

Circulum Vitae

ALFRED B. (AL) CUNNINGHAM

Professor Emeritus of Civil Engineering
Center for Biofilm Engineering (CBE)
366 Barnard Hall
Montana State University
Bozeman, MT 59717-3980
al_c@montana.edu



January 4, 2020

Education

B.S. Civil Engineering, University of Nevada, 1970
M.S. Civil Engineering, Montana State University, 1971
PhD. Hydrology, University of Nevada, 1977

Affiliations

Dr. Cunningham is a *Professor Emeritus of Civil Engineering* at Montana State University (MSU). In addition to the Department of Civil Engineering (CE), Al is affiliated with MSU's Center for Biofilm Engineering (CBE) and the Energy Research Institute (ERI). He also has research and education collaboration with the University of Stuttgart.

CE Department: Graduate and undergraduate teaching and course development in Water Resources, Ground Water Hydrology and Remediation, and Environmental Engineering Investigations. Currently assisting with development of new undergraduate degree program in Environmental Engineering.

CBE: Founding member of CBE and member of the CBE Executive Committee which is responsible for coordinating Center Research, Education and Industrial Associates programs. Currently assisting CBE Director with development of Biofilm-related research initiatives and strategic planning.

ERI: Responsible for development and coordination of large-scale energy research projects related to subsurface storage and leakage mitigation of gas (CO₂, CH₄, and H₂) and associated reservoir fluids. These projects are primarily funded by DOE, involve multiple university and industrial collaborators, and include a field-scale research and testing component. Two Current projects are focused on developing and testing near-well leakage sealing technologies utilizing microbially induced calcite precipitation (MICP) to plug leakage pathways. Collaborators include University of Stuttgart, University of Alabama Birmingham, Southern Company Utilities and Schlumberger. Two additional DOE-funded projects are researching science and technologies for enhancing the production of biogenic methane from coal and organic shale. Collaborators for this project include ERI, CBE, the US Geological Survey and Shell Global Solutions International BV. Dr. Cunningham also assists the ERI Director with strategic planning and research program development.

University of Stuttgart: Dr. Cunningham has a long-standing collaboration with Dr. Rainer Helmig and colleagues at Stuttgart's Institute for Modeling Hydraulic and Environmental Systems (IWS). This collaboration has developed a cross-disciplinary, international research and education program focused on combining the expertise of the CBE (biofilm process) with the computational simulation capabilities of IWS. Topics of collaboration include fate and transport of ground water contaminants, subsurface gas storage and fate, and enhanced biogenic methane production. Dr. Cunningham has served as co-advisor

for four PhD students at Stuttgart and has been named as an International Partner in the newly established Collaborative Research Center (CRC) headquartered in Stuttgart.

Research Interests

Ground Water Hydrology, Bioremediation, Subsurface Biofilm Science and Technology, Subsurface Storage and Leakage Mitigation of Gas (CO₂, CH₄,) and Associated Reservoir Fluids, Synergies between Energy Production and Water Quality

Professional Experience

- Professor Emeritus Montana State University 2015 -present
- Professor Montana State University 1987-2015
- Co-Editor for "*Biofilms--The Hypertextbook*". A web-based teaching and learning resource.
- Research Initiative Coordinator, Center for Biofilm Engineering, 2001-Present
- Co-organizer, Biofilm Science and Technology Meeting, a biofilm research and education symposium hosted semi-annually by the Center for Biofilm Engineering, 1990-present
- Research Coordinator and Principal Investigator, Montana DOE EPSCoR program, 2008-2013.
- Visiting Professor, University of Stuttgart, Stuttgart Germany, 2002.
- Chairman, Board of Directors for The Biofilm Institute, not-for-profit public benefit corporation. dedicated to societal and industrial education about biofilms, 2000-2006.
- Associate Director, Inland Northwest Research Alliance (INRA), 2000-2002.
- Visiting Professor, University of New South Wales, Sydney Australia, 1994.
- Research Coordinator (for Montana), Great Plains/Rocky Mountains Hazardous Substance Research Center, Headquartered Kansas State University, Manhattan Kansas, 1990 – 2000.
- Associate Director for Research Development, Center for Biofilm Engineering, 1990-2001
- Associate Professor, Montana State University, 1982-1987.
- Assistant Professor, Montana State University, 1977-1982.
- Instructor, Department of Civil Engineering, University of Nevada, Reno, 1972-1977.
- Research Associate, Univ. of Nevada Desert Research Institute, 1972-1977.
- Field Hydrologist, U.S. Geological Survey, Helena MT, 1970-1971.
- Registered Professional Engineer. Montana, PEL-PE-LIC-7165 1980-present

Honors and Professional Affiliations

- Mercator Fellow, University of Stuttgart 2019-
- International Partner, Collaborative Research Center, University of Stuttgart
- Organizing Committee: International Conference on Porous Media & Annual Meeting (INTERPORE), 2017 - 2020
- Received award for Excellence in Research, MSU College of Engineering, May 2015.
- Nominated to receive an Honorary PhD in Engineering, University of Stuttgart (2014).
- Received the Outstanding Professor Award from the Center for Biofilm Engineering, July 2014
- Co-organizer, short course on Multiphase Flow, Transport and Bioprocesses in Porous Media, University of Stuttgart, Germany 1997 – present (with Dr. Rainer Helmig).
- International Collaborator with the NUPUS program (The International Research Training Group "Non-linearities and Upscaling in Porous Media" with Dutch, German and Norwegian Universities) (2008-present)
- Life Member ASCE
- Member Interpore, The International Society for Porous Media
- Member American Geophysical Union
- Co-organizer, Second Annual Doha Conference on Applied Mathematics and Computational Science, Texas A & M University at Qatar, Doha Qatar, May 20-21, 2007 (with Dr. Richard Ewing Texas A&M).
- Keynote Speaker, European Bioperspectives 25th Annual Convention of Biotechnologists, Cologne Germany, (May 30-June 1, 2007)

- Chairman, Board of Directors for The Biofilm Institute, not-for-profit public benefit corporation. dedicated to societal and industrial education about biofilms, 2000-2006.
- Research Coordinator (for Montana), Great Plains/Rocky Mountains Hazardous Substance Research Center, Headquartered Kansas State University, Manhattan Kansas, (1990 – 2000).
- Chairman, Board of Directors, for the Learning Circle Montessori elementary school (1999–2003).
- Associate Director, Inland Northwest Research Alliance (INRA), (2000-2002).
- Member, Idaho National Laboratory (INL) Subsurface Science Advisory Board, (2000 – 2004).
- Member, Editorial Review Board of *Biodegradation*, (2001 – 2004).
- Member, Editorial Review Board of *Land Contamination and Reclamation*.
- Visiting Professor, University of Stuttgart, Stuttgart Germany, 2002.
- Organizer for SWCC Workshop on Biofouling in Reverse Osmosis Desalination Systems: Dhaharan Saudi Arabia, (January 5-8 1997).
- Visiting Professor, University of New South Wales, Sydney Australia, 1994.
- Keynote Speaker at the Hazardous Waste Research Conference, Kansas State University, Manhattan, KS, "The Centers Approach to Cross Disciplinary Research", (May 21 1990).
- Member, American Water Resources Association (1980-1988).
- ASCE Committee on Irrigation and Drainage Systems (I&D Div., 1982-1984).
- ASCE Water Conveyance and Distribution Committee (I&D Div., 1984-1986).

Current Funding. (Previously funded projects appear in Appendix 1, Page 18)

Project title: Environmental Networks Integrated with Genomes and Molecular Assemblies (ENIGMA)

Principal Investigator: Matthew Fields PI, (406)994.4770, matthew.fields@erc.montana.edu
 Al Cunningham, Co-Investigator (CI), (406)994.6109, al_c@erc.montana.edu
 Source of Support: U.S. Department of Energy
 Award Amount: \$2,250,000
 Award Period Covered: 10/01/2017– 9/30/2022
 Person-months Committed 0.5 month/yr

Project title: Biofilm and biomineralization methods development in support of SFB 1313 projects C04 and C05 at the University of Stuttgart

Principal Investigator: Al Cunningham (MSU/CBE)
 Senior/Key Personnel: Holger Class, Rainer Helmig (Stuttgart), Robin Gerlach, Adie Phillips
 Source of Support: Deutsche Forschungsgemeinschaft (DFG CL 190/3)
 Award Amount: €100,000 (CBE investigators)
 Award Period: 04/2018-03/2022
 Person months committed 1.0/yr

Pending Funding

Project title: Sentinel biofilms: Development of Biofilm-based Wastewater Testing Technologies for early SARS COV-2 detection

Principal Investigator: Matthew Fields
 Senior/Key Personnel: Al Cunningham, James Wilking, Darla Goeres, Craig Woolard
 Source of Support: NIH RADx-rad Wastewater Detection of SAES-COV-2
 Award Amount: \$1,875,000
 Award Period: 01/01/2021 - 12/31/2022
 Person Months committed: (1.0 month/yr)

