-the-art theory and techniques for unsaturated flow processes. Essentially all teaching has been for hydrogeologists and geologists with limited knowledge of soil science and soil physics. A central element has been to advance awareness, knowledge, and understanding of the crucial and often-neglected role of soils in hydrologic applications. An overriding emphasis in these courses has been to develop the students' ability to approach problems of water-soil interaction with a deeply-based physical intuition, and to keep the physical situation constantly in mind while working mathematics.

Leadership

Coordinated multi-project and multi-disciplinary research collaborations, for example at the Idaho National Laboratory, the Mojave National Preserve, farmlands of the Mississippi Delta, and various projects of the USGS groundwater resources and water-quality programs.

Symposium steering committees, editorial boards, and other committees for AGU, SSSA, IAHR, and other organizations. Organized and led various special sessions for AGU, GSA, and SSSA.

Leader of the Unsaturated-Zone Interest Group (UZIG), which includes about 400 members, most of them USGS personnel. Organizer, often in the primary leadership role, for 8 nationwide UZIG meetings over more than 20 years. Main organizer and editor of a special section highlighting USGS and UZIG research in the May 2009 issue of Vadose Zone Journal.

Service

SSSA Subcommittee for revision of *Glossary of Soil Science*, 1994-1996.
Associate Editor, Soil Science Society of America Journal, 2000-2002.
Guest Editor, *Vadose Zone Journal*, 2007-2009.
AGU Unsaturated Zone Committee, 2000-present.
Chair of the Unsaturated-Zone Interest Group (UZIG, about 500 members), 1999-2012.
Organizer for 8 nationwide UZIG meetings over more than 20 years. Organizer and editor of UZIG special section in *Vadose Zone Journal*, May 2009.
Task-group leader in DOE review of subsurface actinide migration (detection, processes, and modeling) at the INL from 1998 to 2005.

Review panelist for other organizations, in particular Lawrence Livermore National Laboratory, Battelle Pacific Northwest Laboratories, Idaho National Laboratory (INL, 1993, 1996), Environmental Protection Agency, U.S. Department of Energy, CRS4 and CNR in Italy (1994, 2005), NSF Science and Technology; also various universities and private companies.

Frequently sought for consultation by USGS researchers and by the greater scientific community on a wide variety of soil-moisture and unsaturated flow effects, for example

evaluation of soil-water potential to evaluate habitat requirements of plants and amphibians, distortion of fault-creep measurements in swelling soils, and subsurface water dynamics interpreted from cross-hole tomography and ground-penetrating radar. Frequent reviewer of papers for major journals and other publication outlets.

Published Papers and Professional Contributions

Nimmo, J.R., 1975, Proton total reaction cross sections for calcium 40 between 20 and 50 MEV: University of Redlands, B.S. honors thesis, 47 p.

Carlson, R.F., Cox, A.J., Nimmo, J.R., Davison, N.E., Elbakr, S.A., Horton, J.L., Houdayer, A., Sourkes, A.M., van Oers, W.T.H., and Margaziotis, D.J., 1975, Proton total reaction cross sections for the doubly magic nuclei O-16, Ca-40, and Pb-208 in the energy range 20-50 MeV: Physical Review C, v. 12, no. 4, p. 1167-1175.

Nimmo, J.R., Miller, E.E., and Gardner, W.R., 1980, Dynamic systems for measuring soil-moisture characteristics at various temperatures: Wisconsin Water Resources Center Technical Report no. 80-11, 33 p.

Nimmo, J.R., 1983, The temperature dependence of soil-moisture characteristics: University of Wisconsin-Madison, Dissertation Abstracts no. 83-17041, Ph.D. thesis, 144 p.

Nimmo, J.R., and Miller, E.E., 1986, The temperature dependence of isothermal moisture-vs.-potential characteristic of soils: Soil Science Society of America Journal, v. 50, no. 5, p. 1105-1113.

Nimmo, J.R., Rubin, J., and Hammermeister, D.P., 1987, Unsaturated flow in a centrifugal field--Measurement of hydraulic conductivity and testing of Darcy's law: Water Resources Research, v. 23, no. 1, p. 124-134.

