DAVID R. COLE: CURRICULUM VITAE

School of Earth Sciences
305 Mendenhall Laboratory
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EDUCATION/DEGREES:

The Pennsylvania State University, University Park, PA
Degree: Doctor of Philosophy in Geochemistry and Mineralogy, Nov. 1980
Dissertation: Mechanisms and Rates of Stable Isotopic Exchange in Hydrothermal Rock-Water Systems
Adviser: Hiroshi Ohmoto

The Pennsylvania State University, University Park, PA
Degree: Master of Science in Geology, August 1976
Thesis: The Geology and Geochemistry of Lead and Zinc in Soils in the Thurman Area, Southeastern Adirondack Mountains, New York
Adviser: Arthur W. Rose

The State University of New York, College at Cortland, Cortland, NY
Degree: Bachelor of Science in Geology, May 1973
Senior Thesis: Geology of the Raglan Lake Ni-Cu Deposits, N. Quebec, Canada
Adviser: W. Maxwell Hawkins

APPOINTMENTS:

2010-present	Professor, Ohio Research Scholar Endowed Chair, Subsurface Science and Sustainability, School of Earth Sciences, The Ohio State University
2021-presnt	Senator, College of Arts and Sciences
2011-present	Adjunct Professor, Dept. Chemistry and Biochemistry, OSU
2010-present	Director: SEMCAL-Subsurface Energy Materials Characterization and Analysis Laboratory, OSU
2015–2020	Director, OSU Center for Energy Research, Training, and Innovation (CERTAIN)
2011-2019	Executive Committee, Deep Carbon Observatory (DCO)
2011-2015	Chair, Deep Energy Community of the A.P. Sloan Foundation-funded Deep Carbon Observatory, Carnegie Institution of Washington
2005-2010	Head, Geochemistry and Interfacial Sciences Group, ORNL
2003-2010	Distinguished R&D Staff Scientist, ORNL
2001-2004	Task Leader, Geochemistry, Chemical Sciences Division, Oak Ridge National Laboratory (ORNL), Oak Ridge, TN
1996-2001	Group Leader, Geochemistry Group, Chemical and Analytical Sciences Division, ORNL
1992-2002	Senior Research Staff Scientist - Chemical and Analytical Sciences

	Division (now Chemical Sciences Division), ORNL
1982-1991	Research Staff Scientist - Chemistry Division, Oak Ridge National Laboratory, Oak Ridge, TN
1987-2010	Adjunct Professor, Dept. Earth & Planetary Sci., Univ. Tenn. Knoxville
1979-1982	Research Geochemist - Earth Science Laboratory (now Energy and Geosciences Inst.), University of Utah Research Institute, Salt Lake City, UT
1977-1979	NSF Graduate Fellow, Dept. Geosciences, Penn. State Univ.
1975-1977	Research Assistant, Geochemistry Section, Department of Geosciences, The Pennsylvania State University
1975-1976	Consulting Isotope Geochemist, Chevron Resources Co. (through Dept. of Geosciences, Penn. State)
1974	Research Exploration Geologist, St. Joe Mineral Co., Princeton, N. J. (May-August summer M.S. thesis support - Adirondack Mts. New York)
1973-1975	Graduate Teaching Assistant, Geology Section, Department of Geosciences, Pennsylvania State University
1973	Exploration Geologist, St. Joe Mineral Co., Princeton, N. J. (summer-mapping/sampling Adirondacks; Jan. - geophysics N. Carolina Slate Belt)

***RESEARCH INTERESTS*:**

- Energy and mineral resource development and sustainability; associated environmental impacts
- Properties of subsurface energy materials: pore-scale processes, gas shale, seal rocks, oil and gas reservoirs, active and paleo-geothermal systems
- Solid-fluid interfaces: structure, dynamics and reactivity at the nanoscale, weathering processes, biomineralization, corrosion during ultra-supercritical oxidation
- Biogenic versus abiogenic hydrocarbons: deep Earth carbon cycle
- Gas and stable isotope tracers: CO_2 sequestration injection tests (esp. EOR), gas shale, Enhanced Geothermal Systems (EGS), active geothermal systems
- Paleo-environment reconstruction: banded-iron formation, ancient soils

***RESEARCH TOPICS*:**

- Geophysical and geochemical properties of reservoir and caprocks for CO_2 storage Monitoring of geological CO_2 sequestration using isotopes and PF tracers – Cranfield, MS and Gaylord, Michigan CO_2 enhanced oil recovery (EOR) tests
- Evolution of nano-to microporosity in representative seal and reservoir rocks – gas shale, CO_2 storage, geothermal systems
- Physical-chemical response to geomechanical processes during geologic CO_2 sequestration
- Nanopore confinement of C-H-O mixed volatiles and aqueous fluids relevant to subsurface energy systems
- Reduced carbon the Earth's crust and mantle I: Abiogenic versus biogenic origin
- Natural Hydrogen Resources: Reaction mechanisms and rates

EDITORIAL BOARDS:

1999-2010	Associate Editor, American Mineralogist
1999-2010	Associate Editor, Geochimica et Cosmochimica Acta
1999-2001	Associate Editor, Geochemical Newsletter of the Geochemical Society
1986-1988	Editorial Board, J. Geochemical Exploration

PROFESSIONAL SOCIETIES:

Geochemical Society (GS rep to the Spring AGU Planning Committee: 1999-2001)
Mineralogical Society of America (Dana Medal awards committee, 2012-2016; RiMG Short Course 2021-present)
American Geophysical Union Geological Society of America
American Chemical Society American Association for the Advancement of Science
Clay Minerals Society

PROFESSIONAL HONORS/AWARDS:

1977-1979	National Science Foundation Graduate Fellow
1987	ORNL Award of Publication Excellence "Stable Isotope Exchange Kinetics at Elevated P and "
1996	Dept. of Energy, Outstanding Contributions in Geosciences Research, "Salt Effects on Stable Isotope Partitioning" given at the Geosciences Research Symposium on "Reactivity and Mobility of Geologic Fluids: Constraints from Inorganic Geochemistry"
1998	ORNL Research Accomplishment Award "Discovery, Description and Evolutionary Implications of Novel Subsurface Thermophilic Iron-Reducing Bacteria, with T. Phelps"
1998	Distinguished Alumni Award, SUNY College at Cortland
1998	State University of New York Alumni Fellow (system-wide)
2000	ORNL Technical Achievement Award "Exemplary effort leading to multiple, significant advancements in the field of isotope geochemistry" with J. Horita, L. R. Riciputi)
2006	Fellow, Mineralogical Society of America
2009	Oak Ridge National Lab Group Leader of the Year Award Oak Ridge Nat. Lab Director's Award – Top ORNL Scientist of the Year
2011	Bruno M. Hanson Best Paper Award, Div. of Environmental Geosciences American Association of Petroleum Geologists (AAPG)
2019	Fellow, Geological Society of America
2020	Contributor to: *Deep Carbon* - **CHOICE** Outstanding Academic Title of 2020 https://www.choice360.org/choice-pick/choice-outstanding-academic-titles/ Awarded the Association of American Publishers 2021 PROSE award for best Earth Science book https://publishers.org/news/association-of-american-publishers-announces-subject-category-winners-of-2021-prose-awards/

RESEARCH PROTFOLIO

PUBLICATIONS:

(* identifies carbon-based chemistry or geochemistry relevant to energy systems)
(Bold signifies grad students or postdocs as lead authors supported fully or partially by Cole and/or SEMCAL at the time of the publication)

In Review or In Press

Ok, S., Sheets, J., Welch, S, and Cole, D. R. (in review) Natural clay-methane interfacial interactions revealed by high-pressure Magic Angle Spinning (MAS) NMR. (submitted to *Energy and Fuels*)

Ali, A., Cole, D. R. and Striolo, A. (in review) Understanding the aggregation of island and archipelago asphaltene molecules near kaolinite surfaces using molecular dynamics. (submitted to *Energy & Fuels*)

Xu, Z., Cao, H., Yoon, S., Kang, P. K., Jun, Y-S., Kneafsey, T., Sheets, J., Cole., D. and Pyrak-Nolte, L. (in review) Gravity-driven controls on fluid and calcite precipitation distributions in fractures. (submitted to *Sci. Reports*)

Welch, S. A., Sheets, J. M., Kirst, D. and Cole, D. R. (in prep) Geochemical modeling of subsurface CO_2-SO_2 injection. (submitted to *Sci. Reports*)

Ok, S., Gautam, G., Liu, K-H. and Cole, D. R. (2022) Surface interactions and nanoconfinement of methane and methane plus CO_2 revealed by high-pressure Magic Angle Spinning NMR Spectroscopy and molecular dynamics. *Membranes* (IF=4.56) doi.org/10.3390/membranes12121273

Kummali, M. M., Cole, D. R. and Gautam, S. (2022) Dynamics of ethane, CO_2, water, and binary mixtures of ethane with CO_2 and water in ZSM-22. Proceedings 66th DAE Solid State Physics Symposium, Ranchi, Dec. 18-22, 2022.