Book Chapters

- Cunningham A.B., R. Gerlach, A. Phillips, E. Lauchnor, A. Rothman, R. Hiebert, A. Busch, B. Lomans. and L. Spangler. 2015. Assessing Potential for Biomineralization Sealing in Fractured Shale at the Mont Terri Underground Research Facility, Switzerland. Book Chapter, Carbondioxide Capture for Storage in Deep Geological Formations, Volume 4, CPL Press and BP, pp 887-903. http://www.co2captureproject.org/reports/CCP3v4_full_version.pdf
- Cunningham, A.B., Lennox J., Ross, R. J. Editors. 2015. *Biofilms: The Hypertextbook, Version 4, Release 3*. <http://www.biofilmbook.com>
- Gerlach, R., Cunningham, A.B. 2010. Influence of Biofilms on Porous Media Hydrodynamics. Vafai, K. (ed.), *Porous Media: Applications in Biological Systems and Biotechnology*. Taylor Francis. pp. 173-230.
- Bouwer, E.J., H.H.M. Rijnaarts, A.B. Cunningham, and R. Gerlach. 2000. Biofilms in porous media. In *Bryers, J.D. (Ed.): Biofilms II: Process Analysis and Applications*. Wiley-Liss, Inc. pp. 123-158.
- James G.A., B.K. Warwood, R. Hiebert, and A.B. Cunningham. 2000. Microbial Barriers to Stop the Spread of Pollution. In *Bioremediation*. Kluwer Academic pp. 1-14
- Jordan, R.N and A.B. Cunningham. 1999. Surfactant-enhanced bioremediation: a review of the effects of surfactants on the bioavailability of hydrophobic organic chemicals in soils. In: *Bioavailability of Organic Xenobiotics in the Environment and Practical Consequences for Bioremediation*, J.C. Block, P. Baveye, and V. V. Goncharuk (Eds.). Kluwer Academic Publishers.
- Cunningham A.B., and P.J. Sturman. 1998. In situ bioremediation process engineering concepts. invited Chapter, *Bioremediation: Principles and Practice*, Technomics Publishers, Vol 1.
- Lewandowski, Z.L. and A.B. Cunningham, 1998. Biofilm process fundamentals. Invited chapter, *Bioremediation: Principles and Practice*, Technomics Publishers, Vol 1.
- Cunningham A.B., B.K. Warwood, P.J. Sturman, K. Horrigan, G. James, J.W. Costerton and R. Hiebert. 1997. Biofilm processes in porous media--practical applications. In *Microbiology of the Terrestrial Deep Subsurface*, Edited by Amy and Halderman, CRC Press Inc. 325-347.
- Cunningham, A.B., E.J. Bouwer, and W.G. Characklis. 1990. Biofilms in porous media. In: *Biofilms*, W.G. Characklis and K.C. Marshall, editors, John Wiley and Sons, 692-732.
- Cunningham, A.B. and J. Amend. 1985. Role of interactive computer simulation in water resource system management. Invited Chapter, *Computer-Aided Processed Instruction and Research*, edited by George C. Beakley and C.R. Haden, Academic Press.

Journal Publications 2010-2020. (Previous publications appear in Appendix 2 (page 21) 186 total)

- Schweitzer, H., Cunningham, A., Fields, M. (2019) [Changes in microbial communities and associated water and gas geochemistry across redox gradients in coal beds: Powder River Basin, USA](#). *Geochim Comochim Acta*: v. 245 p. 495-513
- Kirkland, C. M., Norton, D., Cunningham, A., Thane, A., Gerlach, R., Hiebert, R., Hommel, J., Kirksey, J., Spangler, L., Phillips, A. (2019) Biomineralization and wellbore integrity: a microscopic

- solution to subsurface fluid migration. SSRN: Proceedings of 14th Greenhouse Gas Control Technologies Conference Melbourne 21-26 October 2018 (GHGT-14)
- Kirkland, C. M., Norton, D., Firth, O., Eldring, J., Cunningham, A., Gerlach, R., Phillips, A. (2019) Visualizing MICP with X-ray μ -CT to enhance cement defect sealing. *International Journal of Greenhouse Gas Control*: v. 86 p. 93-100
- Mitchell, A., Espinosa-Ortiz, E., Parks, S., Phillips, A., Cunningham, A., Gerlach, R. (2019) [Kinetics of calcite precipitation by ureolytic bacteria under aerobic and anaerobic conditions.](#) *Biogeosciences*: v. 16 p. 2147-2161
- Cunningham A. B., H. Class A. Ebigbo. R. Gerlach, A. J. Phillips, J. Hommel, Field-scale modeling of microbially induced calcite precipitation, *Computational Geosciences*,(2019) 23: 399-414. <https://doi.org/10.1007/s10596-018-9797-6>
- Beser, D., West, C., Daily, R., Cunningham, A., Gerlach, R., Fick, D. R., Spangler, L., Phillips, A. (2017) Assessment of ureolysis induced mineral precipitation material properties compared to oil and gas well cements. *American Rock Mechanics Association 51st Annual Meeting Proceedings*
- Phillips, A., Troyer, E., Hiebert, R., Kirksey, J., Rowe, W., Gerlach, R., Cunningham, A., Esposito, R., Spangler, L. (2018) [Enhancing wellbore cement integrity with microbially induced calcite precipitation \(MICP\): a field scale demonstration.](#) *Journal of Petroleum Science and Engineering*: v. 171 p. 1141-1148
- Phillips, A.J., E. Troyer, R. Hiebert, C. Kirkland, R. Gerlach, A. B. Cunningham, L. Spangler, J. Kirksey, W. Rowe, R. Esposito. Enhancing wellbore cement integrity with microbially induced calcite precipitation (MICP): A field scale demonstration. *J. Pet. Sci. Eng.*, vol 171, December 2018 pp 1141-1148.
- Barnhart, E.P., Davis, K.J., Varonka, M., Orem, W., Cunningham, A.B., Ramsay, B.D., Fields, M.W., 2017, Enhanced coal-dependent methanogenesis coupled with algal biofuels: Potential water recycle and carbon capture, *Int. J. Coal Geol.* V. 171, p 69-75 <http://dx.doi.org/10.1016/j.coal.2017.01.001> IP-060264.
- Hodgskiss, L.H., Nagy, J., Barnhart, E.P., Cunningham, A.B., Fields, M.W., 2016, Cultivation of a native alga for biomass and biofuel accumulation in coal bed methane production water, *Algal Research* V.16, p. 63-68. [doi:10.1016/j.algal.2016.07.014](https://doi.org/10.1016/j.algal.2016.07.014), IP-071048
- Phillips, A.J., A.B. Cunningham, R. Gerlach, Randy Hiebert, C. Hwang, B. Lomans, J. Westridge, J. Kirksey, R. Esposito, L. Spangler, 2016. Fracture Sealing with Microbially-Induced Calcium Carbonate Precipitation: A Field Study. *Environ Sci Technol.* 2016 Apr 5;50(7):4111-7. doi: 10.1021/acs.est.5b05559. Epub 2016 Mar 17.
- Barnhart, E.P., Weeks, E.P., Jones, E.J.P., Ritter, D.J., McIntosh, J.C., Clark, A.C., Ruppert, L.F., Cunningham, A.B., Vinson, D.S., Orem, W., Fields, M.W., 2016, Hydrogeochemistry and coal-associated bacterial populations from a methanogenic coal bed: *Int. J. Coal Geol.* [doi:10.1016/j.coal.2016.05.001](https://doi.org/10.1016/j.coal.2016.05.001), IP-071554
- Hommel, J., Lauchnor, E., Gerlach, R., Cunningham, A.B., Ebigbo, A., Helmig, R. and H. Class: Investigating the influence of the initial biomass distribution and injection strategies on biofilm-mediated calcite precipitation in porous media. *Transport in Porous Media* 2016, 114 (2), 557-579.
- Hommel, J., Ebigbo, A., Gerlach, R., Cunningham, A., Helmig, R., Class, H. (2016) Finding a balance between accuracy and effort for modeling biomineralization. *Energy Procedia. European Geosciences Union General Assembly 2016*: v. 97 p. 379-386

- Hommel, J., Lauchnor, E. G., Phillips, A., Gerlach, R., Cunningham, A., Helmig, R., Ebigbo, A., Class, H. (2015) A revised model for microbially induced calcite precipitation: Improvements and new insights based on recent experiments. *Water Resources Research*: v. 51 i. 5 p. 3695-3715
- Jewell S. X. Zhou, M. Apple, L. Dobeck, L. Spangler, and A. Cunningham, (2015) Bulk electric conductivity response to soil and rock CO₂ concentration during controlled CO₂ release experiments: Observations and analytic modeling, geophysics, vol. 80, no. 6 (November-December 2015); p. e293–e308, 10.1190/geo2014-0118.1
- Ritter, D., Vinson, D., Barnhart, E.P., Akob, D. M., Fields, M. W., Cunningham, A. B., Orem, W., McIntosh, J. C., Enhanced, 2015, Microbial Coalbed Methane Generation: A Review of Research, Commercial Activity, and Remaining Challenges, *Int. J. Coal Geol.* V.46, p 28-41, doi: 10.1016/j.coal.2015.04.013, IP-065234.
- Hommel, J.; Lauchnor, E.; Phillips, A.; Gerlach, R.; Cunningham, A. B.; Helmig, R.; Ebigbo, A.; Class, H., A revised model for microbially induced calcite precipitation: Improvements and new insights based on recent experiments. *Water Resources Research* 2015, 51, (5), 3695-3715.
- Phillips, A., J Eldring, R Hiebert, E. Lauchnor, A. Mitchell, R. Gerlach, L. Spangler, A. Cunningham Design of a meso-scale high pressure vessel for the laboratory examination of biogeochemical subsurface processes. *Journal of Petrol. Sci. and Eng.* 126 (2015) 55-62.
- Cunningham, A.B., A. Phillips, E. Troyer, E. Lauchnor, R. Hiebert, R. Gerlach, L. Spangler. Wellbore leakage mitigation using engineered biomineralization. *Energy Procedia*, 2014, 63: 4612-4619.
- Barnhart, E. P., De Le'on, K. B., Ramsay, B. D., Cunningham, A. B., and Fields, M. W. (2013). Investigation of Coal-Associated Bacterial and Archaeal Populations from a Diffusive Microbial Sampler (DMS). *International Journal of Coal Geology*, (doi: 10.1016/j.coal.2013.03.006).
- Phillips, A.J., R. Gerlach, R., Lauchnor, E., Mitchell, A.C, Cunningham, A.B. Spangler L. Engineered applications of ureolytic biomineralization: a review (2013). *Biofouling*, Vol. 29, No. 6, 715–733, <http://dx.doi.org/10.1080/08927014.2013.796550>.
- Mitchell, A. C.; Phillips, A. J.; Schultz, L.; Parks, S.; Spangler, L.; Cunningham, A. B.; Gerlach, R.(2013) Microbial CaCO₃ mineral formation and stability in a simulated high pressure saline aquifer with supercritical CO₂. *International Journal of Greenhouse Gas Control*, Volume 15, July 2013, Pages 86-96. DOI: [10.1016/j.ijggc.2013.02.001](https://doi.org/10.1016/j.ijggc.2013.02.001)
- Lauchnor E., Schultz L., Bugni S., Mitchell A.C., Cunningham A.B., Gerlach R.(2013) Bacterially induced calcium carbonate precipitation and strontium co-precipitation in a porous media flow system. *Environ Sci Technol*; 47(3): 1557–1564. <http://dx.doi.org/10.1021/es304240y>
- Phillips, A.J., Lauchnor, E., Eldring, J., Esposito, R., Mitchell, A.C., Gerlach, R., Cunningham, A.B. and Spangler, L.,(2013) Potential CO₂ Leakage Reduction through Biofilm-Induced Calcium Carbonate Precipitation, *Environ Sci Technol* . 47(1):142–149. <http://dx.doi.org/10.1021/es301294q> DOI: 10.1021/es301294q.
- Cunningham A.B., Lauchnor E., Eldring J., Esposito R., Mitchell A.C., Gerlach R., Phillips A.J., Ebigbo A., Spangler L. 2013. Abandoned Well CO₂ Leakage Mitigation Using Biologically Induced Mineralization: Current Progress and Future Directions. *Greenhouse Gases: Science and Technology*, *Gas Sci Technol.* 3:40–49.
- Phillips, A.J., Lauchnor, E., Eldring, J., Esposito, R., Mitchell, A.C., Gerlach, R., Cunningham, A.B. and Spangler, L. 2013. Potential CO₂ Leakage Reduction through Biofilm-Induced Calcium Carbonate Precipitation, *Environ Sci Technol* 2013; 47(1):142–149.

