

Tetsu K. Tokunaga

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Education:

Ph.D., 1986, Soil Science, University of California, Berkeley
The temperature dependence of gas diffusivities in porous media
B.A., 1979, Soil Resources, University of California, Berkeley.

Biographical Summary:

Tetsu Tokunaga is a Senior Scientist (semi-retired) in the Energy Geosciences Division of Lawrence Berkeley National Laboratory, studying the physicochemical basis of environmental transport processes. While conducting his graduate studies on gas diffusion in porous media at the University of California, Berkeley, he began working at LBNL (1981) as a graduate student on unsaturated flow and transport from uranium mill tailings, and on reactive transport of selenium in contaminated wetland (Kesterson Reservoir). Upon graduation (Ph.D., Soil Science, 1986), he continued at LBNL conducting laboratory and field-based studies on flow and transport problems in soils and geologic media. In addition to his research at LBNL, he taught soil physics at the University of California, Berkeley (1990, 1992). He currently has over 120 publications in peer-reviewed journals.

Research Interests:

Tetsu Tokunaga's research combines soil physics with related fields of hydrogeology and biogeochemistry. His research accomplishments in the area of flow and transport include identifying a novel molecular free-path distribution model for gas diffusion in porous media, identifying scale limits for capillary hysteresis, the permeability-imbibition scaling relation, the importance of water film hydraulics in multiphase fluid flow, modeling and measurements of brine film thicknesses under confinement by supercritical CO₂, experimentally identifying uncertainties associated with scaling predictions of capillary pressure-saturation relations for supercritical CO₂-brine in porous media, showing that infiltration paths in talus rocks evolve towards a Boltzmann (geometric) distribution, measuring multiphase fluid equilibrium and flow in low permeability shales, and measuring solute diffusion through adsorbed water films. In field studies, he has expertise in monitoring subsurface flow and transport, particularly through developing novel methods for measuring hydraulic potentials in tandem with spatially resolved fluid sampling.

In the area of contaminant biogeochemistry, he has developed novel applications of the synchrotron X-ray microprobe for tracking transport and redox transformations of selenium, chromium, and uranium in sediments, identified the unsustainability of reduction-based remediation of uranium contamination, showed that unsaturated drainage of contaminated sediments can leach contaminants into groundwater for decades, and identified the role of uranyl vanadates in controlling uranium concentrations in some oxidizing environments.

In studies of terrestrial carbon, he tested the potential acceleration of soil carbon sequestration through gypsum dissolution, and quantified the contribution of deep unsaturated zone respiration to CO₂ fluxes measured at the soil surface.

Professional Experience:

1989 –1993: Scientist, Earth Sciences Division, Lawrence Berkeley National Laboratory

1990, 1992: Lecturer, Department of Soil Science, University of California, Berkeley.

1993 – 2001: Staff Scientist, Earth Sciences Division, LBNL.

2001 – Present: Senior Scientist, Energy Geosciences Division, LBNL

Service:

Energy Geosciences Division (formerly Earth Sciences Division), Professional Staff Committee (2001 – 2019).

LBNL Staff Committee (2008 – 2011)

Vadose Zone Journal, associate editor (2008 – 2021).

Water Resources Research, associate editor (2009 – 2020).

Patents and Invention Disclosures:

1. Tokunaga, T.K., Y. Kim, and J.M. Wan. Aug. 20, 2013. Method of precipitating uranium from an aqueous solution and/or sediment. Unites States Patent # US 8,512,572 B1.
2. Tokunaga, T.K., and D. Shuman. Aug. 23, 2010. A method to control low capillary pressure differences over arbitrarily high total pressures. Lawrence Berkeley National Laboratory, Invention Disclosure IB-2931.
3. Tokunaga, T.K., J. Wan, Y. Kim, W. Dong, G. Shi. April 5, 2012. Supercritical CO₂ and water microemulsions stabilized with refractory natural organic macromolecules. Lawrence Berkeley National Laboratory, Invention Disclosure IB-3242.

