

Curriculum vitae
HARIHAR RAJARAM

EDUCATION

Bachelor of Technology, Civil Engineering, 1985, Indian Institute of Technology, Madras, India
Theses: "Hydraulic Model Studies of a Cooling Water Intake System"
"Computer-Aided Analysis and Design of Latticed Steel Portal Frames"

Master of Science, Civil and Environmental Engineering, 1987, University of Iowa
(Iowa Institute of Hydraulic Research, now IIHR HydroScience)
Thesis: "Recursive Parameter Estimation of Conceptual Watershed Models"
Supervisor: Konstantine P. Georgakakos

Doctor of Science, Civil Engineering, 1991, Massachusetts Institute of Technology.
Dissertation: "Scale-Dependent Dispersion in Heterogeneous Porous Media"
Supervisor: Prof. Lynn W. Gelhar

POSITIONS HELD

Clark Faculty Fellow, College of Engineering, University of Colorado, 2014-

President's Teaching Scholar, University of Colorado, 2012-

Department of Civil, Environmental and Architectural Engineering, University of Colorado,
Boulder

Associate Chair, (2006-2008),

Professor, (2004 - present)

Associate Professor, (2000 - 2004)

Assistant Professor (1993 - 2000)

Department of Applied Mathematics, University of Colorado, Boulder

Affiliate Faculty Member, (1996 - present)

Post-Doctoral Research Associate (November 1991 - June 1993), Department of Civil
Engineering and Operations Research, Princeton University

Graduate Research Assistant (September 1987 - October 1991), Department of Civil
Engineering, Massachusetts Institute of Technology

Graduate Research Assistant (September 1985 - August 1987), Iowa Institute of Hydraulic
Research, University of Iowa

AREAS OF RESEARCH: Fluid Mechanics and Transport Phenomena in Earth and
Environmental Systems, Stochastic subsurface hydrology, Reactive Transport, Glacier Hydrology,
Glaciology.

SELECTED HONORS AND AWARDS

Clarence Eckel Award for Faculty Excellence, Civil, Environmental and Architectural Engineering, University of Colorado, Boulder, 2016.

Editor, *Water Resources Research*, 2013-2017.

President's Teaching Scholar, University of Colorado, 2012

Boulder Faculty Assembly Teaching Award, University of Colorado, 2012

Best Should Teach Gold Award, Graduate Teacher Program, University of Colorado, 2012

CAREER (National Science Foundation Early Faculty Career Development) Award, National Science Foundation, Hydrologic Sciences Program, 1998.

Faculty Fellowship, University of Colorado, Boulder, 2008-09

Charles Hutchinson Memorial College of Engineering Teaching Award, University of Colorado, Boulder, 1999.

Department Teaching Award, Civil, Environmental and Architectural Engineering, University of Colorado, Boulder, 2011.

Department Teaching Award, Civil, Environmental and Architectural Engineering, University of Colorado, Boulder, 1995.

Editor's Citation for Excellence in Refereeing, American Geophysical Union, cited by Dr. Samuel Colbeck, Editor, *Water Resources Research*, 1998.

Service Award, Civil, Environmental and Architectural Engineering, University of Colorado, Boulder, April 2001

Research Development Award, Civil, Environmental and Architectural Engineering, University of Colorado, Boulder, April 2005

Outstanding Professor Award, Chi Epsilon Honor Society, Department of Civil, Environmental and Architectural Engineering, University of Colorado, Boulder, April 2001

International Student Scholarship, University of Iowa (1985-1987) (awarded upon recommendation of the Dean of the College of Engineering to a single entering international graduate student each year)

Institute Bronze, Indian Institute of Technology, Madras (in recognition of outstanding performances on the Track and Field team), 1985

RESEARCH

REFEREED JOURNAL PAPERS AND BOOK CHAPTERS

[CITATIONS:

Google Scholar 10/21/16: h-Index: 28, i10 index 55, Total citations = 2322;

Web of Science 10/21/16: h-index: 24, Total citations = 1538]

(* Denotes papers involving a student co-author at CU Boulder or a student I formally co-advised elsewhere, student co-authors identified with a *, ** denotes Post-Doctoral researchers)

- *79. Sommers, A., Rajaram, H., Weber, E., MacFerrin, M. Colgan, W. and C. M. Stevens, Inferring permeability from pneumatic tests on the Greenland ice sheet, In Review, *Frontiers in Earth Science – Cryospheric Sciences*.
- *78. *Allen, J., T. Manteuffel and H. Rajaram, A fluidity-based first-order system least squares method for ice sheets, Revised, pending final acceptance, *SIAM Journal of Scientific Computing*
- *77. *Pandey, S. and H. Rajaram, Modeling the influence of preferential flow on the spatial variability and time-dependence of mineral weathering rates, Revised, pending final acceptance, *Water Resources Research*, February 2015
- *76. Rajaram H, *Arshadi M. A similarity solution for reaction front propagation in a fracture–matrix system. *Phil.Trans. R. Soc. A* **374**: 20150424, 2016. doi:10.1098/rsta.2015.0424
- *75. *Armstrong, W.H., Anderson, R.S., *Allen, J. and Rajaram, H., Modeling the WorldView-derived seasonal velocity evolution of Kennicott Glacier, Alaska, *Journal of Glaciology*, 62(234), 763–777, 2016. doi: 10.1017/jog.2016.66.
- *74. *Michael Brutz, Harihar Rajaram, Coarse-scale particle tracking approaches for contaminant transport in fractured rock, *Applied Mathematical Modelling*, 2016.
<http://dx.doi.org/10.1016/j.apm.2016.09.023>.
- *73. Colgan, W., H. Rajaram, W. Abdalati, C. McCutchan, R. Mottram, *M. S. Moussavi, and *S. Grigsby, Glacier crevasses: Observations, models, and mass balance implications, *Rev. Geophys.*, 54, 119–161, 2016. doi:10.1002/2015RG000504.
72. Rajaram, H., J. M. Bahr, G. Bloeschl, X. Cai, D. Scott Mackay, A. M. Michalak, A. Montanari, X. Sanchez-Villa, and G. Sander, A reflection on the first 50 years of *Water Resources Research*, *Water Resour. Res.*, 51, 2015. doi:10.1002/2015WR018089.
- *71. *Arshadi, M., and H. Rajaram, A transition in the spatially integrated reaction rate of bimolecular reaction- diffusion systems, *Water Resour. Res.*, 51, 7798–7810, 2015. doi:10.1002/2015WR017674.