- Ebigbo, A., A. Phillips, R. Gerlach, R. Helmig, A. Cunningham, H. Class, and L. Spangler 2012. Darcy-scale modeling of microbially induced carbonate mineral precipitation in sand columns, *Water Resources Research* 2012; 48(7):1–17.
- Zhou, X., V.R. Lakkaraju, M. Apple, L.M. Dobeck, K. Gullickson, J.A. Shaw, A.B. Cunningham, L. Wielopolski, L.H. Spangler 2012. Experimental observation of signature changes in bulk soil electrical conductivity in response to engineered surface CO₂ leakage. *International Journal of Greenhouse Gas Control* 7 (2012) 20–29.
- Schultz, L. N., Pitts, B., Mitchell, A. C., Cunningham, A. B., & Gerlach, R. 2011. Imaging Biologically-Induced Mineralization in Fully Hydrated Flow Systems. *Microscopy Today* 10-13.
- Faulwetter J.L., M. D. Burr, A. B. Cunningham, F. M. Stewart, A. K. Camper and O. R. Stein. 2011. Floating treatment wetlands for domestic wastewater treatment. *Water Science and Technology*, 64.10, pp 2089-2095.
- Codd S.L., S.J. Vogt, J.A. Hornemann, A.J. Phillips, J.E. Maneval, K.R. Romanenko, L. Hansen, A.B. Cunningham, J.D. Seymour, 2011. "NMR Relaxation Measurements of Biofouling in Model and Geological Porous Media." *Organic Geochemistry* 42: 965–971.
<http://www.sciencedirect.com/science/article/pii/S0146638011000684>
 DOI:10.1016/j.orggeochem.2011.03.014
- Cunningham, A.B., R. Gerlach, L. Spangler, A.C. Mitchell, S. Parks, and A. Phillips 2011. Reducing the risk of well bore leakage of CO₂ using engineered biomineralization barriers. *Energy Procedia* (4) (2011) 5178-5185. Available online @ www.sciencedirect.com.
- Fridjonsson, E.O., J.D. Seymour, L.N. Schultz, R. Gerlach, A.B. Cunningham and S.L. Codd. 2011, NMR measurement of hydrodynamic dispersion in porous media subject to biofilm mediated precipitation reactions, *Journal of Contaminant Hydrology* 120–121 (2011) 79–88.
- Spangler L.H., L.M. Dobeck, K. S. Repasky, A. R. Nehrir, S. D. Humphries, J. L. Barr, C.J. Keith, J. A. Shaw, J.H. Rouse, A.B. Cunningham, S.M. Benson, C.M. Oldenburg, J.L. Lewicki, A. W. Wells, J. R. Diehl, B. R. Strazisar, J.E. Fessenden, T.A. Rahn, J.E. Amonette, J.L. Barr, W.L. Pickles, J.D. Jacobson, E.A. Silver, E.J. Male, H.W. Rauch, K.S. Gullickson, R. Trautz, Y. Kharaka, J. Birkholzer, L. Wielopolski. 2010. A shallow subsurface controlled release facility in Bozeman, Montana, USA, for testing near surface CO₂ detection techniques and transport models. *Environmental Earth Science*, Volume 60, Number 2. DOI 10.1007/s12665-009-0400-2. <http://www.springerlink.com/content/1866-6280/60/2/>.
- Gerlach, R.; Cunningham, A.B. 2010. Influence of Microbial Biofilms on Reactive Transport in Porous Media. *Proceedings of the Third International Conference on Porous Media and its Applications in Science, Engineering and Industry*. Montecatini, Italy. June 20-25, 2010.
- Mitchell A.C., K. Dideriksen, L.H. Spangler, A. B. Cunningham, R. Gerlach. 2010. Microbially enhanced carbon capture and storage by mineral-trapping and solubility-trapping. *Environ. Sci. Technol.*, 44(13):5270-5276.
- Ebigbo, A., R. Helmig, A.B. Cunningham, H. Class, and R. Gerlach. 2010. Modelling biofilm growth in the presence of carbon dioxide and water flow in the subsurface. *Advances in Water Resources*, Volume 33, Issue 7, 762-781.

Symposia Presentations 2012 – 2020 (Previous presentations in Appendix 3 (page 30), 245 total)

- Cunningham, A.B., A. Phillips, R. Gerlach, C Kirkland. "Research Collaboration Highlights: A Tribute to Rainer Helmig", Interpore 2020, MS 23: Special Session Honoring Rainer Helmig, August 31 – September 4, 2020.
- Kirkland, C. M. (Author & Presenter), Thane, A., Troyer, E., Hiebert, R., Hyatt, R., Hommel, J., Kirksey, J., Cunningham, A., Gerlach, R., Spangler, L., Esposito, R., Rowe, W., Phillips, A., Workshop on subsurface biotechnology, "MICP in the field: Enhancement of wellbore cement integrity and permeability modification," Aberystwyth University, Aberystwyth, Wales, UK. (June 2018).
- Kirkland, C. M. (Author & Presenter), Thane, A. (Author), Troyer, E. (Author), Hiebert, R. (Author), Hyatt, R. (Author), Hommel, J. (Author), Kirksey, J. (Author), Cunningham, A. B. (Author), Gerlach, R. (Author), Spangler, L. (Author), Esposito, R. (Author), Rowe, W. (Author), Phillips, A. (Author), InterPore 2018, "MICP in the field: Enhancement of wellbore cement integrity and permeability modification," InterPore, New Orleans, LA, USA. (May 16, 2018).
- Barnhart, E.P., Ruppert, L.F., Orem, W.H., McIntosh, J.C., Gerlach, R., Cunningham, A., Fields, M., Hiebert, R., Hyatt, R., Scholin, C., Yamahara, K., Marin, R., Birch, J., Sepulveda, A., Merkes, C., Wright, P., Kinsey, S., Montana Bureau of Mines and Geology Seminar Series, "Moving microbiology and DNA analysis out of the lab and into the field with new technology," Montana Bureau of Mines and Geology, Butte, Montana. (January 2018).
- Barnhart, E.P., Ruppert, L.F., Orem, W.H., McIntosh, J.C., Gerlach, R., Cunningham, A., Fields, M., Hiebert, R., Hyatt, R., Scholin, C., Yamahara, K., Marin, R., Birch, J., Sepulveda, A., Merkes, C., Wright, P., Kinsey, S., USGS Innovation Conference, "Moving microbiology and DNA analysis out of the lab and into the field with new technology," USGS, Reston, VA. (February 2018).
- Phillips, AJ, Cunningham, A, Gerlach, R, Spangler, L. Mineral precipitation in energy-related applications. ERI Day March 20, 2018, Bozeman, MT
- Meslé, M, Phillips, AJ, Eldring, J, Hodgkiss, L, Dobeck, L, Davis, K, Gerlach, R, Hiebert, R, Barnhart, E, Cunningham, A, Spangler, L, Fields, M. Design and Demonstration of Meso-Scale Coal-Dependent Methanogenesis Under Pressurized Flow Conditions in situ Temperature and Pressure. International Society for Subsurface Microbiology 2017 Conference, November 6-10, 2017.
- Gerlach, R., Mesle, M., Phillips, A.J., Eldring, J., Hodgkiss, L., Dobeck, L., Davis, K., Hiebert, R., Barnhart, E., Cunningham, A., Spangler, L., Fields, M., International Society for Subsurface Microbiology conference, "Design and Demonstration of Meso-Scale Coal-Dependent Methanogenesis Under Pressurized Flow Conditions," International Society for Subsurface Microbiology, Rotorua, New Zealand. (November 2017).
- Phillips, AJ, Cunningham, A, Gerlach, R, Spangler, L. Methods to Enhance Wellbore Cement Integrity with Microbially-Induced Calcite Precipitation (MICP). U.S. Department of Energy, National Energy Technology Laboratory, Mastering the Subsurface Through Technology Innovation, Partnerships and Collaboration: Carbon Storage and Oil and Natural Gas Technologies Review Meeting, August 1-3, 2017, Pittsburg, PA.
- Barnhart, E.P., Ruppert, L.F., Davis, K.J., Orem, W.H., McIntosh, J.C., Gerlach, R., Cunningham, A., Fields, M., Heibert, R., Hyatt, R., SME/PCIMA Conference, "Enhanced Microbial Coalbed Methane Generation: Field Site and Diffusive Microbial Sampler Investigations," SME/PCIMA, Pittsburgh, PA. (October 2017).
- Phillips, AJ, Cunningham, A, Gerlach, R, Spangler, L. Wellbore Leakage Mitigation Using Advanced Mineral Precipitation Strategies. U.S. Department of Energy, National Energy Technology Laboratory, Mastering the Subsurface Through Technology Innovation, Partnerships and