Dhiman, I., Berg, M. C., Cole. D. R. and Gautam, S. (2022) Correlation between structure and dynamics of CO_2 confined in Mg-MOF-74 and the role of inter-crystalline space: A molecular dynamics simulation study. *Applied Surface Chemistry*. (IF=6.7) doi.org/10.1016/j.apsusc.2022.155909

Welch, S. A., Sheets, J M, Elsa Saelans, Matt Saltzman, Tom Darrah, Anthony Lutton, John Olesik, Neil Sturchio and David R Cole (2022) Chemical and isotopic evolution of flowback fluids from the Utica gas shale play, eastern Ohio USA. *Chem. Geol*. (IF=4.32) doi.org/10.1016/j.chemgeo.2022.121186

Hajirezaie, S., Peters, C. A., Cole, D. R., Sheets, J. M., Kim, J. J., Swift, A. M., Crandall, D., Cheshire, M. C., Stack, A. G. and Anovitz, L. M. (2022) Strategies for sealing fractures to

increase the security of geologic CO_2 storage: Lessons learned from a multiscale multimodal imaging study of a syntaxial vein in a mudrock. *Chem. Geol.* (IF = 4.32) doi.org/10.1016/j.chemgeo.2022.121164

Hwang, B., Srivastava, D. J., Deng, H., Grandinetti, P. J. and Cole, D. R. (2022) Sodium diffusion in heterogeneous porous media: Connecting laboratory experiments and simulations. *Geochim. Cosmochim. Acta*. doi.org/10.1016/j.gca.2022.09.028 (IF=5.92)

McGunningle, J., Cano, E., Sharp, Z., Muehlenbachs, K., Cole, D. R., Hardman, M., Stachel, T. and Pearson, G. (2022) Triple oxygen isotope evidence for a hot Archean Ocean. *Geology* doi.org/10.1130/G50230.1 (IF=6.32)

Gautam, S. and Cole, D. R. (2022) Effects of pore connectivity and tortuosity on the dynamics of fluids confined in sub-nanometer pores. *Phys Chem Chem Phys* 19, 11836-11847 DOI: 10.1039/D1CP04955K (IF=3.68)

Lyu, C., Ning, Z., Wang, Q., and Cole, D. R. (2022) Review on underlying mechanisms of low salinity waterflooding: Comparison between sandstones and carbonates. *Energy and Fuels* 36, 2407-2473. (IF=3.61)

Rother, G., Gautam, S., Liu, T., Cole, D. R., Busch, A. and Stack A. (2022) Molecular structures of adsorbed water phases in silica nanopores. (*J. Phys. Chem.-C*) 126, 5, 2885–2895. doi.org/10.1021/acs.jpcc.1c10162 (IF=4.17)

Anovitz, L. M., Beckingham, L. E., Sheets, J. and Cole, D. R. (2022) A Quantitative Approach to the Analysis of Reactive Mineralogy and Surface Area *Earth Space Chem*. 6, 2, 272–287. doi.org/10.1021/acsearthspacechem.1c00198 (IF=3.37)

2021

Lyu, Chaohui, Ning, Z., Wang, Q. and Cole, D. R. (2021) Characterization of nanoscale pores in tight sandstones using complex techniques: A case study of Linxing tight gas sandstone reservoir. *Geofluids*, *Special Issue - New Challenges and Advances in the Unconventional Oil/Gas Reservoirs Characterization and Development*. Article ID 7670556, 10 p. | https://doi.org/10.1155/2021/7670556 (IF=6.32)

Sheets, J. M., Welch, S. A., Liu, T., Buchwalter, E. R., Swift, A. M., Chipera, S., Anovitz, L. M. and Cole, D. R. (2021) A mineralogy, microfabric and pore assessment of core from the Utica/Point Pleasant sub-basin of Ohio, West Virginia, and Pennsylvania. *Marine and Petroleum Geol*. 105345. doi.org/10.1016/j.marpetgeo.2021.105345 (IF = #.28)

Cole, D. R. and Ross, N. – Editors (2021) Exploring Earth and Planetary Materials with Neutrons. *Elements* June vol. 17 no. 3 ISSN 1811-5209 (print); ISSN 1811-5217 (online)

Ross, N. and Cole, D. R. (2021) Neutron Scattering – 101: A Primer for Earth Scientists. *Elements*, June vol. 17 no. 3, 155-160. DOI: 10.2138/gselements.17.3.155 (IF=3.63)

*Stack, A., Wang, H.-W. and Cole, D. R. (2021) Nano-Scale Structure and Dynamics in Geochemical Systems. *Elements*, June vol. 17 no. 3, 169-174.
DOI: 10.2138/gselements.17.3.169 (IF=3.63)

* Gautam, S. and Cole, D.R. (2021) Effects of pore connectivity on the sorption of fluids in nanoporous material: Ethane and CO_2 sorption in silicalite. *ChemEngineering*, *5*, 55. https://doi.org/10.3390/chemengineering5030055 (IF=3.20)

***Ali, A.**, Striolo, A. and Cole, D. R. (2021) CO_2 solubility in aqueous electrolyte solutions confined in calcite nanopores. *J. Phys. Chem. -C* 125, 12333-12341. doi.org/10.1021/acs.jpcc.1c02219 (IF=4.17)

***Le, T. T, B.**, Divine-Avela, C., Striolo, A. and Cole, D. R. (2021) Effects of surface contamination on the interfacial properties of CO_2/water/calcite systems. (*Phys. Chem. Chem. Phys*. 23, 18885. DOI: 10.1039/d1cp01106e (IF=3.68))

*Kummali, M.M., Cole, D. R. and Gautam, S. (2021) Effect of pore-connectivity on the behavior of fluids confined in sub-nanometer pores: Ethane and CO_2 confined in ZSM-22. *Membranes* 11, 113-127. doi.org/10.3390/membranes11020113 (IF=4.56)

Welch, S. A., Sheets, J. M., Daly, R. A., Hanson, A., Sharma, S., Darrah, T, H., Olesik, J., Lutton, A., Mouser, P. J., Wrighton, K. C., Wilkins, M. J., Carr, T. and Cole, D. R. (2021) Comparative geochemistry of flowback chemistry from the Utica/Point Pleasant and Marcellus Formations. *Chem. Geol.* 564, 120041 doi.org/10.1016/j.chemgeo.2020.120041 (IF=4.32)

2020

*Gautam, G. and Cole, D. R. (2020) CO_2 adsorption in metal organic framework Mg-MOF-74: Effects of inter-crystalline space. *nanomaterials* 10, 2274 doi:10.3390/nano10112274

Anovitz, L. M., Cheshire, M., Hermann, R., Gu, X., Sheets, J., Brantley, S., Cole, D. R., Ilton, E., Mildner, D., Gagnon, C., Allard, L. F. and Littrell, K. (2021) Oxidation and associated pore structure modification during experimental alteration of granite. *Geochim. Cosmochim. Acta* 292, 532-556. doi:org/10.1016/j.gca.2020.08.016

***Ali, A.**, Le, T. T. B., Striolo, A. and Cole, D. R. (2020) Salt effects on the structure and dynamics of interfacial water on calcite probed by equilibrium molecular dynamics simulations. *J. Phys. Chem. – C* 124, 24822-24836 doi:org/10.1021/acs.jpcc.0c07621 (Front Cover)

Allen, G. R., Schwartz, F. W., Cole. D. R., Lanno, R. P., Prabhu, A. and Eleish, A. (2020) Algal blooms in a freshwater reservoir: A network community detection analysis of potential forcing parameters. *Ecological Informatics* 60, 101168 doi.org/10.1016//j.ecoinf.2020.101168

*__Le, T. T. B__., Striolo, S. and Cole, D. R. (2020) Supercritical CO_2 effects on calcite wettability – A molecular perspective. *J. Phys. Chem. – C* 124, 18532-18543. doi.org/10.1021/acs.jpcc.0c03210

Ok, S., Hwang, B., Liu, T., Welch, S., Sheets, J., Cole, D. R., Liu, K-H., and Mou, C-Y. (2020) Fluid behavior in nanoporous silica. *Frontiers in Chemistry,* vol. 8 doi: 10.3389/fchem.2020.00734