*70. *Birdsell, D. T., H. Rajaram, D. Dempsey, and H. S. Viswanathan, Hydraulic fracturing fluid migration in the subsurface: A review and expanded modeling results, *Water Resour. Res.*, 51, 2015. doi:10.1002/2015WR017810.

69. S.N. Pandey, A. Chaudhuri, H. Rajaram, S. Kelkar, Fracture transmissivity evolution due to silica dissolution/precipitation during geothermal heat extraction, *Geothermics* 57, 111–126, 2015. DOI: 10.1016/j.geothermics.2015.06.011.

*68. *Birdsell, D. T., H. Rajaram, and *G. Lackey, Imbibition of hydraulic fracturing fluids into partially saturated shale, *Water Resour. Res.*, 51, 2015. doi:10.1002/2015WR017621.

*67. Colgan, W., *A. Sommers, H. Rajaram, W. Abdalati, and J. Frahm, Considering thermal-viscous collapse of the Greenland ice sheet, *Earth's Future*, 3, 252–267, 2015. doi:10.1002/2015EF000301.

*66. *Arshadi, M., H. Rajaram, R. L. Detwiler, and *T. Jones (2015), High-resolution experiments on chemical oxidation of DNAPL in variable-aperture fractures, *Water Resour. Res.*, 51, 2317–2335, doi:10.1002/2014WR016159.

65. McGrath, D, Steffen K, Holland PR, Scambos T, Rajaram H, Abdalati W, Rignot E. The structure and effect of suture zones in the Larsen C Ice Shelf, Antarctica. *Journal of Geophysical Research-Earth Surface*, 119(3):588-602, 2014. DOI: 10.1002/2013JF002935.

64. Pandey SN, Chaudhuri A, Kelkar S, Sandeep VR, Rajaram H. Investigation of permeability alteration of fractured limestone reservoir due to geothermal heat extraction using three-dimensional thermo-hydro-chemical (THC) model. *Geothermics*, 51:46-62 2014, DOI:10.1016/j.geothermics.2013.11.004

*63. Paces, JB; *Nichols, PJ; Neymark, LA; Rajaram, H: Evaluation of Pleistocene groundwater flow through fractured tuffs using a U-series disequilibrium approach, Pahute Mesa, Nevada, USA. *Chemical Geology*, Volume: 358 Pages: 101-118 DOI: 10.1016/j.chemgeo.2013.08.043, 2013.

*62. *Phillips, T; Rajaram, H; *Colgan, W; Steffen, K; Abdalati, W: Evaluation of cryo-hydrologic warming as an explanation for increased ice velocities in the wet snow zone, Sermeq Avannarleq, West Greenland; *Journal Of Geophysical Research-Earth Surface* Volume: 118 Issue: 3 Pages: 1241-1256 DOI: 10.1002/jgrf.20079, 2013. (This paper was cited in the Inter-Governmental Panel on Climate Change 2013 Fifth Assessment Report)

**61. **Chaudhuri, A; Rajaram, H; Viswanathan, H; Early-stage hypogene karstification in a mountain hydrologic system: A coupled thermohydrochemical model incorporating buoyant convection: *Water Resources Research* Volume: 49 Issue: 9 Pages: 5880-5899 DOI: 10.1002/wrcr.20427, 2013.

*60. *Jacob, T; *Pandey, S; Silverstein, J; Rajaram, H; Soluble Microbial Products Decrease Pyrite Oxidation by Ferric Iron at pH < 2: *Environmental Science & Technology* Volume: 47 Issue: 15 Pages: 8658-8665 DOI: 10.1021/es400828g, 2013.

**59. **Colgan, W., Pfeffer, W. T., Rajaram, H., Abdalati, W., and J. Balog, Monte Carlo ice flow modeling projects a new stable configuration for Columbia Glacier, Alaska, c. 2020, *The Cryosphere*, 6, 1395-1409, 2012, doi:10.5194/tc-6-1395-2012

*58. *McGrath, D., Steffen, K., Rajaram, H., Scambos, T. A. A., Abdalati, W., and E. Rignot (2012), Basal crevasses on the Larsen C Ice Shelf, Antarctica: Implications for meltwater ponding and hydrofracture, *Geophys. Res. Lett.*, doi:10.1029/2012GL052413

*57. *McGrath, D.; Steffen, K.; Scambos, T.; Rajaram, H.; Casassa, G.; Rodriguez L., and L. Jose, Basal crevasses and associated surface crevassing on the Larsen C ice shelf, Antarctica, and their role in ice-shelf instability, *Annals of Glaciology*, Volume 53, Number 60, November 2012 , pp. 10-18(9)

**55. **Chaudhuri, A., Rajaram, H. and H. Viswanathan, Fracture alteration by precipitation resulting from thermal gradients: Upscaled mean aperture-effective transmissivity relationship, *Water Resources Research*, DOI: 10.1029/2011WR010983

*54. *Colgan, W., Rajaram, H., Anderson, R.S., Steffen, K., Zwally, H.J., Phillips, T., and W. Abdalati, The annual glaciohydrology cycle in the ablation zone of the Greenland Ice Sheet: Part 2. Observed and Modeled Ice Flow, *J. Glaciol.* 58: 51-64, 2012.