Collaboration: Carbon Storage and Oil and Natural Gas Technologies Review Meeting, August 1-3, 2017, Pittsburg, PA

Troyer, E, West, C, Berninghaus, A, Joyce, J, Gerlach, R, Phillips, AJ, Cunningham AB, and Foreman, C. Biomineralized Art: Using Microbes and Minds to Make Mountains. American Rock Mechanics Association 51st Annual Meeting Proceedings, June 25-28, 2017, San Francisco, CA. (Paper # 460

Cunningham, AB. Session Chairman: Experimental Methods. 9th International Conference on Porous Media & Annual Meeting (INTERPORE), May 8-12, 2017, Rotterdam, Netherlands

Phillips, AJ, Gerlach, R, Cunningham, AB, Hommel, J, Helmig, R, Hiebert, R, Kirksey, J, Rowe, W, Esposito, R, and Spangler, L. Biomineralization: A Strategy to Modify Permeability in the Subsurface. 9th International Conference on Porous Media & Annual Meeting, May 8-12, 2017, Rotterdam, Netherlands

Thane, A, Phillips, AJ, Spangler, L, Cunningham, AB, Gallagher, B. Remediation of Coal Combustion Residuals Using Microbially-Induced Calcite Precipitation. World of Coal Ash Conference, May 8-12, 2017, Lexington, KY

Phillips, AJ, Gerlach, R, Hiebert, R, Cunningham, AB, Spangler, L. (Bio)mineralization for Permeability Modification and Wellbore Sealing. Society of Petroleum Engineers Annual Spring Symposium, April 21, 2017, Montana Tech, Butte Montana

Gerlach, R, Phillips, AJ, Cunningham, AB, Spangler, L "Controlling Fluid Flow in the Subsurface through Ureolysis-Controlled Mineral Precipitation. American Geophysical Union Fall Meeting, December 2016, San Francisco, CA

Barnhart E. M. Fields, A. Cunningham, R. Hiebert. Subsurface environment sampler for improved in situ characterization of subsurface microbial communities. AGU Meeting, December 2016, San Francisco, CA.

Barnhart E. M. Fields, A. Cunningham, R. Hiebert. Subsurface environment sampler for improved in situ characterization of subsurface microbial communities. USGS Innovations Meeting, December 2016, Menlo Park

Schweitzer H, E. Barnhart, M. Fields, A. Cunningham. Aqueous Sulfate Levels Control Methanogen Diversity and Activity in Subsurface Coal Seams, AWRA, Oct. 2016, Anaconda, MT.

Cunningham A.B., Collaborative Research in Support of SRP NUPUS: Currant and future research on Reactive Transport in Porous media. 1st SRP-NUPUS Meeting, Muhlhausen im Tale, 5th-7th October 2016

Meslé, M, Phillips, AJ, Hodgskiss, L, Eldring, J, Hiebert, R, Cunningham, A, and Fields, M. Design of a small-scale high-pressure reactor system to study microbial bioconversion of coal to methane. Geologic Society of America Annual Meeting, September 25-28, 2016, Denver, Colorado.

Phillips, AJ, Gerlach, R, Cunningham, AB, Troyer, E, Norton, D, Hiebert, R, Kirksey, J, Rowe, W, Esposito, R, and Spangler, L. Biomineralization: A Strategy to Modify Permeability in the Subsurface. Geologic Society of America Annual Meeting, September 25-28, 2016, Denver, Colorado.

Davis K., E. Barnhart, M. Fields, A. Cunningham. Scale-Up of Microbially Enhanced Coalbed Methane Strategies Using a Column Upflow Reactor, GSA, Sept. 2016, Denver, CO.

- Davis K., E. Barnhart, M. Fields, A. Cunningham. Identifying the Source, Pathways, and Rates of Enhanced Microbial Coalbed Methane Production, GSA, Sept. 2016, Denver CO.
- Phillips, AJ, Gerlach, R, Cunningham, AB, Spangler, L Methods to Enhance Wellbore Cement Integrity with Microbially-Induced Calcite Precipitation (MICP). Department of Energy, Mastering the Subsurface through Technology Innovation & Collaboration: Carbon Storage & Oil & Natural Gas Technologies Review Meeting, August 17, 2016, Pittsburgh PA
- Phillips, AJ, Gerlach, R, Cunningham, AB, Spangler, L. Wellbore Leakage Mitigation Using Advanced Mineral Precipitation Strategies” Department of Energy, Mastering the Subsurface through Technology Innovation & Collaboration: Carbon Storage & Oil & Natural Gas Technologies Review Meeting, August 17, 2016, Pittsburgh PA
- Phillips, AJ, Gerlach, R, Hiebert, R, Cunningham, AB, Spangler, L Methods to Enhance Wellbore Cement Integrity with Microbially-Induced Calcite Precipitation (MICP). Department of Energy, National Energy Technology Laboratory, DOE Headquarters’ Executive Committees, June 21, 2016 Webinar, Bozeman MT via Morgantown WV
- Gerlach, R., Phillips, A., Cunningham, A., Spangler, L. Biofilm-Mediated Mineral Precipitation Technology – From the Microscale to the Field-Scale. Goldschmidt, Yokohama, Japan June 26-July 1, 2016.
- Feder, M., Phillips, A., Gerlach, R. “Advancing ureolysis driven mineral sealing strategies for environmental engineering applications” Goldschmidt, Yokohama, Japan June 26-July 1, 2016.
- Barnhart E. M. Fields, A. Cunningham, H. Schweitzer. In Situ and Enriched Microbial Community Composition and Function Associated with Coal Bed Methane from Powder River Basin Coals, April 2016, Vienna, Austria
- Phillips, A.J., A. Cunningham, R. Gerlach, Biomineralization Sealing Technology- A Technology Developed in Montana, Presented to the Montana Energy Conference, March 30, 2016, Billings Montana.
- Schweitzer H, E. Barnhart, M. Fields, A. Cunningham. Biogenic methane and production: A look a microbial community dynamics and carbon cycling in coalbeds, Montana State University Microbiology Departmental Seminar, Jan 2016, Bozeman, MT.
- Phillips, AJ, Gerlach, R, Cunningham, AB, Spangler, L. Wellbore Leakage Mitigation Using Advanced Mineral Precipitation Strategies. Department of Energy, National Energy Technology Laboratory, Carbon Storage Division, December 3, 2015 Pittsburg, PA
- Hommel, J., Ebigbo, A., Gerlach, R., Cunningham, A.B., Helmig, R. and H. Class: Finding a balance between accuracy and effort for modeling biomineralization. 2015 NUPUS annual meeting 2015 (8. - 12. September 2015, Freudenstadt).
- Hommel, J., Ebigbo, A., Gerlach, R., Cunningham, A.B., Helmig, R. and H. Class: Finding a balance between accuracy and effort for modeling biomineralization. 2015 IAMG 2015, 17th Annual Conference of the International Association for Mathematical Geosciences (5. - 13. September 2015, Freiberg).
- Phillips, AJ, Gerlach, R, Cunningham, AB, Spangler, L Field Test and Evaluation of Engineered Biomineralization Technology for Sealing Existing wells. Department of Energy, National Energy Technology Laboratory, Storage Capacity & Well Remediation Quarterly Webinar, July 17, 2015, Bozeman MT via Morgantown WV
- Phillips, AJ, Cunningham, AB, Gerlach, R, Spangler, L. Overview of biofilm mediated mineralization and engineering applications. Montana Biofilm Meeting July 15, 2015, Bozeman MT