Ok, S., Sheets, J., Welch, S. A., Cole. D. R., Berman, M., Rua, A., Greenbaum, S., Deepansh, S. and Grandinetti, P. J. (2020) High-temperature and high-pressure NMR investigations of low viscous fluids confined in mesoporous systems. *Zeitschrift für Physikalische Chemie*. vol. 235, no. 7, 2021, pp. 931-959. https://doi.org/10.1515/zpch-2019-1510

Ok, S., Sheets, J., Welch, S. A., Liu, T., Kaya, S. and Cole, D. R. (2020) Wetting behaviors of fluoroterpolymer fiber films. *ePolymers*. 20, 393-410. doi.org/10.1515/epoly-2020-0043

*Gautam, S and Cole, D. R. (2020) Effects of inter-crystalline space on the sorption of ethane and CO_2 in silicalite. *Phys. Chem. Chem. Phys*. 22, 13951-13957. doi:10.1039/d0cp01206h

Rother, G., Stack, A., Gautam, S., Liu, T., Cole, D. R. and Busch, A. (2020) Water uptake in silica nanopores: Impacts of surface hydrophilicity and pore size. *J. Phys. Chem. – C* 124, 15188-15194. doi.org/10.1021/acs.jpcc.0c02595

***Badmos, S. B**., Islam, N., Shah, U., Striolo, A. and Cole, D. R. (2020) Competitive adsorption and reduced mobility: N-octane, CO_2 and H_2S in alumina and graphite pores. *Molec. Phys.* 118(23) doi.org/10.1080/00268976.2020.1781944

***Liu, T**., Gautam, S., Cole, D. R., Patankar, S., Tomasko, D., Zhou, W. and Rother, G. (2020) Structure and dynamics of ethane confined in silica nanopores in the presence of CO_2 *J. Chem. Phys. C* 152 (8) 10.1063/1.5134451 doi: 10.1063/1.5134451

Liu, T., Gautam, S., Daemen, L., Kolesnikov, A. I., Anovitz, L. M., Hartl, M. and Cole, D. R. (2020) Vibrational behavior of water adsorbed on forsterite (Mg_2SiO_4) surfaces. *Earth Space Chem*. 4 (7) 1050-1063. doi.org/10.1021/acsearthspacechem.0c00084

Lyu, C., Ning, Z., Cole, D. R., Wang, Q. and Chen, M. (2020) Experimental investigation on T2 cutoffs of tight sandstone: Comparison between outcrop and reservoir core. *J. Petrol. Sci. Eng*. 191, 107184. doi.org/10.1016/j.petrol.2020.107184

2019

*Gautam, S., Le, T.T.B., Rother, G., Jalarvo, N., Liu, T. Mamontov, E., Dai, S., Qiao, Z, Striolo, A. and Cole, D. R. (2019) Effect of water on the stochastic motion of propane confined in MCM-41-S pores. *Phys. Chem. Chem. Phys*. **21**, 25035-25046

Nixon, S. I., Daly, R. A., Borton, M. A., Solden, L. M., Panescu, J., Welch, S. A., Cole, D. R., Mouser, P. J. Wilkins, M. J. and Wrighton, K. C. (2019) Genome-resolved metagenomics extends the environmental distribution of the Verrucomicrobia phylum to the deep terrestrial subsurface. *mSphere* 4 (6), 1-18 doi.org/10.1128/mSphere.00613-19.
doi: 10.1039/C9CP04741G

***Le, T. T. B.,** Striolo, A. and Cole, D. R. (2019) Partial CO_2 reduction in amorphous cylindrical silica nanopores studied with reactive molecular dynamics simulations. *J. Phys. Chem. C* 2019, 123, 43, 26358-26369. DOI: 10.1021/acs.jpcc.9b07344

***Badmos, S. B.,** Bui, T., Striolo, A. and Cole, D. R. (2019) Factors governing the enhancement of hydrocarbon recovery via acid gas injection: Insights from a molecular dynamics study. *J. Phys. Chem. C* 2019, 123, 39, 23907-23918.
doi:10.1021/acs.jpcc.9b04247

*Cole, D. R. and Striolo, A. (2019) Chapter 12. The Influence of nanoporosity on the behavior of carbon-bearing fluids. In: *Deep Carbon: Past and Present*. (editors – B. Orcutt, I. Daniel, R. Dasgupta), Cambridge University Press, 358-387. Doi:10.1017/9781108677950

*Amonette, J., Zhong, L., Darrah, T., Grove, B. and Cole, D. R. (2019) Noble and major gases released from rock core materials as intrinsic tracers for detecting CO_2 leakage – Laboratory evaluation. *Internat. J. Greenhouse Gas Control* 89, 76-88.
doi.org/10.1016/j.ijggc.2019.05.010

Evans, M. V., Getzinger, G., Luek, J. L., Blotevogel, J., Hanson, A. J., McLaughlin, M. C., Welch, S. A., Nicora, C. D., Purvine, S. O., Xu, C., Cole, D. R., Darrah, T. H., Hoyt, D. W., Metz, T. O., Ferguson, P. L., Lipton, M. S., Wilkins, M. J. and Mouser, P. J. (2019) In situ transformation of ethoxylate and glycol surfactants by shale-colonizing microorganisms during hydraulic fracturing. *Intl. Soc. Microbial Ecology (ISME) J.* 13, 2690-2700.
doi.org/10.1038/s41396-019-0466-0

*Wang, Q., **Lyu, C**. and Cole, D. R. (2019) Effects of hydration on fractures and shale permeability under different confining pressures: An experimental study. *J. Petrol. Sci. Eng.* 176, 745-7453. i.org/10.1016/j.petrol.2019.01.068

*Anovitz, L. M. and Cole, D. R. (2019) Analysis of the pore structures of shale using neutron and X-ray small-angle scattering. In: *Amer. Geophys Union Monograph 238 –Geological Carbon Storage: Subsurface Seals and Caprock*, (eds. S. Vialle, J. Ajo-Franklin, W. Carey), 71-118 https://doi.org/10.1002/9781119118657.ch4

***Gautam, S**., Liu, T. and Cole. D. R. (2019) Sorption, structure and dynamics of CO_2 and ethane in silicalite at high pressure: A combined Monet Carlo and molecular dynamics simulation study. *Molecules* 24 (99), doi:10.3390/molecules24010099.

*Dhiman, I., Shrestha, U. R., Bhowmik, D., Cole, D. R. and Gautam, S. (2019) Influence of molecular shape on self-diffusion under severe confinement: A molecular dynamics study. *Chemical Physics* 516, 92-102. https://doi.org/10.1016/j.chemphys.2018.08.033

*Welch, S., Sheets, J., Place, M., Saltzman, M. Edwards, C. T., Gupta, N. and Cole, D. R. (2019) Geochemical monitoring of CO_2 injection into an oil-bearing reef in the Northern Michigan Basin. *Applied Geochemistry*, 100, 380-392. https://doi.org/10.1016/j.apgeochem.2018.12.008

Liu, T., Luo, W., Asthagiri, A. and Cole, D. R. (2019) Water adsorption on olivine (010) surfaces: Effect of alkali and transition metal cation doping. *J. Chem. Phys*. 150, 044703-1 to 044703-12 doi: 10.1063/1.5058770

2018

Liu, T., Gautam, S., Wang, H-W., Anovitz, L. M., Mamontov, E., Allard, L. F. and Cole, D. R. (2018) Structure and dynamics of water on forsterite surface. *Phys. Chem. Chem. Phys*. 20, 27822-27829. doi: 10.1039/c8cp05075a.