Rubin, J., Hammermeister, D.P., and Nimmo, J.R., 1987, Method and apparatus for steady-state measurement of liquid conductivity in porous media, U.S. Patent no. 4679422, 12 p.

Nimmo, J.R., and Akstin, K.C., 1988, Hydraulic conductivity of a sandy soil at low water content after compaction by various methods: Soil Science Society of America Journal, v. 52, no. 2, p. 303-310.

Nimmo, J.R., 1990, Experimental testing of transient unsaturated flow theory at low water content in a centrifugal field: Water Resources Research, v. 26, no. 9, p. 1951-1960.

Nimmo, J.R., 1991, Comment on the treatment of residual water content in "A consistent set of parametric models for the two-phase flow of immiscible fluids in the subsurface" by L. Luckner et al.: Water Resources Research, v. 27, p. 661-662.

Nimmo, J.R., and Mello, K.A., 1991, Centrifugal techniques for measuring saturated hydraulic conductivity: Water Resources Research, v. 27, no. 6, p. 1263-1269.

Nimmo, J.R., Stonestrom, D.A., and Rubin, J., 1991, Water flux in the unsaturated zone of deserts, *in* Trask, N.J., and Stevens, P.R., eds., U.S. Geological Survey research in radioactive waste disposal--fiscal years 1986-1990: U.S. Geological Survey Water Resources Investigations Report 91-4084, p. 73-77.

Nimmo, J.R., 1992, Semiempirical model of soil water hysteresis: Soil Science Society of America Journal, v. 56, no. 6, p. 1723-1730.

Nimmo, J.R., Akstin, K.C., and Mello, K.A., 1992, Improved apparatus for measuring hydraulic conductivity at low water content: Soil Science Society of America Journal, v. 56, no. 6, p. 1758-1761.

Nimmo, J.R., Stonestrom, D.A., and Akstin, K.C., 1994, The feasibility of recharge rate determinations using the steady-state centrifuge method: Soil Science Society of America Journal, v. 58, p. 49-56.

Rossi, C., and Nimmo, J.R., 1994, Modeling of soil water retention from saturation to oven dryness: Water Resources Research, v. 30, no. 3, p. 701-708.

Nimmo, J.R., 1995, Measurement of unsaturated zone physical characteristics and water fluxes, *in* Stevens, P.R., and Nicholson, T.J., eds., Proceedings of the U.S. Geological Survey-U.S. Nuclear Regulatory Commission Joint Technical Workshop on Research Related to Low-Level Radioactive Waste Disposal, Reston, Virginia, May 4-6, 1993: U.S. Geological Survey Water-Resources Investigations Report 95-4015, p. 91-96.

Rossi, C., and Nimmo, J.R., 1996, Modelli modificati di curve di ritenzione idrica in mezzi porosi non saturi: Quaderni di Geologia Applicata, v. 3, no. 2, p. 127-136.

Shakofsky, S.M., and Nimmo, J.R., 1996, Unsaturated zone properties at a waste disposal site at the Idaho National Engineering Laboratory, *in* Morganwalp, D.W., and Aronson, D.A., eds., U.S. Geological Survey Toxic Substances Hydrology Program--Proceedings of the Technical Meeting, Colorado Springs, Colorado September 20-24, 1993: U.S. Geological Survey Water-Resources Investigations Report 94-4015, p. 949-953.

Nimmo, J.R., 1997a, Modeling structural influences on soil water retention: Soil Science Society of America Journal, v. 61, no. 3, p. 712-719.

Nimmo, J.R., 1997b, Recharging fluxes through layered alluvium: Centrifuge hydraulic property measurements interpreted by Darcian flow simulation, *in* Bartolino, J.R., ed. U.S. Geological Survey Middle Rio Grande Basin Study--Proceedings of the First Annual Workshop, Denver, Colorado, November 12-14, 1996: U.S. Geological Survey Open-File Report 97-116, p. 45, a.