- Phillips, A.J., Gerlach, R., Hiebert, R., Cunningham, A.B., Spangler, L., Esposito, R., Kirksey, J. Biological influences in the subsurface: A method to seal fractures and reduce permeability with microbially-induced calcite precipitation, presented to 49th US Rock Mechanics / Geomechanics Symposium, San Francisco, CA, USA, 28 June 28-July 1, 2015.
- Phillips, AJ, Cunningham, AB, Gerlach, R, Spangler, L. Advancing technologies for mitigating subsurface gas leakage. June 4, 2015 Darcy Lecture Introductory Session, Bozeman, MT
- Hommel, J., Lauchnor, E., Phillips, A., Gerlach, R., Cunningham, A.B., Helmig, R., Ebigbo, A. and H. Class: A revised model for microbially induced calcite precipitation - improvements and insights. Interpore Conference and Annual Meeting 2015 (18. - 21. May 2015, Padua, Italy). 2015.
- Phillips, AJ, Gerlach, R, Cunningham, AB, Spangler, L. "Field Test and Evaluation of Engineered Biomineralization Technology for Sealing Existing wells" Department of Energy, National Energy Technology Laboratory, Storage Capacity & Well Remediation Quarterly Webinar, April 2015, Bozeman MT via Morgantown WV
- Orem W., D. Akob, E. Barnhart, A. Clark, A. Cunningham, D. Dunlap, M. Fields, L. Ruppert, and M. Varonka. Biodegradation Pathways and Organic Intermediates in the Conversion of Coal Geopolymers to Methane. 249th ACS National Meeting, Denver Colorado, March 22-26, 2015
- Barnhart E. M. Fields, A. Cunningham, H. Schweitzer. Coal-dependent Natural Gas Production in the Powder River Basin, Montana Energy Conference, March 2016, Billings MT
- Davis K.J., L. Hodgskiss, H.D. Schweitzer L. Corredor, R. Hiebert, E. Barnhart, A.B. Cunningham, and M.W. Fields. Sustainable Coal Bed Methane (CBM) and Biofuel Production from Algae Grown in CBM Produced Water. Poster presented at the 2015 MT State Legislature, Helena MT, February 10, 2015.
- Corredor L., J. Nagy, R. Gerlach, A.B. Cunningham, E. B. Barnhart, and M.W. Fields. Nutrient and Temperature Stress for Lipid Accumulation in a Novel Environmental Green Microalgae. AGU Abstract January 2015.
- Barnhart E. M. Fields, A. Cunningham, W. Orem. Creating Cleaner Energy from Coal, Energy Synergy Seminar, November 2015, Reston, VA.
- Barnhart E. M. Fields, A. Cunningham, H. W. Orem. Characterization of Hydrogeochemistry and Coal-Associated Bacterial Populations from a Methanogenic Coal Bed: Identification of Potential Biosurfactant Production, GSA, Microbial Hydrocarbon Formation and Biodegradation: Organisms, Pathways, Environmental Limitations, and Isotope Signatures Session, November 2015, Baltimore, Maryland.
- Phillips A., R. Hiebert, J. Kirksey, E. Lauchnor, A. Rothman, L. Spangler, R. Gerlach, A. Cunningham. Microbially Induced Calcite Precipitation (MCIP): A Technology for Managing Flow and Transport in Porous Fractured Media. AGU 2014 Fall Meeting, San Francisco, December 15-19, 2014.
- Gerlach R., A.B. Cunningham, L. Spangler, A. Phillips. Biofilm-Mediated Mineral Precipitation Technology – from the Microscale to the Field-Scale. Reservoir Microbiology Forum – London. November 18-19, 2014
- Gerlach R., M. Fields, E. Barnhart, A. Cunningham, K. Davis, H. Schweitzer. Stimulation of coal-dependent methanogenesis with native microbial consortia from the Powder River Basin (USA). Reservoir Microbiology Forum – London. November 18-19, 2014

- Phillips, AJ, Gerlach, R, Hiebert, R, Cunningham, AB, Spangler, L. Wellbore leakage mitigation with microbially-induced CaCO₃ precipitation. October 2014, 81st Annual Fall Water School for Water & Wastewater Operators & Managers, Bozeman MT
- Cunningham, A.B., A. Phillips, E. Troyer, E. Lauchnor, R. Hiebert, R. Gerlach, L. Spangler. Wellbore leakage mitigation using engineered biomineralization. Presented to The International Conference on Greenhouse Gas Technologies (GHGT-12), Austin TX, Oct. 7, 2014.
- Cunningham A.B. Overview of Contemporary Biofilm Research. Presented at the 2014 NUPUS Research Meeting, Goerghof Germany, Sept 10, 2014.
- Cunningham, A., R. Gerlach, A. Phillips. Field-scale plugging of hydraulic fractures using ureolytic bacteria. Montana Biofilm Science and Technology Meeting. Bozeman, Montana. July 17, 2014.
- Connolly, J., Rothman, A., Jackson, B., Hommel, J., Klapper, I., Cunningham, A., Gerlach, R. (2014): Image-based modeling and parameter estimation in bacterial biomineralization. Platform Presentation. 2014 Pacific Northwest meeting of the Mathematical Association of America. Missoula, Montana, USA. June 26–28, 2014.
- Gerlach R., J. Connolly, B. Jackson, I Klapper T. Zhang, A. Cunningham. Pore Scale Modeling of the Microbially Induced CaCO₃ Precipitation Process . Presented at The 2014 International Conference on Computational Methods in Water Resources (CMWR 2014), University of Stuttgart, Stuttgart Germany, June 10-13, 2014.
- Cunningham, A., R. Gerlach, A. Phillips, E. Lauchnor, L. Spangler, J. Hommel. Investigation of Microbially Induced Calcite Precipitation for Leakage Mitigation in Underground Gas Storage. . Presented at The 2014 International Conference on Computational Methods in Water Resources (CMWR 2014), University of Stuttgart, Stuttgart Germany, June 10-13, 2014
- Gerlach R., A. Cunningham, R. Hiebert. Using Biomineralization Sealing for Leakage Mitigation in Shale. . Presented at The 2014 International Conference on Computational Methods in Water Resources (CMWR 2014), University of Stuttgart, Stuttgart Germany, June 10-13, 2014.
- Hommel, J., A. Cunningham, R. Gerlach, R. Helmig, A. Ebigbo, H. Class, Modeling Microbially Induced Calcite Precipitation as a Leakage Mitigation Technology. . Presented at The 2014 International Conference on Computational Methods in Water Resources (CMWR 2014), University of Stuttgart, Stuttgart Germany, June 10-13, 2014.
- Hommel J., A.B. Cunningham, R. Helmig, A. Ebigbo, H. Class. Numerical investigation of microbially induced calcite precipitation as leakage mitigation technology. Presented to The International Research Training Group NUPUS Conference, University of Stuttgart, March 17, 2014.
- Hommel, J., Cunningham, A.B., Helmig, R., Ebigbo, A. und H. Class: Estimation of uncertain parameters of the biomineralization model by inverse modeling. NUPUS annual meeting 2014 (16. - 19. March 2014, Freudenstadt). 2014.
- Connolly, J.M.; Rothman, A.; Jackson, B.; Klapper, I.; Cunningham, A.B.; Gerlach, R. (2013): Image-based Modeling of Biofilm-induced Calcium Carbonate Precipitation. Poster. 2013 Fall Meeting, AGU, San Francisco, CA. December 09-13, 2013.
- Lauchnor E.G., Logan Schultz, Andrew Mitchell, Al Cunningham, Robin Gerlach. Strontium co-precipitation during biomineralization of calcite in porous media using differing treatment strategies. American Geophysical Union 2013 Fall Meeting, San Francisco, Dec. 9-12, 2013.

- Phillips A., J. Eldring, R. Hiebert, E. Lauchnor, A. Mitchell, R. Esposito, R. Gerlach, A. Cunningham, L. Spangler. Applicability of MICP in subsurface and fractured environments". American Geophysical Union 2013 Fall Meeting, San Francisco, Dec. 9-12, 2013.
- Gerlach, R.; Rothman, A.; Hiebert, R.; Cunningham, A.B. (2013): Using Biomineralization Sealing for Leakage Mitigation in Shale. Poster Presentation. 2013 Fall Meeting, AGU, San Francisco, CA. December 09-13, 2013
- Cunningham, A.B, R. Gerlach, and L.H. Spangler. Well Bore Leakage Mitigation using Engineered Biomineralization. Wellbore Integrity Network Meeting, Application to CO₂ Storage and Other Industrial Sectors. Denver CO, October 16 and 17, 2013.
- Hommel J., A.B. Cunningham, R. Helmig, A. Ebigbo, H. Class. Numerical investigation of microbially induced calcite precipitation as leakage mitigation technology. The International Research Training Group NUPUS Conference. Bergen Norway. September 30 – October 2, 2013.
- Connolly, J., Rothman, A., Jackson, B., Klapper, I., Cunningham, A., Gerlach, R. "Image-Based Modeling of Biofilm-Induced Calcium Carbonate Precipitation" (Oral Presentation). *Interpore 5th International Conference on Porous Media & Annual Meeting*, Prague, Czech Republic. September 2013.
- Phillips, A., Gerlach R. Lauchnor, E., Cunningham, A.B., Montana Biofilm Meeting July 2013, "Controlling permeability reduction in the subsurface through biofilm-induced mineral precipitation: A multi-scale approach". *Montana Biofilm Science and Technology Meeting. Bozeman, Montana. July, 2013.*
- Connolly, J., Rothman, A., Jackson, B., Klapper, I., Cunningham, A., Gerlach, R. "Image-Based Modeling of Biofilm-Induced Calcium Carbonate Precipitation" (Oral Presentation). *Interpore 5th International Conference on Porous Media & Annual Meeting*, Prague, Czech Republic. September 2013.
- Jackson, B., Connolly, J., Rothman, A., Klapper, I., Cunningham, A., Gerlach, R. Biomineralization Using Biofilms: Estimating Kinetic Parameters Using a Simple Flow Channel Model (Poster Presentation). *Society for Mathematical Biology Annual Meeting and Conference*, Phoenix, AZ, June 2013.
- Hommel J., A.B. Cunningham, R. Helmig, A. Ebigbo, H. Class, Numerical investigation of microbially induced calcite precipitation as leakage mitigation technology. Presented as part of the NUPUS International Research Train Group, *European Geosciences Union General Assembly*, Vienna Austria, 10th April 2013.
- Gerlach R., A. Phillips, E. Lauchnor, A. Ebigbo, J. Connolly, A. Mitchell, R. Helmig, A. Cunningham, L. Spangler. "Improving Control of Microbially-Induced Mineral Precipitation in Flow Systems - Experiments and Modelling". *American Geophysical Union Fall Meeting*. San Francisco, Dec. 3-7, 2012.
- Phillips A., J. Eldring, E. Lauchnor, R. Hiebert, R. Gerlach, A. Mitchell, R. Esposito, A. Cunningham, L. Spangler. "Biofilm-induced calcium carbonate precipitation: application in the subsurface" *American Geophysical Union Fall Meeting*. San Francisco, Dec. 3-7, 2012.
- Cunningham A., R. Gerlach, A. Phillips, J. Eldring, E. Lauchnor, I. Klapper, A. Ebigbo, A. Mitchell, L. Spangler. "The potential of microbial activity to increase the efficacy of geologic carbon capture and storage" *American Geophysical Union Fall Meeting*. San Francisco, Dec. 3-7, 2012.