***Borton, M. A**., Daly, R. A., O'Bannion, B., Hoyt, D. W., Welch, S., Hastings, S. S., Meulia, T., Marcus, D. N., Wolfe, R., A., Booker, A. E., Sharma, S. Cole, D. R., Moore, J. D., Wilkins, M. J. amd Wrighton, K. C. (2018) Comparative genomics and physiology of the genus *Methanohalophilus*, a prevalent hydraulically fractured shale methanogen. *Environmental Microbiology* 20(12), 4596–4611 doi:10.1111/1462-2920.14467

***Evans, M. V**., Panescu, J., Hanson, A. J., Welch, S. A., Sheets, J. M., Nastasi, N., Daly, R. A., Cole, D. R., Darrah, T. H., Wilkins, M. J., Wrighton, K. C., and Mouser P. J. (2018) Influence of Marinobacter and Arcobacter taxa on system biogeochemistry during early production of hydraulically fractured shale gas wells in the Appalachian Basin. *Frontiers Microbiol*., Vol. 9, article 2646 | https://doi.org/10.3389/fmicb.2018.02646

***Gautam, S**., Kolesnikov, A. I., Rother, G., Dai, S., Qiao, Z-A. and Cole, D. R. (2018) Effect of confinement, pressure and temperature on vibrational behavior of propane. *J Phys Chem – A* **DOI:** 10.1021/acs.jpca.8b05028

Badmos, S. B., Striolo, A. and Cole, D. R. (2018) Aqueous hydrogen sulphide in slit-shaped silica pores: Confinement effects on solubility, structural and dynamical properties. to *J Phys Chem-C* 122 (26) 14744-14755. https://pubs.acs.org/doi/10.1021/acs.jpcc.8b04527

Horita, J., Driesner, T. and Cole, D. R. (2018) Hydrogen isotope fractionation in the system brucite-water±NaCl to elevated temperatures and pressures: Implications for the D/H reduced partition function ratios of NaCl solutions under geologic conditions. *Geochim Cosmochim Acta* 235, 140-152.

***Le, T. T. B**., Striolo and Cole, D. R. (2018) Structural and dynamical properties predicted by reactive force field simulations of four common pure fluids at liquid and gaseous non-reactive conditions. *Molecular Simulations*. 44 (10), 826-839. Doi.org/10.11080/08927022.2018.1455005

*__Dhiman, I__., Bhowmik, D., Cole, D. R. and Gautam, S. (2018) Effect of molecular shape on rotation under severe confinement. *Chem. Eng. Sci*.180, 33-41. https://doi.org/10.1016/j.ces.2018.01.027

Borton, M. A., Hoyt, D. W., Daly, R. A., Roux, S., Welch, S. A., Morgan, D. M., Nicora, C. D., Purvine, S., Hansen, A. J., Sharma, S., Carr, T. R., Cole, D. R., Mouser, P. J., Lipton, M. S., Wilkins, M. J. and Wrighton, K. C. (2018) Coupled laboratory and field investigations resolve microbial interactions that underpin persistence in hydraulically fractured shales. *Proc. Nat. Acad. Sci*, doi/10.1073/pnas.1800155115

Soltanian, M. R., Amooie, M. A., Cole. D. R., Graham, D., Hosseini, S. A., Hovorka, S., Pfiffner, S. Phelps, T. J. and Moortgat, J. (2018) Transport of perfluorocarbon tracers in the Cranfield Geological carbon sequestration project. *Greenhouse Gases: Science and Technology,* 8 (4) 650-671. https://doi.org/10.1002/ghg.1786

Soltanian, M. R., Amooie, M. A., Cole. D. R., Darrah, T. H., Graham, D., Pfiffner, S. Phelps, T. J. and Moortgat, J. (2018) Impacts of methane on carbon dioxide storage in brine formations. *Groundwater* 56 (2) 176-186. d oi: 10.1111/gwat.12633

***Gautam, S**., Dhiman, I., Song, G., Rother, G. Swift, A., Bilheux, H., Santodonato, L. and Cole, D. R. (2018) Effect of water on the enrichment of ethane perpendicular to the flow direction in a limestone sample: Neutron radiography experiment. *Proceedings of the 62nd DAE Solid State Physics Symposium*, Anushaktinagar, Mumbai, India Dec 26-30.

2017

***Le, T. T. B**., Striolo, A., Gautam, S. and Cole, D. R. (2017) Propane-water mixtures confined within cylindrical silica nano-pores: Structural and dynamical properties probed by molecular dynamics. *Langmuir - K. Gubbins Special Issue* 33(42) 11310-11320. DOI:10.1021/acs.langmuir.7b03093

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Horita, J., Cole, D. R. and Wesolowski, D. J. (1993) The activity-concentration relations of oxygen and hydrogen isotopes in aqueous salt solutions. II: Vapor-liquid water equilibration of mixed salt solutions from 50 to 100°C. *Geochim. Cosmochim. Acta*, v. 57, p. 4703-4711.

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Cole, D. R., Ohmoto, H., and Jacobs, G. K. (1992) Isotopic exchange in mineral-fluid systems III. Rates and mechanisms of oxygen isotope exchange in the system granite-H_2O±NaCl±KCl at hydrothermal conditions. *Geochim Cosmochim. Acta*, v. 56, p. 445-466.

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Cole, D. R. (1992) Possible evidence for fluid-rock oxygen isotope disequilibrium in hydrothermal systems. In *Proceedings of the 7th International Symposium on Water-Interaction - WRI-7*, Park City, Utah, (Kharaka, Y. K. and Maest, A. S., eds.), p. 995-998.

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*Mack, G. H., Cole, D. R. Giordano, T. H., Schaal, W. C. and Barcelos, J. H., (1991) Paleo-climate controls on stable oxygen and carbon isotopes in caliche of the Abo Formation (Permian), south-central New Mexico, U.S.A., *J. Sed. Pet*., v. 61, p. 458-472.

Maya, L., Cole, D. R., and Hagaman, E. (1991) Carbon-nitrogen pyrolyzates: attempted preparation of carbon nitride. *J. Amer. Ceramic Soc*., v. 74, p. 1686-1688.

Cole, D. R., Wesolowski, D. J. and Drummond, S. E. (1991) The solubility of calcite and dolomite to temperatures of 300°C and pressures of 1.3 kbars. In *Proceedings: 1991*

Symposium on Chemistry in High-Temperature Aqueous Solutions, R. M. Izatt, J. L. Oscarson and S. E. Gillespie, editors, Electric Power Research Institute, TR-102706, B20-1.

1990

Cole, D. R., Curtis, D. B., DePaolo, D. J., and others (1990) Isotope geochemistry: A critical component of energy research. *Los Alamos National Laboratory Report, LA-11849-MS*, p. 20.

1989

Cole, D. R. and Wesolowski, D. J. (1989) Oxygen and hydrogen isotope partitioning between water liquid and vapor at elevated temperatures. *Trans. Geothermal Res. Council*, v. 13, p. 235-240.

Cole, D. R. and Wesolowski, D. J. (1989) Influence of NaCl aqueous solutions on isotopic equilibria and rates of exchange in mineral-fluid systems. *Trans. Geothermal Res. Council*, v. 13, p. 227-234.

Willis, R. D., Thonnard, N. and Cole, D. R. (1989) Resonance ionization spectroscopy and its potential application in geosciences. In New Frontiers in Stable Isotope Research: Laser Probes, Ion Probes, and Small-Sample Analysis, W. C. Shanks and R. E. Criss (editors), *U. S. Geol. Survey. Bull. V. 1890*, p. 117-128.

1987

Cole, D. R., Mottl, M. J. and Ohmoto, H. (1987) Isotopic exchange in mineral-fluid systems: II. Oxygen and hydrogen isotopic investigation of the experimental basalt-seawater system. *Geochim. Cosmochim. Acta*., v. 51, p. 1523-1538.

1986

Cole, D. R. and Drummond, S. E. (1986) The effect of transport and boiling on Ag/Au ratios in hydrothermal solutions: A preliminary assessment and possible implications for the formation of epithermal precious-metal ore deposits. In Exploration for Ore Deposits of the North American Cordillera, C. E. Nichols (editor), *J. Geochem. Exploration*, v. 25, p. 44-79.

Cole, D. R. and Ohmoto, H. (1986) Chapter 2, Kinetics of isotopic exchange reactions at elevated temperatures and pressures. In *Stable Isotopes in High Temperature Geological*

Processes, H. P. Taylor, Jr., J. R. O'Neil, and J. W. Valley (editors), *Reviews in Mineralogy*, v. 16, p. 41-90.

1985

Sridhar, K., Jackson, M. L. and Cole, D. R. (1985) Oxygen isotope changes during mica alteration. *Clay and Clay Minerals*, v. 33, p. 214-218.

1984

Cole, D. R. and Ravinsky, L. (1984) Hydrothermal alteration zoning in the Beowawe geothermal system, Eureka and Lander Counties, Nevada. *Econ. Geol*., v. 79., no. 4, p. 759-767.

Cole, D. R. and Rose, A. W. (1984) The distribution and mode of occurrence of zinc and lead in glacial soils. *J. Geochem. Explor*., v. 20, p. 137-160.

Cole, D. R. (1984) Simulating processes within the earth: experimental geochemistry at ORNL. *Oak Ridge National Laboratory Review*, no. 4, 22-31.