Nimmo, J.R., 1997c, Looking for the big picture--U.S. Geological Survey research in arid-region hydrology, *in* Morel-Seytoux, H.J., ed. Proceedings of the Seventeenth Annual American Geophysical Union Hydrology Days, Fort Collins, Colorado, April 14-18, 1997, Hydrology Days Publications, p. 237-238, c.

Lewis, A.M., and Nimmo, J.R., 1998, Preliminary results of aquifer-recharge estimates interpreted from centrifuge hydraulic property measurements, Abo Arroyo, Middle Rio Grande Basin, New Mexico, *in* Slate, J.L., ed. U.S. Geological Survey Middle Rio Grande Basin Study--Proceedings of the Second Annual Workshop, Albuquerque, New Mexico, February 10-11, 1998: U.S. Geological Survey Open-File Report 98-337, p. 69-70.

Nimmo, J.R., 1998, Modeling structural effects on soil hydraulic properties, *in* Proceedings of the 16th World Congress of Soil Science: Montpellier, France, August 20-26, 1998, CD-ROM, 8 p.

Perkins, K.S., Nimmo, J.R., and Pittman, J.R., 1998, Hydrologic and meteorological data for an unsaturated-zone study area near the Radioactive Waste Management Complex, Idaho National Engineering and Environmental Laboratory, Idaho, 1990-1996: U.S. Geological Survey Open-File Report 98-9, Disk and 19 p.

Lewis, A.M., Nimmo, J.R., and Stonestrom, D.A., 1999, Recharge estimates interpreted from centrifuge hydraulic property measurements of core samples from Abo Arroyo, Middle Rio Grande Basin, New Mexico, *in* Bartolino, J.R., ed. U.S. Geological Survey Middle Rio Grande Basin Study--Proceedings of the Third Annual Workshop, Albuquerque, New Mexico, February 24-25, 1999: U.S. Geological Survey Open-File Report 99-203, p. 69-70.

Morel-Seytoux, H.J., and Nimmo, J.R., 1999, Soil water retention and maximum capillary drive from saturation to oven dryness: Water Resources Research, v. 35, no. 7, p. 2031-2041.

Nimmo, J.R., 1999a, Predicting soil-water retention and hydraulic conductivity from textural and structural information, *in* van Genuchten, M.T., Leij, F., and Wu, L., eds., Proceedings International Workshop on Characterization and Measurement of the Hydraulic Properties of Unsaturated Porous Media: Riverside, CA, University of California, v. 2, p. 923-930.

Nimmo, J.R., 1999b, Accounting for fractures and other macropores in predictions of unsaturated hydraulic conductivity, *in* Faybishenko, B., ed. Dynamics of Fluids in Fractured Rocks: Concepts and recent advances--Proceedings of International Symposium in Honor of Paul Witherspoon, Berkeley, CA, February 10-12, 1999, LBNL-42718, p. 110-113.

Nimmo, J.R., Shakofsky, S.M., Kaminsky, J.F., and Lords, G.S., 1999, Laboratory and field hydrologic characterization of the shallow subsurface at an Idaho National Engineering and Environmental Laboratory waste-disposal site: U.S. Geological Survey Water-Resources Investigations Report 99-4263, 31 p.

Nimmo, J.R., Lewis, A.M., and Winfield, K.A., 2000, Discernable large- and small-scale features affecting recharge in Abo Arroyo and similar basins, *in* Cole, J.C., ed. U.S. Geological Survey Middle Rio Grande Basin Study--Proceedings of the Fourth Annual Workshop, Albuquerque, New Mexico, February 15-16, 2000: U.S. Geological Survey Open-File Report 00-488, p. 41-43.

Perkins, K.S., and Nimmo, J.R., 2000, Measurement of hydraulic properties of the B-C interbed and their influence on contaminant transport in the unsaturated zone at the Idaho Engineering and Environmental Laboratory, Idaho: U.S. Geological Survey Water-Resources Investigations Report 00-4073, 30 p.

Su, G.W., Nimmo, J.R., and Dragila, M.I., 2001, Fluid flow mechanisms in an unsaturated porous rock containing a single fracture, *in* Kueper, B.H., Novakowski, K.S., and

Reynolds, D.A., eds., Fractured Rock 2001 Conference Proceedings, March 26-28, 2001, Toronto, Canada, 4 p.