Publications in refereed journals:

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1. Tokunaga, T.K., 1985. Porous media gas diffusivities from a free path distribution model. *J. Chem. Phys.* 82:5298-5299.
2. Narasimhan, T.N., White, A.F., and T. Tokunaga, 1986. Groundwater contamination from an inactive uranium mill tailings pile. 2. Application of a dynamic mixing model. *Water Resources Res.* 22:1820-1834.
3. Tokunaga, T.K., 1988. Laboratory permeability errors from annular wall flow. *Soil Sci. Soc. Am. J.* 52:24-27.
4. Tokunaga, T.K., L.J. Waldron, and J. Nemson, 1988. A closed-tube method for measuring gas diffusion coefficients. *Soil Sci. Soc. Am. J.* 52:17-23.
5. Long, R.H.B., S.M. Benson, T.K. Tokunaga, and A. Yee. 1990. Selenium immobilization in a pond sediment at Kesterson Reservoir. *J. Environ. Qual.* 19:302-311.
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10. Tokunaga, T., 1992. The pressure response of the soil water sampler, and possibilities for simultaneous soil solution sampling and tensiometry. *Soil Sci.* 154:171-183.
11. Tokunaga, T., and R. Salve. 1994. Gauge sensitivity optimization in air pocket tensiometry: Implications for deep vadose zone monitoring. *Soil Sci.* 158:389-397.
12. Tokunaga, T.K., S.R. Sutton, and S. Bajt. 1994. Mapping of selenium concentrations in soil aggregates with synchrotron x-ray fluorescence microprobe. *Soil Sci.* 158:421-433.
13. Pickering, I.J., G.E. Brown, Jr., and T.K. Tokunaga. 1995. Quantitative speciation of selenium in soils using x-ray absorption spectroscopy. *Environ. Sci. Technol.*, 29, 2456-2459.
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104. Shen, W.J., L.G. Zheng, C.M. Oldenburg, A. Cihan, J. Wan, T.K. Tokunaga. 2018. Methane diffusion and adsorption in shale rocks: A numerical study using the dusty gas model in TOUGH2/EOS7C-ECBM. *Transport in Porous Media* 123, 3, 521-531, DOI: 10/1007/s11242-017-0985-y.
105. Wan, J., T.K. Tokunaga, W. Dong, K.H. Williams, Y. Kim, M.E. Conrad, M. Bill, W.J. Riley, S.S. Hubbard. 2018. Deep unsaturated zone contributions to carbon cycling in semi-arid environments. *J. Geophys. Res.- Biogeosci.* 123(9), 3045-3054, DOI: 10.1029/2018JG004669.

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108. Tokunaga, T.K., J. Wan, K.H. Williams, W. Brown, A. Henderson, Y. Kim, A.P. Tran, M.E. Conrad, M. Bill, R.W.H. Carroll, W. Dong, Z. Xu, A. Lavi, B. Gilbert, S. Romero, J.N. Christensen, B. Faybishenko, B. Arora, E.R. Siirila-Woodburn, R. Versteeg, J.H. Raberg, J.E. Peterson, S.S. Hubbard. 2019. Depth- and time-resolved distributions of snowmelt-driven hillslope subsurface flow and transport and their contributions to surface waters. *Water Resources Research*, 55, <https://doi.org/10.1029/2019WR025093>.
109. Wan, J., T.K. Tokunaga, K.H. Williams, W. Dong, W. Brown, A.N. Henderson, A.W. Newman, S.S. Hubbard. 2019. Predicting sedimentary bedrock subsurface weathering fronts and weathering rates. *Scientific Rep.* 9:17198, <https://doi.org/10.1038/s41598-019-53205-2>.
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111. Tokunaga, T.K. 2020. Simplified Green-Ampt model, imbibition-based estimates of permeability, and implications for leak-off in hydraulic fracturing. *Water Resources Research*, 56, e2019WR026919. <https://doi.org/10.1029/2019WR026919>.
112. Chang, C., Kneafsey, T.J., Wan, J., T.K. Tokunaga, S. Nakagawa. 2020. Impacts of mixed-wettability on brine drainage and supercritical CO₂ storage efficiency in a 2.5=D heterogeneous micromodel. *Water Resources Research*, 56(7), <https://doi.org/10.1029/2019WR026789>.
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Book chapters