1983

Cole, D. R., Ohmoto, H. and Lasaga, A. C. (1983) Stable isotopic exchange in mineral-fluid systems: I. Theoretical evaluation of oxygen isotopic exchange accompanying surface reactions and diffusion. *Geochim. Cosmochim. Acta*., v. 47, no. 10, p. 1681-1693.

Cole, D. R. (1983) Theory and application of adsorption and ion exchange kinetics to *in situ* leaching of ores. In: *Leaching and Diffusion in Rocks and Their Weathering Products*, S. S. Augustuthus (editor), Theophrastus Pub., p. 3-28.

Cole, D. R. (1983) Theoretical evaluation of diffusion-controlled oxygen isotopic exchange between silicates and fluids at elevated temperatures. In: *Leaching and Diffusion in Rocks and Their Weathering Products*, S.S. Augustuthus (editor), Theophrastus Pub., p. 113-136.

Cole, D. R. (1983) Time estimates for oxygen isotopic exchange during mineral-fluid interaction in hydrothermal systems. *Trans. Geothermal Res. Council*, v. 7, p. 283-287.

Cole, D. R. (1983) Chemical and isotopic investigation of warm springs associated with normal faults. *J. Volcanology and Geotherm. Research*, v. 16, p. 65-98.

Rimstidt, J. D. and Cole, D. R. (1983) Geothermal mineralization I: The mechanism of formation of the Beowawe, Nevada siliceous sinter deposit. *Amer. J. Sci*., V. 283, p. 861-875.

1982

Capuano, R. and Cole, D. R. (1982) Fluid-mineral equilibria in a hydrothermal system, Roosevelt Hot Springs, Utah. *Geochim. Cosmochim. Acta*., v. 46, p. 1353-1364.

Cole, D. R. (1982) Tracing fluid sources in the East Shore Area, Utah. *Ground Water J*., v. 20, no. 5, p. 586-593.

Cole, D. R. (1982) Chemical and sulfur isotope variations in a thermal spring system sampled through time. *Trans. Geothermal Res. Council*, v. 6, p. 81-84.

Bowman, J. R. and Cole, D. R. (1982) Hydrogen and oxygen isotope geochemistry of cold and warm springs from Tuscarora, Nevada Thermal Area. *Trans. Geothermal Res. Council*, v. 6, p. 77-80.

1981

Cole, D. R. (1981) Isotopic and ion chemistry of waters in the East Shore Area, Northern Utah. *Trans. Geothermal Res. Council*, v. 5, p. 63-66.

1980

Cole, D. R. and Ohmoto, H. (1980) Mechanisms and rates of oxygen isotopic exchange in experimental hydrothermal rock-water systems. In: *Proceedings of the Third International Symposium on Water-Rock Interaction*, Edmonton, Alberta, B. Hitchon (editor), International Assoc. of Geochemistry and Cosmochemistry, p. 64-67.

Cole, D. R. (1980) Chapter IV. Oxygen and carbon isotope analyses. In: A Comprehensive Study of LASL Well C/T-2, Roosevelt Hot Springs KGRA, Utah, and Applications to Geothermal Well Logging, W. E. Glenn, J. B. Hulen and D. L. Nielsen, *Los Alamos National Laboratory, Report LA-8686-MS*, p. 77-92.

EDUCATION DIRECTED

Courses Taught:

Earth Sci. 8861 Geological CO_2 Sequestration (2011)
Earth Sci. 5675 Scanning Electron Microscopy (2012, 2013, 2015, 2018)
Earth Sci. 8821 Non-Traditional Stable Isotope Geochemistry (2012)
Earth Sci. 8860 Shale Energy Resources (2013)
Earth Sci. 8821 Fluids in the Crust (2014)
Earth Sci. 2210 Energy, Mineral Resources and Society (Aut 2014, Aut 2020)
Earth Sci. 2203 Environmental Geosciences (Sp 2019, Sp 2020, Sp 2021, Sp 2022)
Earth Sci. 8821 Introduction to Geochemical Kinetics (2017)

Postdoctoral and Research Associates Supervised or Co-Supervised (yr.):

Timothy Burch (1992-1995) - isotope/chemical fractionation in melt-H_2O systems
Thomas Driesner (1998) – MD/ab initio MD modeling of molecular behavior of H_2O
Lee Riciputi (1991-1993) – SIMS studies of water-rock interaction
Chuanlun Zhang (1997- 1998) – isotopic fractionation relevant to microbial systems
Steve Fortier (1994-1995) – isotopic fractionation in iron oxide and carbonate systems
Julie Sheets (2011-present) – mineralogical studies of subsurface materials
Sue Welch (2011-present) – isotope and fluid geochemistry of subsurface systems (half time)
Salim Ok (2012-2016) – use of NMR to probe hydrocarbon-mineral interfacial behavior
Siddharth Gautam (2013-present) – use of neutron scattering to probe interfacial fluids
Tingting Liu (2017- 2021) MD and neutron scattering of fluid-solid interfaces
Gerald Allen (2017 – 2020) – USEEL; CERTAIN data analytics

Graduate Students Supervised or co-Supervised (ORNL + OSU; Degree, Yr):

Timothy Burch, Yale University (PhD; 1988-1992) –
Isotope fractionation in the system calcite- H_2O-CO_2
Ian Richards, University of Tennessee (PhD; 1994) –
Isotope behavior during fluid-rock interaction in the Black Hills
Brian Butler, Indiana University (MS; 1986) –
Hydrogen isotope behavior of biotites from the Duluth Complex
Suman De, University of Alberta (PhD; 2000-2001) –
Hydrogen diffusion in hydrous minerals
Mike DeAngelis – Univ. TN (MS; 2003-2005) –
Fluid-rock interactions at elevated temperatures and pressures
Mike DeAngelis – Univ. TN (PhD; 2007-2011) –
Mechanisms and rates of low-T dissolution and alteration of olivine
Mike Murphy – OSU (PhD; 2010-2013) –
Evolution of mineralogy, organics and porosity in the Utica Formation
Alex Swift – OSU (PhD; 2011-2020) – Water-rock interaction in subsurface energy systems
Tingting Liu – OSU (PhD; 2011-present) – Behavior of water at olivine surfaces
Sumant Patankar – OSU (PhD, 2011-2016) –
Role of Confinement on the Properties of Ethane and Ethane-CO_2 Mixtures in Mesoporous Silica

Bohyun Hwang – OSU (MS, 2012-2014) – Mineral alteration: Coso Geothermal System
Bohuyun Hwang – OSU (PhD – 2015-2020) – Fluid Behavior in Nano-to Micro Confined Systems
Edwin Buchwalter – OSU (MS, 2014-2016) – The Geochemical and Spatial Argument for Microbial Life Surviving into Early Diagenesis in the Appalachian basin
Derek Foley – OSU (MS, 2014-2016) – Analysis of the Point Pleasant/Lexington/Trenton Formations: Sulfide, Mineralogy, and Trace Element as Geochemical Proxies
Aaron Evelsizor – (2016 – 2020, OSU, M.S.) -
Characterization of organic-rich strata within the Lower Huron Member in southern Ohio
Brendan Wilson (Ph.D., 2018 - 2021) co-advised with Prof. Philip Grandinetti – Chem/Biochem
NMR Characterization of C, H and O-bearing fluids in Porous Media
Jessica Nelson Grealey (MS, 2018-) – Kaolin alteration in a porphyry Cu deposit (Owens-Corning)
Chaohui Lyv (PhD – visiting grad student, co-adviser; 2018-2020) China University of Petroleum, Beijing

<u>Undergraduate OSU B.S. Theses Supervised (graduation date):</u>

Josh Flood (2011) –
Detailed Stratigraphic Study of the Rose Run Sandstone in Coshocton, Holmes and Tuscarawas Counties, Ohio: A Potential Carbon Dioxide Injection Horizon
Nick Leeper (2012) –
Characterization of the Mt. Simon Sandstone in Southwest Ohio for CO_2 Sequestration
Brad Hull (2012) –
Characterization of the Upper Cambrian and Lower Ordovician Formations for CO_2 Sequestration, Scioto County, Ohio
Kyle Cox (2012) - Total Organic Carbon Variability in the Utica Shale of Northwest Ohio
Zach Cowan (2014) –
Development of Ion Milling Methods for SEM Imaging of the Utica Shale
Harold Elston (2014) - Mineralogical and Geochemical Assessment of the Eagle Ford Shale
Michaela Wells (2015) –
Potential Sources of Salts from Water-Rock Interaction during Hydraulic Fracturing: An Experimental Study
Matt Edgin (2016) –
Mineralogical and Geochemical Analysis of Strontium and Barium in the Point Pleasant Formation
Dan Ardrey (2016) - Experimental Shale-Fluid Interaction: With a Theoretical Comparison to Hydraulically Fractured Flowback Waters
Christina Jauregui (2017) – Method Development for Dissolved Inorganic and Organic Analysis of Flowback Fluids from the Utica-Point Pleasant.
Chandler Adamaitis (2017) – Fracking the Code on Flowback Fluid
Clay Bonin (2018) Development of Water-Based Fracturing Fluids
Laura Keister (2018) Rock properties of Silurian Niagaran reef carbonates in Michigan after CO_2 injection
Kelly Lang (2019) – Pore Structure and Stable Carbon Isotope Evolution of a Niagaran Reef