- Lauchnor E. A. Phillips, A. Cunningham, R. Gerlach. "Laboratory-scale column studies to evaluate ureolytically drive CaCO₃ mineralization" *American Geophysical Union Fall Meeting*. San Francisco, Dec. 3-7, 2012.
- Barnhart, E., McIntosh, M., Clark, A., Orem, W., Cunningham, A., Fields, M., *In-situ* and Enriched Microbial Community Composition and Function Associated with Coal-bed Methane from Powder River Basin Coals, 14th International Society of Microbial Ecology (ISME) Conference, poster, Copenhagen, Denmark, August 2012.
- Barnhart, E., Mclure, M., Hunt, K., Fields, M., (2012) Genomic Insight into the Evolution of Acetoclastic Methanogenesis, 14th International Society of Microbial Ecology (ISME) Conference, oral, Copenhagen, Denmark, August 2012.
- Cunningham, A.B., "Overview of Center for Biofilm Engineering Research Program", Biofilm Induced Mineralization Workshop, Sponsored by NSF, Montana State University, August 7–10, 2012
- Connolly, J.; Pitts, B.; Cunningham, A.; Gerlach, R.. (2012): Imaging and Analysis of Microbially Induced Calcium Carbonate Precipitates and Biofilm at the Center for Biofilm Engineering, Montana State University. Microscopy Society of America, Microscopy & Microanalysis Meeting. Phoenix, Arizona. July 29-August 02, 2012.
- Cunningham, A.B. "Overview of MSU/CBE Energy and Environmental Research" Montana Biofilm Science and Technology Meeting, Bozeman MT, July 2012.
- Gerlach, R, Phillips, A., Lauchnor, E., Cunningham, A.B., "Well Leakage mitigation using Biomineralization" . Montana Biofilm Science and Technology Meeting. Bozeman, Montana. July, 2012.
- Barnhart, E., Cunningham, A.B., Fields, M. " In_situ and Enriched Microbial Community composition and function associated with Coal Bed Methane from Powder River Basin Coals". Montana Biofilm Science and Technology Meeting. Bozeman, Montana. July, 2012.
- Connolly, J.; Rothman, A.; Jackson, B.; Klapper, I.; Cunningham, A.; Gerlach, R. Pore Scale Processes in Microbially Induced CaCO₃ Precipitation. Montana Biofilm Science and Technology Meeting. Bozeman, Montana. July, 2012.
- Mitchell, A.C.; Phillips, A.J.; Lauchnor, E.; Connolly, J.; Schultz, L.N.; Gerlach, R.; Cunningham, A.B. Potential of Microbiologically Induced Mineralisation to Increase Geologic CO₂ Storage Security. Platform Presentation (Invited). Goldschmidt Conference - Earth in Evolution, Montreal (Canada), June 24-29, 2012
- Barnhart, E., Meredith, E., McIntosh, M., Clark, A., Orem, W., Cunningham, A., Fields, M., *In-Situ* and Stimulated Microbial Communities Associated with Coal Beds, Biogenic Coal Bed Natural Gas Conference, oral, Laramie, WY, June 2012.
- Fields, M. Characterization of Microbial Communities Associated Powder River Basin Coals: Structure to Function Relationships, invited talk, Geochemical Goldschmidt conference, Montreal, Canada. June 2012.
- Gerlach, R.; Connolly, J.; Ebigbo, A.; Klapper, I.; Lauchnor, E.; Mitchell, A.C.; Phillips, A.J.; Schultz, L.; Spangler, L.H.; Zhang, T.; Cunningham, A.B. The Potential of Microbial Activity to Increase the Efficacy of Geologic Carbon Capture and Storage. Platform Presentation (Invited). 4th International Conference on Porous Media and its Applications in Science, Engineering and Industry. Potsdam, Germany, June 17–22, 2012.
- Connolly, J.; Rothman, A.; Jackson, B.; Klapper, I.; Cunningham, A.B.; Gerlach, R. The Potential of Microbial Activity to Increase the Efficacy of Geologic Carbon Capture and Storage. Platform

Presentation. 4th International Conference on Porous Media and its Applications in Science, Engineering and Industry. Potsdam, Germany, June 17–22, 2012.

Gerlach, R.; Connolly, J.; Ebigbo, A.; Klapper, I.; Lauchnor, E.; Mitchell, A.C.; Phillips, A.J.; Schultz, L.; Spangler, L.H.; Zhang, T.; Cunningham, A.B. The Potential of Microbial Activity to Increase the Efficacy of Geologic Carbon Capture and Storage. Poster Presentation. 4th International Conference on Porous Media and its Applications in Science, Engineering and Industry. Potsdam, Germany, June 17–22, 2012.

Lauchnor, E.; Schultz, L.; Mitchell, A.C.; Gerlach, R. Microbially induced CaCO₃ mineralization and strontium co-precipitation in porous media reactors. Platform Presentation. 4th International Conference on Porous Media and its Applications in Science, Engineering and Industry. Potsdam, Germany, June 17–22, 2012.

Gerlach, R. Gerlach, R.; Phillips, A.J.; Lauchnor, E.; Ebigbo, A.; Connolly, J.; Zhang, T.; Mitchell, A.C.; Klapper, I.; Helmig, R.; Cunningham, A.B.; Spangler, L.H. Improving Control of Microbial Activity and Microbially-Induced Mineral Precipitation in Flow Systems - Experiments and Modelling. Platform presentation (Invited). 4th International Conference on Porous Media, Purdue University, West Lafayette, Indiana, May 14–16, 2012.

Cunningham A.B., A. Phillips, A.C. Mitchell, L. Spangler, and R. Gerlach. Abandoned Well Leakage Mitigation Using Biomineralization. 11th Annual Conference on Carbon Capture Utilization & Sequestration, Pittsburg Pennsylvania. April 30 – May 3, 2012.

Barnhart, E., Meredith, E., McIntosh, M., Clark, A., Orem, W., Cunningham, A., Fields, M. Stimulation in the Powder River Basin, Conservation District Meeting, oral Forsyth, MT, March 2012.

Other University Affiliations

University of New South Wales (Sydney Australia)

I was a visiting professor at UNSW from Decemer 1993 to July 1994 (sabbatical; leave). My main focus there was collaboration with Dr. Kevin Marshall (co-editor with Bill Characklis on the first edition of *Biofilms* John Wiley, 1990). Our collaboration focused on biofouling issues and nitrification/denitrification issues in surface and subsurface water systems. Upon completion of this sabbatical leave my CBE research program shifted to the study of subsurface biofilm barriers aimed at denitrification of nitrate plumes in groundwater.

University of Stuttgart

I was a visiting professor at the University of Stuttgart in the (Spring 2002) and have enjoyed a long-standing collaboration with Dr. Rainer Helmig and colleagues at Stuttgart's Institute for Modeling Hydraulic and Environmental Systems (IWS). This collaboration has developed into a major cross-disciplinary, international research and education program focused on combining the expertise of the CBE (biofilm process) with the computational simulation capabilities of IWS. Through IWS I have become an International Collaborator with the NUPUS program (The International Research Training Group "Non-linearities and Upscaling in Porous Media). NUPUS is a Dutch-German-Norwegian graduate school, in which researchers from TU Delft, TU Eindhoven, Wageningen University, Utrecht University, University of Bergen and University of Stuttgart participate. NUPUS is funded by the German Research Foundation (DFG), the Netherlands Organisation for Scientific Research (NWO) and the Research Council of Norway.

Through NUPUS, Stuttgart graduate students focused on computational simulation have been able to work in close collaboration with me and other CBE researchers and students to incorporate biofilm-

related processes into multi-phase, multi-component simulation models. Specifically we have addressed modelling of biofilm growth and its influence on CO₂ and water flow in porous media and numerical investigation of microbially induced calcite precipitation as leakage mitigation strategy. This integrated experimental and computational approach has resulted in computational tools for more efficient experimental design and data analysis at the CBE and which greatly enhance our understanding of bioprocess behavior in complex porous media systems. Field applications for these simulations include issues with Carbon Capture and Underground Storage (CCUS) and Enhanced Oil and Gas Recovery which deal with formation leakage mitigation and wellbore integrity. Currently I am working with Dr. Helmig to extend this collaboration toward developing simulation models for the analysis of biogenic processes related to methane production in shales and coal beds.

Graduate Students. Advisor or Co-advisor

PhD Students

Johannes Hommel	PhD. Environmental Engineering	University of Stuttgart
A. Phillips	PhD Environmental Engineering	Montana State University
E. Barnhart	PhD. Microbiology	Montana State University
A. Ebigo	PhD. Environmental Engineering	University of Stuttgart
A. Bielinski	PhD. Environmental Engineering	University of Stuttgart
Y. Reinhardt	PhD. Environmental Engineering	University of Stuttgart
D. Goeres	PhD. Environmental Engineering	Montana State University
P. Sturman	PhD. Environmental Engineering	Montana State University
R. Hunt	PhD. Computer Science	Montana State University
J. Komlos	PhD. Environmental Engineering	Montana State University
R. Gerlach	PhD. Environmental Engineering	Montana State University
R. Sharp	PhD. Environmental Engineering	Montana State University
R. Jordan	PhD. Environmental Engineering	Montana State University
E. Visser	PhD. Civil Engineering	Montana State University

Masters Students

K. Davis	M.S. Environmental Engineering	Montana State University
E. Barnhart	M.S. Microbiology	Montana State University
S. Parks	M.S. Chemical and Biological Engineering	Montana State University
L. Schultz	M.S. Chemical and Biological Engineering	Montana State University
L. Wheeler	M.S. Chemical and Biological Engineering	Montana State University
J. Harwood	M.S. Chemical Engineering	Montana State University
C. Lang	M.S. Environmental Engineering	University of Stuttgart
D. Walker	M.S. Environmental Engineering	Montana State University
J. Eyre	M.S. Chemical Engineering	Montana State University
P. Buchanan	M.S. Environmental Engineering	Montana State University
B. Ide	M.S. Environmental Engineering	Montana State University
R. Lundman	M.S. Chemical Engineering	Montana State University
J. Peccia	M.S. Environmental Engineering	Montana State University
F. Stewart	M.S. Civil Engineering	Montana State University
D. Crawford	M.S. Civil Engineering	Montana State University
D. Peterson	M.S. Civil Engineering	Montana State University

Post Docs

E. Lauchnor	Post-doctoral researcher, Environmental Eng.	Montana State University
A. Mitchell	Post-doctoral researcher, Biogeochemistry	Montana State University
R. Gerlach	Post-doctoral researcher, Environmental Eng.	Montana State University
J. Komlos	Post-doctoral researcher, Environmental Eng.	Montana State University
R. Jordan	Post-doctoral researcher, Environmental Eng.	Montana State University
E. Visser	Post-doctoral researcher, Environmental Eng.	Montana State University

Symposia/Workshop Organization Co-organizer and session chairman for the following symposia:

Organizing Committee: International Conference on Porous Media & Annual Meeting (INTERPORE), 2017 - 2020

Biofilm Science and Technology Meeting, a biofilm research and education symposium hosted semi-annually by the Center for Biofilm Engineering, 1990-present.