1. Tokunaga, T.K., P.T. Zawislanski, P.W. Johannis, D. Lipton, and S.M. Benson. 1994. Field investigations of selenium speciation, transformation, and transport in some Kesterson Reservoir and Lahontan Valley soils. *in* *Selenium in the Environment*, W.T. Frankenberger, Jr., and S.M. Benson, eds. Marcel Dekker, Inc.
2. H.M. Ohlendorf, E.R. Byron, G.M. Santolo, S.M. Benson, P.T. Zawislanski, T.K. Tokunaga, and M. Delamore. 2002. Ecological Risk Assessment Example: Waterfowl and Shorebirds Feeding in Ephemeral Pools at Kesterson Reservoir, California. *Handbook of Ecotoxicology*, Second Edition, David J. Hoffman, Barnett A. Rattner, G. Allen Burton, Jr., John Cairns, Jr. Editors. CRC, Lewis Publishers.

3. Tokunaga, T.K. 2004. Tensiometry. *in* Encyclopedia of Soils in the Environment, D. Hillel, Ed., Elsevier.
4. Tokunaga, T.K., and J. Wan. 2013. Capillary pressure and mineral wettability influences on reservoir CO₂ capacity. *in* Reviews in Mineralogy and Geochemistry, D.J. DePaolo, D.R. Cole, A. Navrotsky, and I.C. Bourg, eds., Vol. 77, Chapter 14, pp. 481-503.

Selected conferences, proceedings, and invited talks (past 20 years)

1. Tokunaga, T. K., J. Wan, T. C. Hazen, E. Schwartz, M. Firestone, S. Sutton, M. Newville, K. Olson, A. Lanzirotti, and W. Rao. Diffusion-limited chromium reduction in soil aggregates. 222nd Am. Chem. Soc. National Meeting, Chicago, Aug. 26-30, 2001.
2. Tokunaga, T. K., Chromium-contaminated soils: Cr redox zonation in soil aggregates. Invited seminar, Dept. of Chemistry and Biochemistry, San Francisco State University, Oct. 19, 2001.
3. Tokunaga, T. K., J. Wan, T. C. Hazen, M. K. Firestone, E. Schwartz, S. R. Sutton, M. Newville, K. R. Olson, A. Lanzirotti, W. Rao, Intra-aggregate biogeochemical dynamics of chromium contamination and in-situ remediation. Am. Geophys. Union, Fall Meeting, San Francisco, CA Dec. 14, 2001.
4. Tokunaga, T. K. Chromium biogeochemistry in contaminated sediments: Linking laboratory batch scale and field-scale understanding. Invited seminar, Geological and Environmental Sciences, Stanford University, Jan. 29, 2002.
5. Tokunaga, T. K., J. Wan, T. C. Hazen, E. Schwartz, M. Firestone, D. Herman, S. Sutton, M. Newville, K. Olson, A. Lanzirotti, and W. Rao. Chromium biogeochemistry in contaminated sediments: Linking laboratory batch scale and field-scale understanding. U.S. Dept. of Energy, Natural and Accelerated Bioremediation Research Program Meeting, Warrenton, VA, March 18, 2002.
6. Tokunaga, T. K., J. Wan, K. R. Olson. Unsaturated hydraulic properties of gravels. Environmental Remediation Technology Department, Lawrence Berkeley National Laboratory, Sept. 23, 2002.
7. Tokunaga, T. K. Chromium biogeochemistry in contaminated sediments: Linking laboratory batch scale and field-scale understanding. Soil Microbiology seminar, Ecosystem Sciences, Department of Environmental Science, Policy and Management, University of California, Berkeley, Oct. 31, 2002.
8. Tokunaga, T. K., J. Wan, T. C. Hazen, E. Schwartz, M. Firestone, D. Herman, S. Sutton, M. Newville, K. Olson, A. Lanzirotti, and W. Rao. Chromium redox transformations in diffusion-
9. limited domains: Linking micro- and macroscale processes. Soil Science Society America Annual Meeting, Indianapolis, IN, Nov. 11, 2002.