Dane Bryant (2021-2022) - Sulfide formation in black shale

Student PhD, MS, BS Committees (in SES/OSU unless otherwise noted; year completed)

Elijah Mullins (B.S. 2022) Barton
Danika Mayback M.S., (2022 -) Ashely
Christian Roumelis (M.S., 2022 -) Audrey
Fawz Nain (Ph.D., 2022 -) Ann C
Ben Jones (M.S. 2022 -) Ann
Derek James (M.S. present)
Brendan Wilson (Ph.D., Chemistry and Biochemistry)
Kevin Shen (Ph.D. 2020, Chem Eng)
Billy Eymold (Ph.D. 2020)
Jeff Pigott (Ph.D., 2015)
Emma Oti (Ph.D., 2019)
Urmi Majumdar (Ph.D., 2018)
Kuashik Rangharajan (Ph.D., 2018; Mechanical Engineering)
Josh Martin (Ph.D., current)
Fengyang Xiong (Ph.D., 2020)
Myles Moore (Ph.D., 2020)
Witopo Salim (Ph.D., 2017; Chemical and Biomolecular Engineering; external examiner)
Deepansh Srivastava (Ph.D., Chemistry and Biochemistry)
Amelia Nelson (M.S, 2019)
Yi Yang (Ph.D., 2014; Washington Univ., St. Louis)
Allen Andersen (M.S., 2010; Washington State Univ.)
Michael DeAngelis (Ph.D., 2011; Univ. Tennessee)
Ian Richards (Ph.D., 1994; Univ. Tennessee)
Suman De (Ph.D., 1999-2001; Univ. Alberta)

SERVICE/OUTREACH

At OSU:

School of Earth Sciences, Environmental, Health and Safety Committee (2011-2013)
School of Earth Sciences, Strategic Planning Document Committee (2011-2012)
School of Earth Sciences, Earth Fluids Faculty Search Committee (2012-2013)
College of Arts and Sciences, Strategic Planning Working Group: Environment, Energy and Sustainability Initiative (2011-2012)
College of Arts and Sciences, Research, Innovation and Commercialization Faculty Advisory Committee (2012)
College of Arts and Sciences, Measurement/Instrumentation Implementation Committee (2013)
College of Engineering, Civil Engineering Subsurface Faculty Search Committee (2012-2013)
University Faculty Advisory Board, Energy and Environment Discovery Theme (2013-2014)
OSU President's University Research Committee – (2013-2016)
University Review Committee for The Center for Higher Education Enterprise and Policy (2013)
University Senate Committee on Sustainability Curriculum (2013-2016, co-Chair)
College of Arts and Sciences Committee on Industry Partnering (2012-2013)
Subsurface Energy Resources Center (SERC) Faculty Advisory Committee (SFAC, chair; until August 31, 2015)
Director, Subsurface Energy Resources Center (SERC; Sept 1, 2015 to 2017)
Redefined - Center for Energy Research, Training and Innovation (CERTAIN; 2017-2020)
Faculty Search Chair for Director of SERC (2016-2017)
SES Faculty Evaluation Committee (2015-2016)
SES Alumni Committee (Chair to 2016)
SES Health and Safety Committee (to 2017)
Technical Advisory Council (TAC) member to the University Coalition for Fossil Energy Research, a DOE/NETL funded organization (Penn State as lead) - 2017 - present
Review Committee, College Arts and Sciences Distinguished College Faculty (2017; 2019)
Member - Sustainable and Resilient Economy (SRE) Faculty Advisory Board (2017-2018)
Member of the Sustainability Institute -Faculty Advisory Board (FAB)
Sustainability Education Learning Committee (SELC) - 2017-present
Lead, Sustainable Energy Research, OSU Sustainability Institute (SI) – 2019 - present
Director – CERTAIN: Center for Energy Research, Training, and innovation (formerly known as SERC -Subsurface Energy Resource Center), 2015-2020
Shale Energy Work Group (out of FAES) member; now known as OSU Extension Energy Outreach Program (EEOP).
Search Committee Member, ENGIE Endowed Chair in Energy Systems (2018-2019)
Chair, Solid Earth Dynamics Division, SES 2019-2020
Member, ESGP Faculty (2020 - present)
Member ESGP Graduate Studies Committee (2020-2023)
NSF NRT EmPOWERment Program Advisory Council (2020-present)
SES Awards committee (2020 – 2022)
SES Graduate Studies Committee (2021-2022)

College of Arts and Sciences Senate (2020 - 2022)
NMS panel Curriculum Committee, Arts and Sciences

External to OSU:

Mineralogical Society of America Dana Medal Committee (2012-2016)
Department of Energy Early Career Award Review Panel (2017-2020)
Department of Energy Graduate Research Fellowship Review Panel (2018)
Deep Carbon Observatory (DCO) Executive Committee (2011-2019)
DCO Synthesis Group 2019 committee (2017-2018)
DCO Deep Energy Community Scientific Steering Committee (2015-2019)
DCO Emerging Leader Award Committee (2017-2019)
NIST Center for Neutron Research user proposal review panel (2017-2022)
ORNL Neutron Sciences user review panel (2016-2021)
Member, National Academy of Sciences NRC Unconventional Hydrocarbon Roundtable (2016 – 2019)
Science Advisory Committee to ShaleXenvironmenT, a European Commission Horizon 2020 research and innovation project (2015-2018)
Science Advisory Committee to S4CE – Science for Clean Energy, a European Commission Horizon 2020 research and innovation project (2018-2021)
University Energy Institute Collaborative (UEIC) - Steering Committee plus all 7 organizing committees; Lead of Governance and Structure Committee
MSA Committee on Short Courses for a four-year term, late 2021- 2024.
Member -Interpore Midwest and Northeast Chapter Founding Committee (2022-)

PROFESSIONAL ACTIVITIES:

Group Leader, Solution Chemistry Working Group, Evaluation of solution chemistry as it applies to in-situ mining of deeply buried ore, Funded by NSF, the U. S. Bureau of Mines and Industry Consortia (AMAX, Inc.; AMOCO Minerals Co.; Anaconda Copper Co.; Duval Corp.; Kennecott Minerals Co.; Phelps Dodge Corp.), Univ. of Utah Research Institute, Salt Lake, City 1980-1981.
Blue Ribbon Panel Member, Review of DOE Brine Injection Program, Office of Geothermal and Hydropower Technology, Oct. 1984, Burlingame, CA.
Working group co-lead - Appalachian Ultra-Deep Core Hole (ADCOH) Project - August 1986 Workshop, Helen, GA
Member, Ad Hoc Committee on Isotope Geochemistry at DOE National Labs (1989-1992)
Science Alliance Faculty Review Committee - University of Tennessee, Knoxville (1989-to 1999)
DOE, Division of Geothermal Energy, Advisory Panel on Reservoir Modeling, the Geysers Geothermal System, CA (1991)
DOE Working Group, ORNL representative, Subsurface Contaminant Transport Emphasis Area (1992-1995)
ORNL Lab representative to the SecurEarth – a DOE/NSF subsurface science research initiative, 2004-2006
Member, Los Alamos Neutron Science Center (LANSCE) Materials Program Advisory Committee (MPAC), 2007-2009; 2011-2015

Special Editor (with Eric Oelkers) *Elements* issue (2008, v. 4, no. 5) on "Carbon Dioxide Sequestration" (DOE co-sponsored)

Lead organizer of the Technical Perspectives Resource document for the March 4-5, 2010 DOE BES sponsored workshop on *Carbon Capture: Beyond 2020*.