*53. *Colgan, W., Rajaram, H., Anderson, R., Steffen, K., Phillips, T., Zwally, H. J., and W. Abdalati, The annual glaciohydrology cycle in the ablation zone of the Greenland Ice Sheet: Part 1. Hydrology Model. *J. Glaciol.* 57 (204), 697-709, 2011.

*52. *Colgan, W., Steffen, K., McLamb, S.W., Abdalati, W., Rajaram, H., Motyka, R., Phillips, T., and R.S. Anderson, An Increase In Crevasse Extent, West Greenland, Hydrologic Implications, *Geophys. Res. Lett.*, 38, L18502, doi:10.1029/2011GL048491, 2011.

*51. *Phillips, T., Leyk, S., Rajaram, H., *Colgan, W. , Abdalati, W., *McGrath, D. and K. Steffen, Modeling the Moulin Distribution on Sermeq Avannarleq Glacier using ASTER and WorldView Imagery and Fuzzy Set Theory. *Rem. Sens. Environ.*, 115(9), 2292-2301., 2011.

*50. *Phillips, T., Rajaram, H., and K. Steffen, Cryo-hydrologic warming: A potential mechanism for rapid thermal response of ice sheets, *Geophys. Res. Lett.*, doi:10.1029/2010GL044397, 2010. (This paper was cited in the Inter-Governmental Panel on Climate Change 2013 Fifth Assessment Report)

*49. *Valerio. A, Rajaram, H., and E. Zagona, Incorporating Groundwater-Surface Water Interaction into River Management Models, *Groundwater*, 48(5): 661-673, 2010.

*48. *Mallikamas, W., and H. Rajaram, An improved two-dimensional depth-integrated

flow equation for rough-walled fractures, *Water Resources Research*, W08506, doi:10.1029/2009WR008779, 2010.

*47. Rajaram, H., *Cheung, W. and **A. Chaudhuri, Natural Analogs For Improved Understanding Of Coupled Processes In Engineered Earth Systems: Examples From Karst System Evolution, *Current Science* 97(8): 1162-1176, 2009.

46. Detwiler, R. L., Rajaram, H. and R. J. Glass, Inter-phase mass transfer in variable aperture fractures: Controlling parameters and a proposed constitutive model, *Water Resources Research*, W08436, doi:10.1029/2008WR007009, 2009.

**45. **Chaudhuri, A., Rajaram, H., H. Viswanathan, G. Zyvoloski and F. Stauffer, Buoyant convection resulting from dissolution and permeability growth in vertical limestone fractures, *Geophysical Research Letters* VOL. 36, L03401, doi:10.1029/2008GL036533, 2009.

*44. *Sakaki, T., and H. Rajaram, Drying behavior of a partially saturated single fracture-matrix system: Experiments and modeling using a non-linear diffusion equation approach, *Water Resources Research* VOL. 45, W02427, doi:10.1029/2007WR006790, 2009.

**43. **Chaudhuri, A. H. Rajaram, and H. Viswanathan, Alteration of fractures by precipitation/dissolution in gradient reaction environments: computational results and stochastic analysis, *Water Resources Research* VOL. 44, W10410, doi:10.1029/2008WR006982, 2008.

42. Detwiler, R.L. and H. Rajaram, Predicting dissolution patterns in variable aperture fractures: Development and evaluation of an enhanced depth-averaged computational model, *Water Resources Research*, 43(4): W04403, doi:10.1029/2006WR005147, 2007.

*41. *Sakaki, T. and H. Rajaram, Performance of different types of TDR probes for water content measurement in partially saturated rocks, *Water Resources Research*, 42, W07404, doi:10.1029/2005WR004643, 2006.

*40. *Mallikamas, W. and H. Rajaram, Anisotropy of Aperture Correlation and Effective Transmissivity in Variable Aperture Fractures Generated by Sliding Between Identical Self-Affine Surfaces, *Geophysical Research Letters*, 32(11): Art. No. L11401, 2005.

39. Detwiler, R.L., Rajaram, H., and R. J. Glass, Satiated relative permeability of variable-aperture fractures, *Physical Review E*, 71(3): Art. No. 031114, 2005.

*38. *Fernández-García, D., H. Rajaram, and T. H. Illangasekare (2004), Assessment of the predictive capabilities of stochastic theories in a three-dimensional laboratory test aquifer: Effective hydraulic conductivity and temporal moments of breakthrough curves, *Water Resources Research* 41(4): Art. No. W04002, 2005.

*37. *Fernández-García, D., T. H. Illangasekare, and H. Rajaram, Differences in the scale-dependence of dispersivity and retardation factors estimated from forced-gradient and uniform flow

tracer tests in three-dimensional physically and chemically heterogeneous porous media, *Water Resources Research* 41(3): Art. No. W03012, 2005.

*36. *Fernández-García, D., Illangasekare, T. H., Rajaram, H., Differences in the scale-dependence of dispersivity estimated from temporal and spatial moments in physically and chemically heterogeneous porous media. *Advances in Water Resources*, 28(7) 745-749, 2005.

*35. *Andre, B. and H. Rajaram, Dissolution of limestone fractures by cooling waters: early development of hypogene karst systems. *Water Resources Research*, 41(1), W01015, doi:10.1029/2004WR003331, 2005.

*34. *Fernández-García, D., Illangasekare, T.H. and H. Rajaram, Conservative and sorptive forced-gradient and uniform flow tracer tests in a three-dimensional laboratory test aquifer, *Water Resources Research*, 40 (10), W10103, 10.1029/2004WR003112, 2004.