Short course on Multiphase Flow, Transport and Bioprocesses in Porous Media, University of Stuttgart, Germany 1997 – present (with Dr. Rainer Helmig).

Second Annual Doha Workshop on Applied Mathematics and Computational Science, Texas A & M University at Qatar, Doha Qatar, May 20-21, 2007 (with Richard Ewing).

INRA Subsurface Biotechnology and Bioremediation Symposium, at MSU, Thursday June 22, 2006.

Biofilms 2004. Sponsored by International Water Association (IWA), Las Vegas NV, Oct 24-26, 2004.

Subsurface Science Symposium. Sponsored by INRA/INEEL. Salt Lake City, UT, October 6-8, 2003.

Subsurface Science Symposium. Sponsored by INRA/INEEL. Boise ID, October 13-15, 2002.

Subsurface Science Symposium. Sponsored by INRA/INEEL. Idaho Falls ID, September 6-7, 2001.

Institute for Mathematics and its Applications Workshop on Reactive Flow and Transport Phenomena. Workshop title: *Confinement and Remediation of Environmental Hazards*. University of Minnesota January 15-19, 2000 (With R. Ewing and J. Chadam)

Fifth International Symposium on In Situ and On-Site Bioremediation, Sponsored by Battelle, San Diego CA, Session Title: *In Situ Biobarriers*, April 19-22, 1999.

Subsurface Barrier Technologies. An IBC Environmental Technology Symposium. Scottsdale. AZ. Session Title: *Containment Barriers*, February 1-2, 1999.

Microbial Ecology of Biofilms: Concepts, Tools, and Applications. IWA International Speciality Conference. Lake Bluff, Illinois, October 8-10 1998. (with B. Rittmann (chairman), P. Bishop, E. Bouwer).

Subsurface Barrier Technologies. An IBC Environmental Technology Symposium. Tucson AZ. January 26-27, 1998.

Workshop on Biofouling in Reverse Osmosis Desalination Systems: Dhahran Saudi Arabia, January 5-8 1997.

13th Annual Great Plains/ Rocky Mountain Hazardous Waste Research Center Conference on Hazardous Waste Research, Snowbird, UT. Session title: *In Situ Bioremediation Technologies*. May 24 –26 1998.

12th Annual Conference on Hazardous Waste Research, Sponsored by Great Plains/Rocky Mountain HSRC, Kansas City KS, Session title: *Bioremediation*. May 19-22 1997.

Fourth International Symposium on In Situ and On-Site Bioremediation, New Orleans, Louisiana,. Session title: *Bench Scale to Full Scale Interpretations*. April 28-May 1, 1997.

HSRC/WERC Joint Conference on the Environment, Albuquerque, NM,. Session title: *Subsurface Mass Transport Phenomena*, May 21-23 1996.

HSRC/WERC Joint Conference on the Environment, Albuquerque, NM, Ma. Session title: *Subsurface Barrier Technologies*, May 21-23, 1996.

The 1995 Rocky Mountain Ground Water Conference, Jackson Hole Wyoming, Session title: *In_situ Bioremediation Technologies*, October 4-6,1995.

Third International Symposium on In Situ and On-Site Bioreclamation, San Diego CA, Sponsored by Battelle. Session Title: *Bench –Scale to Field Scale Interpretations*, April 4-6, 1995,

Bioremediation Alternatives Workshop An interactive workshop addressing the technical information needs of environmental regulators and practitioners concerned with bioremediation of petroleum hydrocarbons, chlorinated solvents, and mine waste. Helena, MT December 7, 1995, (DNRC), Chicago, IL March 11, 1996 (UST/LUST), Albuquerque, NM May 11, 1996 (EPA/HSRC), Bourgas Bulgaria, June 3-5 1996 (USETI), Salt Lake City, UT June 28 1996 (MAXIM), Snowbird, UT October 3, 1996 (ASM).

9TH Annual Conference on Hazardous Waste Remediation--a three day Conference held at the Center for Biofilm Engineering, Strand Union Building, Montana State University, Bozeman MT, June 8-10 1994.

Second International Symposium on In Situ and On-Site Bioreclamation, San Diego CA, , Sponsored by Battelle. April 1993

Biofouling/Biocorrosion in Water Systems--a three-day symposium for the American Chemical Society National Meeting, Washington, D.C., August 1992.

Biofouling/Biocorrosion in Industrial Water Systems. A five-day short course held at the Center for Interfacial Microbial Process Engineering, Montana State University, Bozeman, MT, 12-16 August 1991.

Interfacial Microbial Process Engineering. A three-day workshop held at the Center for Interfacial Microbial Process Engineering, Montana State University, Bozeman, MT, 18-20, July 1990.

Review Panelist. Chosen by DOE to review Pacific Northwest Laboratory's Environmental Science Research Center (ESRC), , Richland, WA, August 6-8, 1990.

Biofilms in Municipal and Industrial Water Systems. A three-day short course held at the Institute for Biological and Chemical Process Analysis, Montana State University, Bozeman, MT, July 25-27, 1988.

Amer. Soc. Civ. Eng. Hydraulics Div. Specialty Conference, Orlando, FL. Aug. 13-15, 1985.

Research Proposal Reviewer

U.S. Department of Energy
U.S. Department of Defense
National Science Foundation
Office of Water Research and Technology
Environmental Protection Agency

Journal Reviewer

Journal of Greenhouse Gases
Environmental Science and Technology

Biotechnology and Bioengineering
ASCE Journal of the Environmental Engineering Division
Journal of Hydrology
ASCE Journal of Water Resources Planning and Management Division
Research Journal Water Pollution Control Federation
Editorial Board Biodegradation (Springer) (2001 – 2004)
Editorial Board *Land Contamination and Reclamation*

APPENDIX 1 Previous Research Projects

Project/ title: Optimization, Scale-up, and Design of Coal-Dependent Methanogenesis in Preparation for in situ Field Demonstration
PI/PD: Matthew Fields (Principal Investigator), Lee Spangler (project Director)
Source of Support: U.S. Department of Energy
Award Amount: \$812,500
Award Period Covered: 10/01/2015 – 9/30/2018
Person-months Committed 1.0-person months/yr

Project title: Increasing the rate and extent of microbial coal to methane conversion through optimization of microbial activity, thermodynamics, and reactive transport (with M.Fields (PI), R. Gerlach), L. Spangler
Source of Support: U.S. Department of Energy
Award Amount: \$494,274
Award Period Covered: 10/1/2014 – 9/30/2017

Project/ title: Collaborative Research: Hydrodynamic controls on microbial community dynamics and carbon cycling in coalbeds (with J. McIntosh (PI), M. Fields)
Source of Support: NSF
Award Amount: \$486,000
Award Period Covered: 10/01/2013 – 9/30/2017

Project title: Field Test and Evaluation of Engineered Biomineralization Technology for Sealing Existing Wells (with A. Phillips, R. Gerlach, L. Spangler, A. Cunningham (PI))
Source of Support: U.S. Department of Energy
Award Amount: \$ 1,999,374
Total Award Period Covered: 10/1/2012 – 9/30/2015

Assessing Potential for Biomineralization Sealing in Fractured Shale at the Mont Terri Underground Research Facility, Switzerland (with A. Phillips, R.Gerlach, L.Spangler, A. Cunningham (PI)), CCP3 (CO₂ Capture Project-2013), \$ 146,867, (06/01/2013 – 12/31/2014)

Advanced CO₂ Leakage Mitigation using Engineered Biomineralization Sealing Technologies (with A. Phillips, R.Gerlach, L.Spangler, A. Cunningham (PI)), U.S. Department of Energy, \$1,999,398, 1/01/2010 – 03/30/2015

Impact of Mineral Precipitating Biofilms on the Physical and Chemical Characteristics of Porous Media (with I. Klapper (PI), T. Zhang, R.Gerlach, National Science Foundation Division of Mathematical Sciences, \$750,000,10/01/09 – 9/30/14

Basic Science of Retention Issues, Risk Assessment & Measurement, Monitoring & Verification for Geologic CO₂ Sequestration (ZERT). With L. Spangler (PDO, A.Cunningham (PI). U.S. Department of Energy, \$1,206,878 (10/01/04 – 9/30/2014)

Biofilms: The Hypertextbook, National Science Foundation (CCLI)\$480,000
Total Award Period Covered: (9/1/2006—8/31/2013) (with R. Ross, J Lennox, P. Stewart)

Environmental Responses to Geologic CO₂ Sequestration, U.S. Department of Energy (EPSCoR), \$1,440,000 (9/1/2008 – 8/31/2013).