Member, Executive Committee, Sloan Foundation funded Deep Carbon Observatory Administered by the Carnegie Institution for Science, Washington, D.C. 2010-present

Director of the Deep Energy Directorate of the Sloan Foundation funded Deep Carbon Observatory (DCO), 2010-2015

Session chair/discussion lead/workshop co-author, "Geological Processes" – in NSF sponsored workshop on " Identification of Fundamental Interfacial and Transport Phenomena for Sustainable Deployment of Hydraulic Shale Fracturing – Role of Chemicals Used" ; co-author of report to NSF (NSF Grant # CBET-1229931), 2012

Special Editor (with Michael Arthur) *Elements* issue (August 2014) on "Unconventional Hydrocarbon Resources"

NIST Center for Neutron Scattering User Proposal BTAC Review Panel 2014-present

Co-organizer of the DOE sponsored 'Shale at All Scales' Workshop, hosted by Sandia National lab, Santa Fe N Mex, 2015

Advisory Board member: EU-funded SXT-ShaleXEnvironment program, led by University College London, 2014- 2017

Advisory Board member: EU-funded Science for Clean Energy (S4CE) program, led by University College London, 2017- 2021

External Review panel- Chair of the BWAVES beam line review - Second Target Station for the Spallation Neutron Source, Oak Ridge National laboratory - 2021

Special Lead Editor (with Nancy Ross, VaTech) *Elements* issue (2021; June) on "Exploring Earth and Planetary Materials with Neutrons" 2021

<u>Keynote/Invited Lectures</u>:

Invited presenter (1981, 1993) - Gordon Research Conferences on Inorganic Geochemistry of Hydrothermal Ore Deposits

Distinguished Lecturer, Dept. of Geology and Geophysics, University of Utah, Nov. 1981

Invited Seminar speaker, Dept. Geology, University of Tennessee, Oct. 1983

Turner Distinguished Lecturer, Dept. of Geological Sciences, University of Michigan, Ann Arbor, April 1987

Shell Distinguished Lecturer, Dept. of Geology, Duke University, Durham, Feb. 1988

Invited Speaker, "New Frontiers in Stable Isotope Research: Laser Probes, Ion Probes, and Small-Sample Analysis", sponsored by the U. S. Geol. Survey, held at Reston, VA, Jan. 12-13, 1988

Invited lecturer, MSA Short Course on Stable Isotopes in High Temperature Geological Processes, held at San Antonio Geol. Soc. Amer. Annual Mtg., Nov. 1986

Invited presenter - "Sedimentary Basin Geochemistry and Fluid/Rock Interactions Workshop," Norman, Okla., Nov. 18-19, 1991, sponsored by Geosciences Research Program, DOE

Invited presenter - "Workshop on Experimental and Analytical Geochemistry," Caltech, Pasadena, CA, Jan. 14-15, 1993, sponsored by Geosciences Research Program, DOE

Invited speaker, Geothermal Workshop/Program Review XI, "Geothermal Energy - The Environmentally Responsible Energy Technology for the Nineties," Berkeley, CA, May 1993

Invited presenter - "Workshop on Sedimentary Systems, Aqueous and Organic Geochemistry," Lawrence Berkeley Lab, July 15-16, 1993, sponsored by Geosciences Research Program, DOE

Invited Seminar lecturer - Dept. of Geological Sciences, University of Tennessee, Knoxville, Jan. 1993

Invited speaker - Symposium on "Reactivity and Mobility of Geologic Fluids: Constraints from Inorganic Geochemistry" sponsored by the Office of Basic Energy Sciences, Geosciences Program, U. S. Dept. of Energy, Oak Ridge, TN Jan 29-30, 1996

Invited speaker/writer, DOE Computational Science Initiative Workshop on Fluid Transport in Terrestrial Systems, May 7, 1998, Germantown, MD, hosted by Geosciences Program Office, Basic Energy Sciences, Dept. of Energy

Invited speaker, Inaugural Workshop on the Awibengkok, Indonesia, Geothermal Research Project, June 2-3, 1998, Salt Lake City, UT, hosted by the Energy and Geoscience Institute of the University of Utah and Dept. of Energy, Division of Geothermal Technology

Invited speaker, DOE 2nd Workshop for the Center for Nanophase Materials Science

Invited presenter, NSF/DOE-BES Sponsored Workshop on Nanogeoscience, held at LBNL, June 14-15, 2002; (co-author of Workshop document)

Invited lecturer, Department of Geology, Vanderbilt University, April, 2003

Invited lecturer, Department of Geology, Vanderbilt University, April, 2003

Invited lecturer, Department of Geosciences, Western Michigan University, March, 2004

Lowenstein Lecturer, New Mexico State University, March, 2005

Invited seminar speaker, Geosciences Department, Penn State University, Oct. 3, 2006

Invited speaker, Department of Earth Sciences, Washington State University, Nov. 2, 2006

Invited speaker, MSA Short Course, Neutron Scattering in Earth Science, Editor, H.-R. Wenk (UC Berkeley), Dec. 2006 (lead author chapter 13)

Invited speaker, Department of Chemical, Biological and Mechanical Engineering, Oklahoma University, Nov. 14-15, 2007

Invited Panelist/writing contributor: to the DOE Office of Basic Energy Sciences Workshop on "Basic Research Needs in Geosciences: Facilitating 21st Century Energy Systems" held Feb. 21-23, 2007, Bethesda, MD

Invited speaker, workshop on "Advancing the Science of Geologic Carbon Sequestration" hosted by Ohio State University, Ohio University, Battelle Energy Technology and America Electric Power, Inc., March 2009

Invited speaker – "Advancing the Science of Geologic Carbon Sequestration", hosted by Ohio State Univ., Ohio Univ., Battelle and American Electric Power; March 9-10, 2009

Plenary Lecturer, XIV International Clay Conference, Castellaneta Marina, Italy, June 2009, "The role of clay minerals in carbon dioxide sequestration"

Invited Speaker, "Structure and Dynamics of Fluids in Nanoporous Earth and Engineered Materials Determined from Neutron Scattering and MD Simulations" V M Goldschmidt Conference, Davos Switzerland, June 2009

Invited speaker – 239th American Chemical Society National meeting (San Francisco) March 21-25, 2010

Invited speaker – Annual American Association of Petroleum Geologists convention (New

Orleans) April 11-14, 2010

Invited speaker – "Geologic Carbon Sequestration Site Integrity: Characterization and Monitoring Science and Technology", hosted by Ohio State Univ., Battelle and American Electric Power; June 7-8, 2010

Invited lecturer: Dept. of Earth and Environmental Sciences, University of Illinois, Chicago, Oct, 14-15, "Supercritical Fluid Behavior at Nanoscale Interfaces: Implications for CO_2 Sequestration in Geologic Formations" hosted by Prof. Steve Guggenheim

Invited Speaker: "Session I: Fluid Properties – Overarching Strategy and Synergism"; Lawrence Berkeley National Laboratory, DOE Sponsored Energy Frontier Research Center – Nanoscale Control of Geologic CO_2; Oct. 21-22, 2010

Invited lecturer at the 2011 Los Alamos National Laboratory Neutron School, July 20, 2011.

Invited speaker, DOE Mid-Region Carbon Sequestration Partnership (MRCSP) Annual meeting, Baltimore, MD, Sept. 8-9, 2011 "Geochemical Tools for Monitoring Geologic Carbon Sequestration"

Invited Speaker, International Deep Carbon Observatory Meeting, Washington, DC, 2012 Hosted by the Carnegie Institution of Washington; Feb.

Seminar Speaker, School of Earth and Environmental and Society, Bowling Green State Univ. April 2012

Seminar Speaker, Dept. Earth and Environmental Sciences, Wright State Univer. April 2012

Keynote speaker, Pardee Symposium on "Understanding Earth through Carbon". Geol. Soc. Amer. Mtg Charlotte, NC, Nov. 2012

Invited speaker, Amer Chem Soc. Meeting Indianapolis, Sept. 2013; Session on Kinetics of Mineral Growth and Dissolution from the Nanoscale to the Macroscale, A. Stack lead

Invited speaker, International Deep Carbon Observatory meeting, Washington, DC hosted by The National Academy of Sciences, March 2013

Invited speaker, International Deep Carbon Observatory meeting, London UK hosted by The Royal Society of London, Sept. 2013

Seminar Speaker, Dept. Chemistry, Wright State University, Oct. 2013

Invited speaker, Deep Carbon Observatory Industry meeting, Houston TX hosted by Rice University, Jan. 2014

Invited speaker, Deep Carbon Observatory PI meeting, Washington, DC hosted by Carnegie Institution of Washington, March 2014

Seminar Speaker, Dept. Geosciences, University of Pittsburgh, PA Oct. 2014

Invited Seminar speaker, Department of Chemistry, Berea College, KY Jan 2017

Invited Seminar speaker, SES-OSU August 31, 2017

Invited Speaker, 2017 AGU, New Orleans, Union session "Shale Across Scales"

Invited Speaker, 2018 ACS, New Orleans – two talks:

Cole, D. R. and Striolo, A. (2018) Behavior of Supercritical C-O-H Fluids in Nanoporous Materials.