33. Molz, F. J., Rajaram, H., and S. Lu, Stochastic Fractal-Based Models of Heterogeneity in Subsurface Hydrology: Origins, Applications, Limitations and Future Research Questions, *Reviews of Geophysics* 42, RG1002, Paper No. 2003RG000126, 42 pages, 2004.

*32. Glass R.J. , Nicholl M.J., Rajaram H. and *B. Andre, Development of slender transport pathways in unsaturated fractured rock: Simulation with modified invasion percolation, *Geophysical Research Letters* 31 (6): Art. No. L06502, 2004

31. Runkel, R.L., D.M.McKnight and H. Rajaram, Modeling hyporheic zone processes - preface, *Advances in Water Resources* 26(9) 901-905, 2003.

30. Glass, R. J., Rajaram, H., and **R. L. Detwiler, Immiscible displacements in rough-walled fractures: Competition between roughening by random aperture variations and smoothing by in-plane curvature, *Physical Review E* 68, 061110-1 to 6, 2003.

29. Glass, R. J., Nicholl, M. J., Rajaram, H. and T. R. Wood, Unsaturated flow through fracture networks: Evolution of liquid phase structure, dynamics, and the critical importance of fracture intersections, *Water Resources Research*, 39 (12), 1352, doi:10.1029/2003WR002015, 2003.

*28. *Barth, G.R., Illangasekare, T.H. and H. Rajaram, Demonstration of Solute Flux Sensitivity to Entrapped Nonaqueous Phase Liquids: Intermediate-Scale Experiments in Heterogeneous Porous Media, *Journal of Contaminant Hydrology* 67, 247-268, 2003.

*27. *Sakaki, T., Rajaram, H., and T. Naganuma, Fractosphere: The Site of Hydrogeological-Microbial Interaction: Current and Future Perspectives, *Journal of Geography* (Tokyo Geographical Society) 112 (2), 288-301, 2003.

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- *25. *Detwiler, R. L., Rajaram, H. and R. J. Glass, Experimental and Simulated Solute Transport in a Partially Saturated Variable-Aperture Fracture, *Geophysical Research Letters*, 29(8) 113-1 – 113-3, doi: 10.1029/2001GL013508, , 2002.
- *24. *Detwiler, R. L., *S. R. Mehl, H. Rajaram and *W. Cheung, Comparison of an Algebraic Multigrid Algorithm to Two Iterative Solvers Used for Modeling Groundwater Flow and Transport, *Groundwater* 40(2) 267-272, 2002.
23. Rajaram, H., Perturbation Theories For Estimation of Macrodispersivities in Heterogeneous Aquifers, refereed book chapter in *Stochastic Methods in Subsurface Contaminant Hydrology* (edited by Rao S. Govindaraju) ASCE Press, 2002.
- *22. *Detwiler, R. L., Rajaram, H. and R. J. Glass, Dissolution of Entrapped Nonaqueous Phase Liquids in Rough-Walled Fractures: A Depth-Averaged Computational Model and Comparison to an Experiment, *Water Resources Research* 37(12) 3115-3130, 2001.
- *21. *Barth, G.R., M. C. Hill, T. H. Illangasekare and H. Rajaram, Predictive Modeling of Flow and Transport in a Two-Dimensional Intermediate-Scale Heterogeneous Porous Medium, *Water Resources Research* 37 (10) 2503-2512, 2001.
- *20. Glass, R. J., Rajaram, H., Nicholl, M .J. and *R. L. Detwiler, The Interaction of Two Fluid Phases in Fractured Media, *Current Opinion in Colloid and Interface Science* 6(3) 223-235, 2001.
- *19. *Carron, J. C. and H. Rajaram, Impact of Variable Reservoir Releases on Management of Downstream Water Temperatures, *Water Resources Research* 37(6) 1733-1744, 2001.
- *18. *Barth, G.R., T. H. Illangasekare, M. C. Hill and H. Rajaram, Analysis of Intermediate-Scale Tracer Experiments for the Development of Tracer Density Guidelines in a Heterogeneous Porous Medium, *Water Resources Research* 37(1) 21-31, 2001.
- *17. *Chao, H.-C., H. Rajaram and T. H. Illangasekare, Intermediate Scale Experiments and Computational Studies of Transport During Radial Flow in a Heterogeneous Porous Medium, *Water Resources Research* 36(10), 2869-2884, 2000.
- *16. *Detwiler, R.L., H. Rajaram and R.J.Glass, An Investigation of the Relative Importance of Taylor Dispersion and Macrodispersion in Variable Aperture Fractures, *Water Resources Research* 36(7), 1611-1625, 2000.
15. Nicholl, M. J., H. Rajaram and R. J. Glass, Factors Controlling Saturated Relative Permeability in a Partially Saturated Horizontal Fracture, *Geophysical Research Letters*, 27 (3) 393-396, 2000.
- *14. Nicholl, M. J., H. Rajaram, R. J. Glass, and *R. L. Detwiler, Saturated Flow In A Single Fracture: Evaluation Of The Reynolds Equation In Measured Aperture Fields, *Water Resources Research*, 35(11), 3361-3373, 1999.