10. Tokunaga, T.K., K.R. Olson, and J. Wan, Predicted disappearance of saturation hysteresis in coarse granular media based on capillary and gravity scaling, and experimental tests, Am. Geophys. Union, Fall Meeting, San Francisco, CA, Dec. 8, 2002.
11. Tokunaga, T.K., K.R. Olson, and J. Wan. Comparing unsaturated hydraulics of fractured rocks and gravels. 2nd Int. Symp. on Dynamics of Fluid in Fractured rocks, Berkeley, CA Feb. 10-12, 2004.
12. Tokunaga, T. K., J. Wan, J. Pena, S. Sutton, and M. Newville. Uranium diffusion in soils. Remediation of Chlorinated and Recalcitrant Compounds, The 4th International Conference, Monterey, CA, May 24-27, 2004.
13. Tokunaga, T.K., J. Wan, J. Pena, E. Brodie, M.K. Firestone, T.C. Hazen, S.R. Sutton, A. Lanzirotti, M. Newville. Uranium bioreduction dynamics in low permeability sediments. 10th International Symposium on Microbial Ecology, Cancun, Mexico, August 22-27, 2004.
14. Tokunaga, T.K. Infiltration flow path distributions in unsaturated rocks. Geosciences Research Program, Basic Energy Sciences, Symposium on Flow and Transport. Gaithersburg, MD, Sept. 24-25, 2004.
15. Tokunaga, T.K. K.R. Olson, and J. Wan. Infiltration flow path distributions in unsaturated rocks. Modeling Forum, Earth Sciences Division, Lawrence Berkeley National Laboratory, Oct. 6, 2004.
16. Tokunaga, T.K., K.R. Olson, and J. Wan. Infiltration flow path distributions in unsaturated rocks. Am. Geophys. Union, Fall Meeting, San Francisco, Dec. 14, 2004.
17. Tokunaga, T.K., J. Wan, T.C. Hazen, M.K. Firestone, E. Brodie, Z. Zheng, J. Larsen, D. Herman. Reoxidation of bioreduced uranium under reducing conditions. NABIR PI Workshop, Warrenton, VA, April 18, 2005.
18. Tokunaga, T.K., Y. Kim, J. Wan, R. Daly, E. Brodie, M.K. Firestone, T.C. Hazen. Long-term stability of biogeochemically reduced U and Cr in contaminated sediments. DOE-ERSP PI Meeting: invited talk, April 19, 2007. Warrenton, VA.
19. Tokunaga, T. K., J. Wan, Y. Kim, S. Sutton, A. Lanzirotti, M. Newville, and W. Rao. Long-term stability of chromate reduction in soil using organic carbon. Remediation of Chlorinated and Recalcitrant Compounds, The 6th International Conference, Monterey, CA, May 19-22, 2008.
20. Tokunaga, T.K. Hydraulic properties of adsorbed water films. Geosciences Research Program, DOE-BES Research Symposium on Experimental and Theoretical Geochemistry. Annapolis, MD, March 12-13, 2009.
21. Tokunaga, T.K., Y. Kim, and J. Wan. Searching for sustainable approaches to remediate U-contaminated environments. DOE-ERSP PI Meeting: April 22, 2009. Lansdowne, VA.
22. Tokunaga, T.K., and J. Wan, Hydraulics of water films in the subsurface. Am. Geophys. Union, Fall Meeting, San Francisco, Dec. 16, 2009.
23. Tokunaga, T.K., T.W. Kim, D. Shuman, A. Mei, A. Lanzirotti, S. Sutton, M. Newville, and B. Rao. Brine films in pores during geologic CO₂ sequestration: Hypothesized behavior and