Cole, D. R. and Wesolowski, D. (2018) Structure and Dynamics of Earth Materials, Interfaces and Reactions. Amer. Chem. Soc. Conf., New Orleans, March 18-22.

Invite Speaker, Rensselaer Polytechnic Inst., Troy, N. Y., Nov. 2, 2018

Invited Speaker, Amer Chem Soc. Conf. Orlando FL March 2019

Session on "Hydrocarbon/Water/Mineral Interactions in the Subsurface".

Session on "Environmental Interfaces under Nano-scale Confinement"

Keynote Speaker, Goldschmidt Conference, Barcelona, Spain Aug. 20, 2019

Invited Speaker, SUNY College Cortland STEM Symposium, Oct. 12, 2019

Invited Poster, A.P. Sloan Foundation, Deep Carbon Observatory Science Symposium, National Academy of Sciences, Oct. 26, 2019

Invited Speaker, AGU Workshop on "Smaller, Deeper and Lighter: Advanced Neutron Techniques for the Geosciences", December 8, 2019

Invited Speaker, Amer Chem Soc. Conf. Philadelphia PA March 2020
Session on "Environmental Challenges and Solutions in Oil and Gas Development".
Session on "Fundamental Reactions Driving Macroscopic Geochemical Processes"

Invited Seminar Speaker, Southern Methodist University, Dept. of Earth Sciences, Nov. 1 (2019)

Invited Panelist/speaker, First Energy Educational of the Future Forum, Texas A&M/Qatar Dec 5 and 6, 2021

<u>Convener/Organizer of Scientific Conferences/Workshops</u>:

Convener (with Colin Graham)/Presenter - Symposium on "Mechanisms of Isotopic and Chemical Communication in Crust and Mantle Rocks" held in conjunction with the Fourth V.M. Goldschmidt Conference, University of Edinburgh, Edinburgh, Scotland, Aug. 29 - Sept. 2, 1994

Convener (with J. Valley)/Presenter - Theme Session on "Isotope Exchange During Fluid/Rock Interaction in Crust and Mantle Systems," held in conjunction with the Seventh V.M. Goldschmidt Conference, Tucson, Univ. Arizona, June 2-6, 1997

Organizer, DOE/BES Geosciences PI Symposium on "From Atoms to Organisms (and Back): Rates and Mechanisms of Geochemical Processes", held in Gaithersburg. MD, Oct. 15 – 16, 2000.

Executive Organizing Committee, 11th V. M. Goldschmidt Meeting, Hot Springs, VA, 2001

Co-Convener (with D. Wesolowski) Symposium at the 11th V. M. Goldschmidt Conf. – "Geochemical Aspects of Sustainable Energy Utilization" - May 2001, Hot Sps., VA

Co-Convener/Editor (with John Valley), Stable Isotope Geochemistry MSA Short Course, Boston, 2001 (DOE-sponsored), Reviews in Mineralogy and Geochemistry, Vol 43

Invited speaker, 2nd Workshop for the Center for Nanophase Materials Science; Co-author of the Research Focus Area titled: Nanoconfined and Nanostructured Fluids (with M. Ramsey, H. Cochran), 2002

Organizing Committee, 2nd Annual DOE Conference on Carbon Capture and Sequestration, Alexandria, VA. (2003)

Scientific Organizing Committee, 11th International Symposium of Water/Rock Interaction, Saratoga Springs, NY, June 27 – July 2, 2004 (DOE-sponsored)

Thematic Organizing Chair, "Fluids and Rocks in the Crust," 15th V. M. Goldschmidt Conference, 2005, Univ. of Idaho (with Barb Dutrow and Alan Matthews).

Session Organizing Chair, Earth and Planetary Materials, Amer. Physical Soc. Annual Mtg., Los Angeles, March 2005 (with J. Bass, Univ. Ill; B. Militzer, Carnegie Geophysical Lab)

Session Organizing Chair, "Application of Neutron Scattering to Geochemistry and Mineralogy," 18th V. M. Goldschmidt Conference, 2008, Vancouver, BC (with Nancy Ross)

International Program Chair and Co-Organizer – International V M Goldschmidt Conference, 2010, Knoxville, TN, June 13-18, 2010

Co-Convener (with Yousif Kharaka) 2010 GSA Annual Mtg., Denver. Topical Session 64: "Geochemistry of Geologic Sequestration of CO_2."

Co-convener (with Susan Altman and Bayeni Cardenas) 2010 Fall AGU session "CO_2 Sequestration Inside Pores: From Molecules to Microbes"

Co-convener, "Multiscale Spatiotemporal Complexity in Geologic Carbon Sequestration: Linking Experimentation and Modeling (Geochemistry Division)", The 242nd American Chemical Society National Meeting in Denver, CO, August 28-September 1, 2011, with Young-Shin Jun (Washington University)

Co-Chair: "Carbon Sequestration Analogues"; with Chris Ballentine (Manchester University), V.M. Goldschmidt Conference, 2011 Prague

Co-Convener (with Chris Ballentine and Claude Jaupart), Deep Carbon Observatory Deep Energy Workshop, Institut de Physique du Globe de Paris (IPGP), France; May 3-4, 2012

Co-Convener (with Chris Ballentine), Deep Carbon Observatory Deep Energy Workshop, University of Manchester, UK; Jan.31-Feb. 1, 2013

Co-Convener/Co-Editor (with Ian Bourg, Alex Navrotsky, Don DePaolo), Geochemistry of Geological Carbon Sequestration, Rev Mineral Geochem. Vol. 77, MSA Short Course, Berkeley, CA, 2013, (DOE-sponsored)

Co-Convener (with Ian Bourg, Alex Navrotsky, Don DePaolo), Geochemistry of Geological Carbon Sequestration, 2 oral and 1 poster session at the 2013 Amer. Geophys. Union Annual meeting

Co-Convener (with Isabelle Daniel, Univ of Lyon), Joint Deep Energy-Deep Life Deep Carbon Observatory Workshop, Lyon France, April 6-8, 2014

Co-Convener/Organizer, DOE sponsored "Shale Across All Scales: Exploring Coupled Processes", Sandia National Lab; Santa Fe, N Mex June 9-11, 2015

Co-Convener with Prof. Nancy Ross, 2015 Prague V.M. Goldschmidt Conference, Session 14d: Reaction Mechanisms, Rates and Transport in Minerals, Glasses and Melts

Co-Organizer of Panel 3/writer: Contaminant Fate and Transport in Geological Environments, for Office of Science, DOE Basic Energy Sciences workshop on Basic Research Needs (BRN) for Environmental Management; co-writer of workshop report, 2015

Panelist and writing contributor: DOE Basic Energy Sciences, Basic Research Needs Workshop, Basic Research Needs for Innovation and Discovery of Transformative Experimental Tools: Solving Grand Challenges in the Energy Sciences, 2016

Organizer/Lead – OSU Subsurface Energy Resource Center (SERC) Shale Energy and Environment Leadership Workshop, Sept. 7-8, 2016, Blackwell Conference Center, Ohio State University.

Organizing Committee – Earth Science and Chemistry themes, International Conference on Neutron Scattering, Daejeon, So. Korea (July 9-13, 2017)

Co-Convener, 2017 Paris V.M. Goldschmidt, Session 08i: Geochemical Processes in Confined Media

Session convener – Clay Mineral Society Conf., The Role of Clay Minerals in Controlling the Properties and Geochemical Processes Associated with Hydrocarbon Systems, June 11-15 2018

Co-Convener – OSU Symposium on Energy Solutions for "Deep Decarbonization: Hydrogen Energy", Dec 6th 2019.

Session co- convener, Geol. Soc. Amer., Montreal 2020: The unconventional shale systems: From source rocks to reservoirs (with Max Hu, UT Arlington) virtual session

Co-convener with Jeff Bielicki, OSU Sustainability Institute – Energy Transition and Decarbonization Symposium, Feb. 10-11th, 2021
Invited Panelist/speaker, First Energy Education of the Future Forum, Texas A&M/Qatar Dec 5 and 6, 2021

***<u>Consulting Activities</u> (past and present)*:**

Aminoil Inc.
Energy and Geosciences Institute, Univ. of Utah
St. Joe American
Hunt Energy Co.
ChevronTexaco
New Mexico State University
Exploraciones del Altiplano, Mexico
Gulfport Energy