- *13. *Mishra, A. K., A. Gutjahr, and H. Rajaram, Transport with Spatially Variable Kinetic Sorption: Recursion Formulation, *Advances in Water Resources*, 22(5), 549-555, 1999.
- *12. Stockman, H. W., R. J. Glass, *C. Cooper, and H. Rajaram, Accuracy and Computational Efficiency in 3D Dispersion via Lattice-Boltzmann: Models for Dispersion in Rough Fractures and Double-Diffusive Fingering, *International Journal of Modern Physics C*, 9(8), 1545-1558, 1998.
- *11. *Hanna, R. B., and H. Rajaram, Influence of Aperture Variability on the Dissolutional Growth of Fissures in karst Formations, *Water Resources Research* 34 (11), 2834-2853, 1998.
10. Rajaram, H., Time and Scale-Dependent Effective Retardation Factors in Heterogeneous Aquifers, *Advances in Water Resources*, 20(4), 217-230, 1997.
9. Rajaram, H., L. A. Ferrand and M. A. Celia, Prediction of Relative Permeabilities for Unconsolidated Soils using Pore-scale Models, *Water Resources Research*, 33(1) 43-52, 1997.
8. Rajaram, H. and L. W. Gelhar. Plume-scale dependent dispersion in aquifers with a wide range of scales of heterogeneity. *Water Resources Research*, 32(10) 2469-2482, 1995.
7. Rajaram, H. and L. W. Gelhar. Plume-scale dependent dispersion in heterogeneous aquifers. Part II: Eulerian analysis, dispersion in three-dimensional random media and applications. *Water Resources Research*, 29(9), 3261-3276, 1993.
6. Rajaram, H. and L. W. Gelhar. Plume-scale dependent dispersion in heterogeneous aquifers. Part I - Lagrangian analysis and dispersion in a perfectly stratified aquifer. *Water Resources Research*, 29(9), 3249-3260, 1993.
5. Celia, M. A., H. Rajaram, and L. A. Ferrand, A multi-scale computational model for multiphase flow in porous media, *Advances in Water Resources* 16, 81-92, 1993.
4. Rajaram, H. and L.W.Gelhar, Three-dimensional spatial moments analysis of the Borden tracer test, *Water Resources Research*, 27(6), 1239-1251, 1991.
3. Rajaram, H. and D. McLaughlin, Identification of large-scale spatial trends in hydrologic Data, *Water Resources Research*, 26(10), 2411-2423, 1990.
2. Rajaram, H. and K. P. Georgakakos, Recursive parameter estimation of hydrologic models, *Water Resources Research*, 25(2), 281-294, 1989.
1. Nikolaidis, N. P., H. Rajaram, J. L. Schnoor and K. P. Georgakakos, A generalized softwater acidification model, *Water Resources Research*, 24(12), 1983-1996, 1988.

EXTERNAL RESEARCH FUNDING

(Senior Personnel - budget allocated to my responsibilities in the project - \$315K for 4 years)
Hazards SEES: The Risk Landscape of Earthquakes Induced by Deep Wastewater Injection (P.I. Abbie Liel, co-P.I.s Amy Javernick-Will, Anne Sheehan, Liesel Ritchie, other senior personnel - Kristy Tiampo, Kathryn Mutz), NSF,

\$2,630,000

Boulder Creek Critical Zone Observatory II: Evolution, Form, Function, and Future of the Critical Zone, PI: Suzanne Anderson, Co-PIs: R. S. Anderson, N. Molotch, H. Rajaram, G. E. Tucker; others listed as senior personnel; total 12 investigators), NSF – EAR- Earth Surface Processes

\$4,900,000

Assessing Greenland crevasse extent and characteristics using historical ICESat and Airborne Laser Altimetry data: a baseline for assessing changes with ICESat-2, P.I. Waleed Abdalati, co-P.I.'s Harihar Rajaram, William Colgan, National Aeronautics and Space Administration, Research Opportunities in Space and Earth Sciences, October 2013-September 2016

\$565,654

Discrete Fracture Network Models for Coupled Thermo-Hydrologic-Mechanical-Chemical Processes, P.I. Harihar Rajaram, co-P.I. Hari Viswanathan. Institute for Geophysics and Planetary Physics, Los Alamos National Laboratory, 10/1/2012-9/30/2015

\$ 191,728

(Senior Personnel and lead of Water Quantity team: portion of overall budget allocated to my part of the project is about \$85K/year): Routes to Sustainability for Natural Gas Development and Water and Air Resources in the Rocky Mountain Region, PI: J.N. Ryan; co-PIs: P. Bourgeron, M. Williams, M. Hannigan, and P. Limerick, University of Colorado Boulder; others listed as senior personnel; nine institutions, 27 investigators total), NSF-Chemical, Bioengineering, Environmental, and Transport Division; 10/1/12-9/30/17

\$11,999,328

Boulder Creek CZO Renewal: Weathered Profile Development in a Rocky Environment and Its Influence on Watershed Hydrology and Biogeochemistry, PI: Suzanne Anderson (PI), Co-PIs: R. S. Anderson, N. Molotch, H. Rajaram, G. E. Tucker; others listed as senior personnel; total 12 investigators), NSF – EAR- Earth Surface Processes Section: 9/1/12-8/31/13

\$1,000,000

Using Experimental Data to Improve Enthalpy-Based Models of Ice Sheet Ablation Zones, Institute for Geophysics and Planetary Physics, Los Alamos National Laboratory, 5/1/2012-4/30/2014

\$133,188

Integrating Icebridge And ICESat Data With A Monte-Carlo Modeling Framework To Constrain The Mechanisms Of Recent Acceleration In West Greenland Outlet Glaciers, National Aeronautics and Space Administration, Research Opportunities in Space and Earth Sciences, January 2012-December 2015

\$302,776

Linking Glacier Sliding and Hydrology: Exploiting Unique Natural Experiments on the Kennicott Glacier (co-P.I. with Robert S. Anderson, INSTAAR), National Science Foundation, Geomorphology and Landform Dynamics, October 2011-September 2014

\$410,000

Subsurface Carbon Cycling in Bioremediation of Acid Mine Drainage: Experiments and Modeling (co-P.I. with JoAnn Silverstein), National Science Foundation, Chemical, Bioengineering, Environmental, and Transport Systems (CBET), July 2009 – June 2011. (extended to 2012)

\$339,089

Collaborative Research: Refinement of Techniques for Estimation of Evapotranspiration From Narrow Riparian Zones: Water Balance and Atmospheric Measurements, National Science Foundation, ETBC/Hydrologic Sciences, October 2008-September 2011. (extended to 2012)

University of Colorado Budget **\$313,398**

Experimental and Theoretical Investigations of Fundamental Processes Relevant to Chemical Oxidation of Dense Nonaqueous Phase Liquids in Fractured Rock, National Science Foundation, Hydrologic Sciences, February 2008-January 2011. (extended to 2012)

\$230,484

Scale-Dependent Fracture-Matrix Interactions and Their Impact on Radionuclide Transport (Collaboration with Lawrence Livermore National Laboratory, co-P.I. Russell Detwiler, now at UC Irvine) under independent budget, March 2008-February 2011. (extended to 2013)

University of Colorado Budget **\$265,680**

Is the Ground Drying Up in the South Platte? CIRES Innovative Research Program, (co-P.I. with Balaji Rajagopalan) January 2007 – May 2008.