- experimental update. Invited talk. Workshop on Supercritical CO₂-Materials Interactions, Brookhaven National Laboratory, Upton, New York, March 21-23, 2011.
24. Tokunaga, T.K. Some experimental approaches for investigating coupled soil processes at multiple scales. Invited talk. U.S. National Committee for Soil Science. Washington, DC. June 15-16, 2011.
 25. Tokunaga, T.K., Physicochemical controls on adsorbed water film thicknesses in unsaturated porous media. Goldschmidt Conference, Prague, August 14-19, 2011.
 26. Tokunaga, T.K., Brine Films in Reservoir Pores During Geologic CO₂ Sequestration. Invited talk. Am. Geophys. Union, Fall Meeting, San Francisco, Dec. 5, 2011.
 27. Tokunaga, T.K., Approaches for Investigating Hydraulic and Biogeochemical Gradients at Multiple Scales in Critical Zone Processes. Invited talk. Am. Geophys. Union, Fall Meeting, San Francisco, Dec. 8, 2011.
 28. Tokunaga, T.K. Capillary pressure relations for brine film thicknesses and for reservoir storage. Center for Nanoscale Control of Geologic CO₂ Symposium, Berkeley, October 18-19, 2012.
 29. Tokunaga, T.K., Water films in unsaturated porous media. BES Geosciences Workshop on Reactions and Transport within Internal Domains of Porous Media, San Francisco, Dec. 1-2, 2012.
 30. Tokunaga, T.K., J. Wan, J. Jung, T.W. Kim, Y. Kim, Saturation-capillary pressure relations in geologic CO₂ sequestration reservoirs. NRAP-LBNL meeting with Tom Richards, Jan. 17, 2013.
 31. Tokunaga, T.K., J. Wan, J. Jung, T.W. Kim, Y. Kim, W. Dong, S. Wang, Testing predictability of capillary pressure-saturation relations for geological CO₂ sequestration, Center for Nanoscale Control of Geologic CO₂ seminar, Lawrence Berkeley National Laboratory, July 30, 2013.
 32. Tokunaga, T.K., J. Wan, J. Jung, T.W. Kim, Y. Kim, W. Dong, S. Wang, Capillary pressure relations with brine saturations under geologic carbon sequestration conditions. Clay Minerals Society Annual Meeting, University of Illinois, Urbana-Champaign, Oct. 6-10, 2013.
 33. Tokunaga, T.K., Film hydrostatics and flow under control by capillarity and adsorption. Geological Society of America Annual Meeting, Denver, Oct. 26-30, 2013.
 34. Tokunaga, T.K., and J. Wan, Capillary pressure and mineral wettability influences on reservoir CO₂ capacity. Mineralogical Society of America Short Course on Geochemistry of Geological CO₂ sequestration, Lawrence Berkeley National Laboratory, December 7-8, 2013.
 35. Tokunaga, T.K., Geologic carbon sequestration for mitigation of climate change, and the influence of capillary phenomena. Invited seminar, School of Environmental Science and Technology, Dalian University of Technology, Dalian, China, April 1, 2014.