Nimmo, J.R., Perkins, K.S., Rose, P.A., Rousseau, J.P., Orr, B.R., Twining, B.V., and Anderson, S.R., 2001, Kilometer-scale rapid flow in a fractured-basalt unsaturated zone at the Idaho National Engineering and Environmental Laboratory, *in* Kueper, B.H., Novakowski, K.S., and Reynolds, D.A., eds., Fractured Rock 2001 Conference Proceedings, March 26-28, 2001, Toronto, Canada, 4 p.

Nimmo, J.R., Deason, J.A., Izbicki, J.A., and Martin, P., 2002a, Evaluation of unsaturated-zone water fluxes in heterogeneous alluvium at a Mojave Basin site: Water Resources Research, v. 38, no. 10, 1215, p. 33-1 - 33-13.

Nimmo, J.R., Perkins, K.S., Rose, P.A., Rousseau, J.P., Orr, B.R., Twining, B.V., and Anderson, S.R., 2002b, Kilometer-scale rapid transport of naphthalene sulfonate tracer in the unsaturated zone at the Idaho National Engineering and Environmental Laboratory: Vadose Zone Journal, v. 1, p. 89-101.

Nimmo, J.R., 2002a, Meter-to-kilometer scaling of preferential flow in the unsaturated zone, *in* Findikakis, A.N., ed. Bridging the Gap between Measurements and Modeling in Heterogeneous Media--Proceedings of the International Groundwater Symposium, Berkeley, California, March 25-28, 2002: IAHR: Madrid, Spain, CD-ROM, 9 p.

Haverkamp, R., Reggiani, P., and Nimmo, J.R., 2002, Property-transfer models, *in* Dane, J.H., and Topp, G.C., eds., Methods of soil analysis, Part 4--Physical methods: Soil Science Society of America Book Series No. 5: Madison, Wisconsin, Soil Science Society of America, p. 759-761, 781-782.

Nimmo, J.R., 2002b, Guidelines for method selection [water retention and storage], *in* Dane, J.H., and Topp, G.C., eds., Methods of soil analysis, Part 4--Physical methods: Soil Science Society of America Book Series No. 5: Madison, Wisconsin, Soil Science Society of America, p. 716-720.

Nimmo, J.R., 2002c, Property transfer from particle and aggregate size to water retention, *in* Dane, J.H., and Topp, G.C., eds., Methods of soil analysis, Part 4--Physical methods: Soil Science Society of America Book Series No. 5: Madison, Wisconsin, Soil Science Society of America, p. 777-782.

Nimmo, J.R., and Perkins, K.S., 2002, Aggregate stability and size distribution, *in* Dane, J.H., and Topp, G.C., eds., Methods of soil analysis, Part 4--Physical methods: Soil Science Society of America Book Series No. 5: Madison, Wisconsin, Soil Science Society of America, p. 317-328.

Nimmo, J.R., Perkins, K.S., and Lewis, A.M., 2002c, Steady-state centrifuge [simultaneous determination of water transmission and retention properties], *in* Dane, J.H., and Topp, G.C., eds., Methods of soil analysis, Part 4--Physical methods: Soil Science Society of America Book Series No. 5: Madison, Wisconsin, Soil Science Society of America, p. 903-916, 933-936.

Nimmo, J.R., and Winfield, K.A., 2002, Miscellaneous methods [water retention and storage], *in* Dane, J.H., and Topp, G.C., eds., Methods of soil analysis, Part 4--Physical

methods: Soil Science Society of America Book Series No. 5: Madison, Wisconsin, Soil Science Society of America, p. 710-714, 717-720.

Winfield, K.A., and Nimmo, J.R., 2002, Controlled liquid-volume [water retention and storage], *in* Dane, J.H., and Topp, G.C., eds., Methods of soil analysis, Part 4--Physical methods: Soil Science Society of America Book Series No. 5: Madison, Wisconsin, Soil Science Society of America, p. 698-703, 717-720.