\$30,000

Collaborative Research: Dynamical Origins of Statistical Scaling in Floods on Real Networks-An Exploratory Diagnostic Analysis, National Science Foundation, Hydrologic Sciences (SGER), (co-P.I. with Vijay Gupta), January 2007.- May 2008.

\$53,218

Coupled Process-Modeling of Hypogene Karstification: A Test Case for Modern High-Performance Multi-Physics Simulation of Large Fractured Rock Masses, Institute for Geophysics and Planetary Physics, Los Alamos National Laboratory, January 2007-2010.

\$119,000

Preventing Pyrite Oxidation: A Geomicrobial Strategy for Source Control of Acid Mine Drainage, (co-P.I. with JoAnn Silverstein, 50% responsibility), National Science Foundation, Environmental Engineering Program, July 2005- December 2007.

\$196,013

Advanced Conceptual Models for Unsaturated and Two-Phase Flow in Fractured Rock, Department of Energy, Environmental Management Science Program, joint proposal with Sandia National Laboratories (Robert J. Glass), University of Idaho (Michael J. Nicholl) and Idaho National Environmental and Engineering Laboratory (Thomas R. Wood) under independent budget, September 2002-2005.

University of Colorado Budget **\$230,000**

The Interaction of Two Fluid Phases in Fractured Media, Department of Energy, Office of Basic Energy Sciences, joint proposal with Sandia National Laboratories (Robert J. Glass) and University of Idaho (Michael J. Nicholl) under independent budget, November 2001-2004.

University of Colorado budget **\$248,000**

Moisture Migration in Unsaturated Fractured Rock, (collaboration with Hiroshima University, Japan, funded by the Japan Nuclear Cycle Development Agency), January 2000 – December 2003.

University of Colorado budget **\$134,000**

Estimation of Transport Parameters Using Forced-Gradient Tracer Tests in Heterogeneous Aquifers, Department of Defense, Army Research Office, Terrestrial Sciences Branch, joint proposal with Colorado School of Mines (P.I. Tissa Illangasekare) under independent budget, June 1999-2002.

University of Colorado budget **\$109,187**

Simulation and Control of Stream Temperatures in the Green River Below Flaming Gorge Dam, United States Bureau of Reclamation, January-December 1999.

\$54,401

The Physics of Two-Phase Flow Immiscible Fluid Flow in Single Fractures and Fractured Rock, Department of Energy, Office of Basic Energy Sciences, joint proposal with Sandia National Laboratories (Robert J. Glass) and Oklahoma State University (Michael J. Nicholl) under independent budget, November 1998-2001.

University of Colorado budget **\$180,801**

CAREER: Feedback Coupling Between Flow and Reactions in Heterogeneous Porous and Fractured Media: Computational and Experimental Studies (Early Faculty Career Development Award), National Sciences Foundation, Hydrologic Sciences Program, April 1998-2003.

\$224,000

Uncertainty Analysis and Stochastic Control for River Basin Management, Task VI under "Watershed Modeling Systems Initiative : Decision Support for Colorado River Operations and Planning", co-operative agreement between Center for Advanced Decision Support in Water and Environmental Systems (CADSWES) and the United States Bureau of Reclamation, (Edith Zagona was responsible for other Tasks I. - V. under independent budget), January 1996 - June 1998.

\$150,000

Two-Phase Immiscible Fluid Flow in Fractured Rock: The Physics of Two-Phase Flow Processes in Single Fractures, Department of Energy, Office of Basic Energy Sciences, joint proposal with Sandia National Laboratories (Robert J. Glass) under independent budget, November 1995-98.

University of Colorado budget

\$202,983

An Experimental Database for the Evaluation of Theories for Upscaling in Modeling Groundwater Flow, Solute Transport and Multiphase Fluid Flow in Aquifers, Army Research Office, Terrestrial Sciences Branch, (50% responsibility with Tissa Illangasekare, then at University of Colorado, Boulder), April 1995-98.

\$223,054

TEACHING AND EDUCATIONAL ACTIVITIES:

COURSES TAUGHT

CVEN 3313	Theoretical Fluid Mechanics (F93, S97, S98, F98, S99, S03, S05, Sum 06, S07, S10, S12, S14, S16)
CVEN 3323	Hydraulic Engineering (S01)
CVEN 5353	Groundwater Hydrology (F94, F99, F00, F02, F03, F12)
CVEN 5343/4343	Open Channel Hydraulics and Environmental Transport (S94, S95, S96, S97, S98, S99)
CVEN 4353	Groundwater Engineering (F95, F96, F97)
CVEN 5383	Groundwater Modeling (S95, S99, S00 as independent study)
CVEN 5454	Quantitative Methods in Environmental and Water Resources (F95, F03)
CVEN 5537/4537	Numerical Methods in Civil Engineering (F04, F05, F06, F07, F09, F10, F11, F12, F13, F14, F15, F16)
CVEN 5833-1	Mathematical Methods in Engineering I (F96)
CVEN 5833-2	Mathematical Methods in Engineering II (S97)
CVEN 5833-3	Spc. Tpcs: Modeling Reactive Transport in Aquatic Environments (S00, S01, F05)
CVEN 5833/5343	Environmental Transport and Dispersion Processes (S11, S13, S15)
CVEN 6383	Flow and Transport in Porous Media (S06, S10, F11, F14, F16)
CVEN 6833-1	Spc. Tpcs: Advanced Groundwater Modeling (F94, F96)
CVEN 6833-2	Spc. Tpcs: Transport in Random Media (F99)
CVEN 6833-3	Spc. Tpcs: Computational Methods for Glacier Modeling (F10)