36. Tokunaga, T.K., Geologic carbon sequestration for mitigation of climate change, and the role of pore-scale processes. Invited seminar, School of Environmental Science and Technology, Dalian University of Technology, Dalian, China, April 3, 2014.
37. Han, Y.-S., T.K. Tokunaga, and C. Oh. Soil carbon sequestration in semi-arid soil through the addition of flue gas desulfurization gypsum (FGDG). European Geophysical Union General Assembly, Vienna, Austria, April 27 to May 2, 2014.
38. Tokunaga, T.K., J. Wan, W. Dong, K.H. Williams, Y. Kim, B. Faybishenko, M.E. Conrad, J.N. Christensen, C. Hobson, B. Gilbert, R.D. Dayvault, P.E. Long, S.S. Hubbard, Determining water and carbon fluxes into groundwater from a semi-arid floodplain vadose zone, Goldschmidt Conference, Sacramento, CA, June 12, 2014.
39. Tokunaga, T.K., SFA2.0 Tracking Component update/overview. Sustainable Systems SFA2.0 Fall 2014 Retreat, Bodega Bay, October 23, 2014.
40. Tokunaga, T., S. Wang, J. Wan, Y. Kim, W. Dong. Capillary trapping of scCO₂ in reservoirs: Laboratory experiments on quartz and limestone sands. Center for Nanoscale Control of Geologic CO₂ Annual Fall Symposium, November 3, 2014
41. Tokunaga, T.K., J. Wan, W. Dong, Y. Kim, K.H. Williams, M.E. Conrad, J.N. Christensen, M. Bill, B. Faybishenko, C. Hobson, R.D. Dayvault, P.E. Long, S.S. Hubbard, Water and carbon fluxes in a semi-arid region floodplain: Constraining seasonal- and depth-dependent fluxes at Rifle, Colorado, American Geophysical Union Fall Meeting, San Francisco, December 18, 2014.
42. Tokunaga, T., S. Finsterle, Y. Kim, J. Wan, T. Lanzirotti, and M. Newville. Solute diffusion along water films in unsaturated porous media. LBNL-ESD BES Geochemistry Cluster seminar, March 3, 2015.
43. Tokunaga, T., S. Wang, J. Wan. Capillary controls on CO₂-brine distributions in porous media. NCGC Dynamic Wetting Workshop, LBNL, April 21, 2015.
44. Tokunaga, Tetsu K., Jiamin Wan, Wenming Dong, Boris Faybishenko, Yongman Kim, John N. Christensen, Mark E. Conrad, Markus Bill, Chad Hobson, Kenneth H. Williams, Philip E. Long, and Susan S. Hubbard. Fluxes of Water and Carbon within the Rifle Floodplain Vadose Zone:
45. Overview of the Tracking Component of the Genomes to Watershed LBNL SFA. Poster. 2015 Environmental System Science PI Meeting, Washington, D.C. April 28-29, 2015.
46. Tokunaga, T.K., D.J. DePaolo, J. Wan, S. Wang, I. Bourg. Interfacial controls on geologic carbon sequestration. Joint Workshop of ESD and CSD BES Programs, LBNL, May 20, 2015.
47. Tokunaga, T., S. Wang, J. Wan, Y. Kim. Why do some scCO₂-brine saturation relations deviated from capillary scaling predictions? Center for Nanoscale Control of Geologic CO₂ Pore-scale multiphase Workshop, Stanford University, Aug. 25, 2015.