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Landa, E.R., and Nimmo, J.R., 2003, The life and scientific contributions of Lyman J. Briggs: Soil Science Society of America Journal, v. 67, no. 3, p. 681-693, cover, i.

Nimmo, J.R., 2003, How fast does water flow in an unsaturated macropore? Evidence from field and lab experiments, *in* Álvarez-Benedí, J., and Marinero, P., eds., Estudios de la Zona No Saturada del Suelo, Vol. VI: Valladolid, Spain, Instituto Tecnológico Agrario de Castilla y León, v. VI, p. 1-8.

Nimmo, J.R., Stonestrom, D.A., and Healy, R.W., 2003, Aquifers--Recharge, *in* Stewart, B.A., and Howell, T.A., eds., Encyclopedia of Water Science: Agropedia: New York, Marcel Dekker, p. 22-25.

Su, G.W., Nimmo, J.R., and Dragila, M.I., 2003, Effect of isolated fractures on accelerated flow in unsaturated porous rock: Water Resources Research, v. 39, no. 12.

Nimmo, J.R., 2004a, Aggregation--Physical Aspects, *in* Hillel, D., ed. Encyclopedia of Soils in the Environment: London, Elsevier, v. 1, p. 28-35.

Nimmo, J.R., 2004b, Porosity and Pore Size Distribution, *in* Hillel, D., ed. Encyclopedia of Soils in the Environment: London, Elsevier, v. 3, p. 295-303.

Nimmo, J.R., Rousseau, J.P., Perkins, K.S., Stollenwerk, K.G., Glynn, P.D., Bartholomay, R.C., and Knobel, L.L., 2004, Hydraulic and geochemical framework of the Idaho National Engineering and Environmental Laboratory vadose zone: Vadose Zone Journal, v. 3, no. 1, p. 6-34.

Caputo, M.C., and Nimmo, J.R., 2005a, Quasi-steady centrifuge method for unsaturated hydraulic characterization, *in* Tarantino, A., Romero, E., and Cui, Y.J., eds., Advanced Experimental Unsaturated Soil Mechanics: London, Balkema, p. 287-290.

Heppner, C.S., and Nimmo, J.R., 2005, A computer program for predicting recharge with a master recession curve: U.S. Geological Survey Scientific Investigations Report 2005-5172.

Nimmo, J.R., 2005, Unsaturated Zone Flow Processes, *in* Anderson, M.G., and Bear, J., eds., Encyclopedia of Hydrological Sciences: Part 13--Groundwater: Chichester, UK, Wiley, v. 4, p. 2299-2322.

Nimmo, J.R., Healy, R.W., and Stonestrom, D.A., 2005a, Aquifer Recharge, *in* Anderson, M.G., and Bear, J., eds., Encyclopedia of Hydrological Science: Part 13. Groundwater: Chichester, UK, Wiley, v. 4, p. 2229-2246.

Nimmo, J.R., and Landa, E.R., 2005, The soil-physics contributions of Edgar Buckingham: Soil Science Society of America Journal, v. 69, no. 2, p. 328-342.

Šimunek, J., and Nimmo, J.R., 2005, Estimating soil hydraulic parameters from transient flow experiments in a centrifuge using parameter optimization technique: Water Resources Research, v. 41, W04015.

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Nimmo, J.R., Herkelrath, W.N., and Laguna Luna, A.M., 2007, General Framework for Estimating Soil Water Retention from Textural Data: Vadose Zone Journal, v. 6, p. 766-773.

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Caputo, M.C., Nimmo, J.R., and Vurro, M., 2007, Impiego della forza centrifuga per la caratterizzazione idraulica di rocce porose in condizioni di saturazione variabile: Geoingegneria Ambientale e Mineraria (Geoengineering Environment and Mining), v. 44, no. 1, p. 49-55.

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Nimmo, J.R., 2008, The Public Fountains of the City of Dijon by H. Darcy--translated by P. Bobeck [Book Review]: Vadose Zone Journal, v. 7, no. 4, p. 1311-1312.

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