INNOVATIVE TEACHING

1. Hands-on Experimental Modules for undergraduate Fluid Mechanics course in the Integrated Teaching and Learning Laboratory, (CVEN 3313)
2. Computer Animation of Taylor Dispersion Phenomena using IDL and MATLAB (CVEN 5343, CVEN 5833-3)
3. *Mathematica* Modules for computation of gradually varied flow profiles in open channels and visualization of mixing processes (CVEN 5343)
4. *Mathematica* Modules for computation and visualization of solutions to the groundwater flow equation (CVEN 4353 and 5353)
5. Development of Advanced Experimental Modules - Benchtop Watershed Model, with funding from Integrated Teaching and Learning laboratory and the National Science Foundation.

EDUCATIONAL GRANTS

Development of a Hydrologic Test Bed, Integrated Teaching and Learning Laboratory, College of Engineering, University of Colorado, 1997-98

\$20,000

A general-purpose system identification module for engineering systems in MATLAB, Engineering Excellence Fund, University of Colorado, 2007-08. **\$ 2,000**

Experimental and Computational Modules for Flow and Transport in Groundwater, Soils and Porous Media, Engineering Excellence Fund, University of Colorado, 2007-10 **\$24,500**

GRADUATE THESES SUPERVISED (students from Civil Engineering Department at CU Boulder unless otherwise specified)

MASTER OF SCIENCE

1. Hanna, R. Blair, Genesis of Hydraulic Conduits in karst Aquifers: a Two-Dimensional Modeling Approach, Fall 1996.
2. Weiler, Daniel K., Recursive parameter Estimation and Uncertainty Propagation in Linear Muskingum Routing: Application to Low Flow Prediction, Summer 1997.
3. Cox, Timothy J., Investigation and Quantification of Boundary Reaction Effect on Solute transport Parameterization: Application to Laminar Flow Through Cylindrical Biofilm Reactors, Fall 1997.
4. Setzer, Steven R., Particle-Tracking Simulations of Solute Transport in Biofilm Coated Tubes: laminar and Turbulent Flow, Fall 1999.
5. Andre, Benjamin R., Dissolution of a Limestone Fracture in a Forced Convective Thermal Regime, Spring 2003.
6. Tumey, April (co-advised with JoAnn Silverstein), Acid Generation And Prevention In Partially Saturated Waste Rock, Fall 2005.
7. Lundberg, Matthew, Experimental Studies Of Fracture Wall Dissolution And Its Influence On Fluid Phase Structure In Partially Saturated Fractures, Fall 2005.
8. Bliss, Matthew, High-Resolution Numerical Simulations Of Solute Transport In Partially Saturated Fractures, Fall 2005.
9. Mobley, John, An Exploration Of Models For Estimating Evapotranspiration From Stream Fluctuations In Riparian Corridors, Spring 2007.
10. Coolidge, Carter, Two-species diffusion and reaction in a porous medium: Application to chemical oxidation of DNAPLs in fractured rock, Summer 2009.
11. Valerio, Allison, Modeling Groundwater-Surface Water Interactions by Linking RiverWare with MODFLOW, Spring 2008 (co-supervisor: Edith Zagona).

12. Michael Records, Investigations of Physical Laboratory Analogs of Glacier Sliding, Fall 2011.

13. Macpherson, Brian, Enthalpy-Based Models for Ice Sheets and Improving Understanding of Cryo-Hydrologic Warming. Fall 2013.

14. Nossokoff, Austin, Using Small Scale Physical Experiments to Improve Enthalpy Based Models of Ice Sheets, Fall 2013.

DOCTOR OF PHILOSOPHY (primary supervisor)

1. Chao, Hsin-Chia, Intermediate-Scale Experiments and Numerical Simulations of Non-Reactive and Reactive Transport in Heterogeneous Porous Media, thesis defended in December 1998, graduated Fall 2000.

2. Carron, John C., Simulation and Optimization of Unsteady Flow and Water Temperature in Reservoir-Regulated Rivers, Spring 2000.

3. Detwiler, Russell, L., An Experimental and Computational Investigation of Solute Transport and Nonaqueous Phase Liquid Dissolution in Discrete Rough-Walled Fractures, Fall 2000. (co-supervisor: Robert J. Glass, Sandia National Laboratories)

4. Bloechle, Brian W., (Applied Mathematics, CU Boulder) On the Taylor Dispersion of Reactive Solutes in a Parallel Plate Fracture-Matrix System, Spring 2001.

5. Cheung, Wendy W., Toward a Better Understanding of Fissure Growth in karst Formations: Investigations from Genesis to Maturation and the Influence of Fracture-Matrix Interactions, Spring 2002.

6. Sakaki, Toshihiro, The Role of Fracture-Matrix Interaction in Drying of Unsaturated Fractured Rock: Experiments and Modeling, Fall 2005.

7. Mallikamas, Wasin, Stochastic Analysis of the Influence of Mid-Plane Tortuosity on Flow and Transport in Fractures, Summer, 2008.

8. Andre, Benjamin, Reactive Transport Modeling of Acid Generation in Waste Rock Piles, Spring 2009.

9. Solis, Jose R., Refinement of Water Balance Methods for Estimating Evapotranspiration from Narrow Riparian Zones, Fall 2015.