48. Tokunaga, T., S. Wang, J. Wan, Y. Kim. What causes deviations in predictions of scCO₂-brine saturation relations? Center for Nanoscale Control of Geologic CO₂ Fall 2015 Symposium, LBNL, Nov. 19-20, 2015.
49. Tokunaga, T.K., Y. Kim, J. Wan, W. Dong, M.E. Conrad, M. Bill, C. Hobson, K.H. Williams, P.E. Long. CO₂ production rate maxima in the deeper unsaturated zone of a semi-arid floodplain at rifle, Colorado. American Geophysical Union Fall Meeting, San Francisco, December 14-18, 2015.
50. Tokunaga, T.K., Y. Kim, M.E. Conrad, M. Bill, C. Hobson, K.H. Williams, W. Dong, J. Wan, M.J. Robbins, P.E. Long, B. Faybishenko, J.N. Christensen, S.S. Hubbard. Deep vadose zone respiration contributions to CO₂ fluxes from a semi-arid floodplain. Environmental System Science Principal Investigator Meeting. Bolger Center, Potomac, Maryland. April 26-27, 2016.
51. Tokunaga, T.K., A. Cihan, J. Wan, Y. Kim, and W. Shen. Understanding water controls on shale gas mobilization, U.S. Department of Energy, National Energy Technology Laboratory, Mastering the Subsurface Through Technology, Innovation, and Collaboration: Carbon storage and oil and gas technologies review meeting. Pittsburgh, PA, August 16-18, 2016.
52. Tokunaga, T.K., S. Finsterle, Y. Kim, J. Wan, A. Lanzirrotti, and M. Newville. Ion diffusion through water films in unsaturated sands. American Geophysical Union Fall Meeting, San Francisco, December 12-16, 2016.
53. Tokunaga, T.K., J. Wan, B. Dafflon, E. Lege, B. Arora, E. Woodburn, Y. Kim, A. Lavy, J.J. Beisman, B. Faybishenko, M. Conrad, M. Bill, J.N. Christensen, W. Brown, J. Raberg, J. Banfield, R. Maxwell, K.H. Williams. Hillslope subsurface characterization, measurements, and modeling. Environmental System Science Principal Investigator Meeting. Bolger Center, Potomac, Maryland. April 25-26, 2017.
54. Tokunaga, T.K., A. Cihan, J. Wan, Y. Kim, and W. Shen. Water interactions with shales, and impacts on gas mobilization into fractures, U.S. Department of Energy, National Energy Technology Laboratory, Mastering the Subsurface Through Technology, Innovation, and Collaboration: Carbon storage and oil and gas technologies review meeting. Pittsburgh, PA, August 1-3, 2017.
55. Tokunaga, T.K. Some uncertainties associated with capillarity in geologic CO₂ sequestration. Center for Nanoscale Control of Geologic CO₂, Fall 2017 Symposium, LBNL, Nov. 2-3, 2017.
56. Tokunaga, T.K., J. Wan, S. Wang, C. Garing, S. Benson. Uncertainties associated with capillarity in geologic CO₂ sequestration. Invited talk, 13th International Symposium on Reservoir Wettability and its Effects on Oil Recovery. University of Texas, Austin, May 8-9-2018.
57. Tokunaga, T.K. Unsaturated flow and transport at Riverton, Kesterson, Rifle, and East River. Invited talk, Earth System Science, Stanford University, November 13, 2018.
58. Tokunaga, T.K., J. Wan, W. Brown, Y. Kim, K.H. Williams, A. Henderson, A.P. Tran, W. Dong, Z. Xu, M. Bill, M.E. Conrad, A. Lavy, J.N. Christensen, B. Faybishenko, B. Arora, S. Romeror, B. Gilbert, R. Versteeg, S.S. Hubbard. Constraining the depth and temporal

distribution of subsurface flow and transport along a hillslope transect. American Geophysical Union Fall Meeting, Washington, D.C., December 9-13, 2018.

59. Tokunaga, T.K. Subsurface flow, solute discharges, and hillslope weathering. Watershed Science Community Call, Lawrence Berkeley National Laboratory, May 14, 2019.
60. Tokunaga, T.K. Matric (capillary) potential measurements, their importance and some persistent challenges. Energy Geosciences Division Colloquium, Lawrence Berkeley National Laboratory, June 18, 2019.
61. Tokunaga, T.K., S. Finsterle, A. Lanzirotti, M. Newville. Unsaturated porous media experiments on nanoconfinement influences of water films on diffusion and flow. Goldschmidt Conference, Barcelona, August 18-23, 2019.
62. Tokunaga, T.K. Scaling to reduce uncertainty in predictions of short-term imbibition. American Geophysical Union Fall Meeting, San Francisco, December 9-13, 2019.