10. Arshadi, Masoud, Chemical Oxidation of Nonaqueous Phase Liquids in Fractured Rock – Experiments and Modeling, Fall 2015.

11. Pandey, Sachin, Modeling the Chemical and Geomicrobial transitions in Acid Generating Waste Rock Piles Following Carbon Addition, Fall 2015.
12. Sommers, Aleah, Improved Coupled Models of Glacier Flow and Sliding, In Progress.
13. Lackey, Gregory, Models of methane transport and isotopic fractionation in deep subsurface systems, In Progress.
14. Birdsell, Daniel, Modeling the fate and transport of hydraulic fracturing fluids in the subsurface, In Progress.
15. Allen, Jeffery, Improved Stokes equation formulations for glaciers and ice sheets, In Progress.

DOCTOR OF PHILOSOPHY (co-supervisor)

1. Mishra, Anil K., (Division of Hydrology, New Mexico Institute of Mining and Technology) Reactive Transport in Chemically and Physically Heterogeneous Porous Media : Effect of Non-equilibrium Linear Sorption, (Primary supervisor: Allan Gutjahr (deceased), New Mexico Tech). Spring 1997.
2. Garcia, Daniel F., (Department of Environmental Science and Engineering, Colorado School of Mines) Scale-Dependence of Non-reactive and Sorptive Transport Parameters Estimated From Radial and Uniform Flow Tracer Tests in Complex Geologic Formations: Numerical and Experimental Investigations, (Primary Supervisor: Tissa Illangasekare, Colorado School of Mines). Spring 2003.
3. Rick, Ursula, (Program in Oceanic and Atmospheric Sciences, University of Colorado, Primary Supervisors: W.T.Pfeffer and K. Steffen) Downslope Surface Meltwater Transport on the Greenland Ice Sheet. Fall 2008.
4. Phillips, Thomas, (Geography, University of Colorado, Boulder) The Influence of Hydrology on the Thermal Regime of the Ablation Zone of the Greenland Ice Sheet (Primary Supervisor: Konrad Steffen). Spring 2010.

POST-DOCTORAL RESEARCHERS

- Detwiler, Russell, Fall 2000 – Summer 2001.
- Cheung, Wendy, Fall 2002 - Spring 2003.
- Chaudhuri, Abhijit, Spring 2007 – Spring 2010.

SIGNIFICANT SERVICE AND PROFESSIONAL ACTIVITIES:

SERVICE AT THE UNIVERSITY OF COLORADO

Department:

Coordinator, Academic Program Review Self Study, 2010-11.

Associate Chair, 2006-2008

College:

First-Level Review Committee (Promotion and Tenure Review Committee), College of Engineering and Applied Science, University of Colorado, Boulder, 2005-2008, 2011-13.
Vice Chair (2012-13), (Chair 2013-14)

Member, mock-CAREER panel, Summer 2012.

Campus:

Member, Research Review Board, 2012-present

Member, Data Management Task Force, Boulder Campus, 2011-2013.

Member, Executive Advisory Council to the Graduate School, (EAC), 2006 – 2008

External Member, INSTAAR (Institute for Arctic and Alpine Research) Personnel Committee, 2004 - 2007

Member, Executive Committee, Campus-wide Graduate Research Traineeship Program Program in Hydrologic Sciences, 1998 – 2002.

OUTREACH ACTIVITIES

High School Honors Institute Presentation on Water and the Environment, August 1996

High School Honors Institute – Overview Presentation on Civil Engineering, August 2007

Presentation on Fluid Mechanics for “Go With the Flow”, ITLL Summer Program for Middle School Students and Teachers, Summer 1997.

Presentation on Civil Engineering Education and Careers, Engineering Open House, 1997, 1998, 1999, 2000, 2003

Coordinator, Engineering Open House Activities for Department of Civil, Environmental and Architectural Engineering, 2003, 2006, 2007

PROFESSIONAL SERVICE

Editor, Water Resources Research, 2013-present

Associate Editor, Water Resources Research, 2001-2003, 2009-2013.

Hydrologic Sciences Award Committee, American Geophysical Union, 2008-2010, (Chair 2010).

Associate Editor, ASCE Journal of Hydrologic Science and Engineering, 2001-2004

Guest Editor, Advances in Water Resources, Special Issue on Hyporheic Zone Processes and Modeling, (with Robert Runkel and Diane McKnight), 2001-03.

Member of Organizing Committee for AGU Chapman Conference on “Fractal Scaling, Nonlinear Dynamics and Chaos in Hydrologic Systems” held at Clemson, South Carolina, May 1998

Invited Participant, National Research Council Workshop on Conceptual Models of Flow and Transport in the Fractured Vadose Zone, Irvine, CA, March 18-19, 1999.

Member, Technical Peer Review Panel, South Metro (Denver) Water Supply Board study on Regional Groundwater Model and Well/Well-Field Simulation Under 100 Years of Projected Pumping, 2000-2001.

Invited Participant – Department Of Energy workshop on Computational Subsurface Sciences, Bethesda, MD, Jan 9-12, 2007.

Reviewed Papers for journals: Water Resources Research; American Society of Civil Engineers: Journal of Hydraulics; Journal of Hydrologic Science and Engineering; Journal of Water Resources Planning and Management; Advances in Water Resources; Transport in Porous Media; Journal of Hydrology; Journal of Contaminant Hydrology; Journal of Hydraulic Research; Geophysical Research Letters; Geological Society of America Bulletin; Stochastic Hydrology and Hydraulics; Canadian Geotechnical Journal; Science

Reviewed Proposal for: various National Science Foundation and Department of Energy Programs, Army Research Office (Department of Defense), National Aeronautics and Space Administration.