Control of Microbial Processes for Enhanced Water Treatment Using Floating Island Treatment Systems Montana Board of Research and Commercialization Technology, \$125,158/yr (August 1, 2008 – July 31, 2010).

Research Support for Standardizing Comprehensive Biofilm Efficacy Test System Montana Board of Research and Commercialization Technology \$66,985/yr (September 1 2008 – August 31 2010).

INRA Subsurface Biotechnology and Bioremediation Research Initiative \$250,000, (June 2006 – May 2008).

Research Support for the Development and Manufacturing of a Rapid Biofilm Analysis Test Kit, Montana Board of Research and Commercialization Technology, \$75,125, (July 2006-June 2008).

Health Implications of Biofilms in Drinking Water Source of Support: DOD/Army Research Office Total Award Amount: \$3,851,972, (July 2003 – June 2007).

Evaluation of Pathogen Transport in Drinking Water Systems, Army Research Office, \$550,000, (April 2003 – March 2007).

Modeling Pathogen Transport in Water Supply Systems, Army Research Office, \$200,000 (March 2003-October 2005).

Development of an Oxygen-Consuming Biofilm Barrier to Prevent Oxidation of Pyritic Mine Tailings, Montana Board of Research and Commercialization, \$129,848 (October 2002 – September 2004).

Long-term Stewardship of Mixed Wastes: Passive Barrier for Simultaneous In Situ Remediation of Heavy Metal, Chlorinated Solvent, and Radionuclide Contaminants U.S. Department of Energy EMSP Program, \$270,000, (October 2002 - September 2005).

Evaluating Hyporheic Zone Biodegradation and Attenuation of MTBE and Other Oxygenates, American Petroleum Institute, \$51,470, (March 2003 – February 2005). In collaboration with Utah State University.

Indirect Microbial Alteration of Reducible Metal Ions, Inland Northwest Research Alliance, \$225,000 (October 2000 – September 2003).

Biofilm Induced Changes in Soil Organic Matter Structure and Resulting Impact on the Bioavailability of Sorbed 2,4,6-Trinitrotoluene and Amine Metabolites, DEPSCoR, \$472,521, (May 1999 – March 2003).

Development of a Distance Learning Course in *Subsurface Contaminant Bioremediation*, Inland Northwest Research Alliance, \$56,000 (June 2002 - December 2002).

Development of an Oxygen-Consuming Biofilm Barrier to Prevent Oxidation of Pyritic Mine Tailings, Montana Board of Research and Commercialization, \$129,848 (October 2002 – September 2004).

Microbial Process research for the Commercialization of Biofilm Barriers Montana Board of Research and Commercialization, \$126,000 (June 2001 - May 2003).

Modeling and Evaluation of Subsurface Biobarriers. USEPA Hazardous Substance Research Center, Kansas State University, \$75,000/year (May 17, 1996 - May 16 1999).

Effects of Biosurfactants on Bioavailability of Hydrophobic Organic Contaminants. Pacific Northwest National Laboratory, \$135,000/year (December 1, 1997 - November 30, 1999).

Enhancement of Fuel Oxygenate Biodegradation Potential in Groundwater. U. S. Geological Survey, \$20,000/year. (October 1, 1998 - October 1, 2001).

Cationic Surfactants: Process Analysis of their Bioavailability and Biodegradation. Nation Science Foundation. \$45,000, (October 1, 1998 - September 30, 1999).

Evaluation of Subsurface Biobarrier Formation and Persistence. U.S. Dept. Of Energy and MSE Inc. \$1,200,000 (April 1994 - December 1996).

Enhanced Bioremediation Strategies at BTEX Contaminated Ground Water and Soil Sites. Conoco Inc. \$65,000 (September, 1993-September 1996).

Evaluation and Modeling of Subsurface Biobarrier Formation and Persistence. U.S. EPA Hazardous Substance Research Center, Great Plains - Rocky Mountain Region, Kansas State University, (May 15 1995- May 14 1998).

Microbial Product Souring in Oil Bearing Formations, ERC Industrial Associates, (January 1992-December 1994).

In Situ Bioremediation of Organic Groundwater Contaminants. EPA, HRSC Kansas State University, (Sept. 1988-Sept. 1992).

Bioremediation of Water and Soil, Conoco,(September 1991-August 1992).

Influence of Biofilm Accumulation on Porous Media Mass Transport Properties, NSF, (April 1990-April 1992).

Influence of Deposit Accumulation on Frictional Resistance and Heat Transfer Resistance in Closed Conduits. NSF, April 1990-April 1992.

Microbial Processes in Porous Media. EPA Hazardous Substance Research Center, Kansas State University,(Feb. 1989 - Jan. 1992).

Influence of Microbial Transport on the *In Situ* Biotransformation of Organic Groundwater Contaminants. USGS (Sept.1988-Aug.1990).

In Situ Control of Groundwater Contaminants by Microbiological Processes. U.S. Geological Survey, (Sept 1986 -Sept. 1988).

Hydrology of the Butte Mining District. U.S.Environmental Protection Agency,(Sept. 1987-June 1988).

Impact of Winter Weather Modification on Surface Runoff and Groundwater Recharge. U.S. Bur. of Reclamation and MT Dept. of Natural Resources and Conservation, (Oct. 1986-Sept. 1987).

Correlation of 100 Year and Probable Maximum Flood for Intermountain and High Plains Basins. MT Dept. of Natural Resources and Conservation, (May 1987-June 1987).

Development of a Forecast/Operational Model for Improved Water Management. State of Montana, Dept. of Natural Resources and Conservation, (July 1986-June 1987).

Investigation of Factors Controlling Iron Bacterial Clogging of Relief Wells and Drainage Systems, USDOE Waterways Experiment Station, Vicksburg, Mississippi, (June 1985-June 1986).

Investigation of Factors Controlling the Interaction of Surface and Groundwater with Application to Simulation Modeling. National Science foundation, (Jan. 1981-Sept. 1985).

A Method For Estimating Flow-Duration Curves for Ungaged Basins in Intermountain and High Plains Regions. Office of Water Research and Technology, (May 1982 - April 1983).

Development of a Procedure for Forecasting Hydropower Potential in Intermountain Regions. MSU Engineering Experiment Station, (Sept. 1980 – Sept. 1982).

Development of an Initiative Program for Small Scale Hydropower in Montana. U.S. Dept. of Energy and Montana Dept. of Natural Resources and Conservation, (June 1981-May 1982).

Application of Hydrologic Modeling Techniques to Water Rights Investigations in Montana. MSU Engineering Experiment Station, (Sept. 1979-Aug. 1980).

Development of a Procedure for Forecasting Hydropower Potential in Intermountain Regions. MSU Engineering Experiment Station,(Sept.1979 - Aug. 1980).

A Resource Survey of Low Head Hydroelectric Potential Pacific Northwest Region. U.S. DOE, (1977-1979).

Development of a Streamflow Forecasting Procedure for Intermountain Basins. OWRT, (1978).

Application of Numerical Simulation Techniques to Flood Plain Management - A Case Study of Truckee Meadows. OWRT Matching, (1977-1978).

Simulation of Spatial and Temporal Aspects of Snowmelt Runoff Process with Application to Runoff Forecasting. OWRT (1977).

Quantitative Evaluation of Factors Affecting Flash Floods and Debris Flows in Selected Regions of Nevada. OWRT, (1977).

Investigation of Wind-Hydro Power Generation for Supplying Demands at Remote Locations. OWRT Matching, (1976-1977).

Synthesis of Snowmelt Runoff. OWRT, (1976).

Groundwater and Surface Water Interrelationships in a Semi-arid Region: A Case Study of the Truckee Meadows Reach of the Truckee River, Nevada. OWRT Matching, (1975-1976)

Consideration of Total Energy Loss in the Theory of Flow to Wells. OWRT, (1975).

Investigation of Urban Runoff Quality, Truckee River Basin. State of Nevada, (1974-1975).

Arid Basin Management Model with Concurrent Quality and Flow Constraints (Phases I, II, & III). OWRT Title II, (1973-1975).

Evaluation of Flood Peak Prediction Methods in Semi-Arid Regions in Relation to Dam Safety. OWRT, (1974).

APPENDIX 2. Publications prior to 2010 (133 total)

- Mitchell, A.C., A. Phillips, R. Hiebert, R. Gerlach, and A.B. Cunningham. 2009. Biofilm enhanced subsurface sequestration of supercritical CO₂. *International Journal Greenhouse Gas Control*, Vol (3), No1, 90-99.
- Cunningham, A.B., R. Gerlach, L. Spangler, L. Schultz and A.C. Mitchell. 2008. Microbially Enhanced Geologic Containment of Sequestered Supercritical CO₂. Proceedings, 9th International Conference on Greenhouse Gas Technologies, November, 2008. Available through Energy Procedia at <http://www.sciencedirect.com/science/journal/18766102>.
- Mitchell, A.C, A. Phillips, M. Hamilton, R. Gerlach, J.Kuszuba, and A.B. Cunningham. 2008. Resilience of planktonic and biofilm communities to supercritical CO₂. *Journal of Supercritical Fluids*. Vol 47, Issue 2, 318-325.
- Mitchell, AC, Phillips, A, Kaszuba, J, Hollis, HK, Gerlach, R, Cunningham, A. 2008. Microbially enhanced carbonate mineralization and containment of CO₂. *Geochimica et Cosmochimica Acta*. 72 (12), A636.
- Mulholland, T., A.B. Cunningham, B.G. Kania, M.T. Osterlund, F.M. Stewart 2008. Floating Islands as an alternative to constructed wetlands. *Land Contamination and Reclamation*. Vol 16, Number 1.
- Viamajala S., Gerlach R., Sivaswamy V., Peyton B.M., Apel W.A., Cunningham A.B., Petersen J.N. 2008. Permeable reactive biobarriers for in-situ Cr(VI) reduction: Bench scale tests using *Cellulomonas* sp. strain ES6. *Biotechnology and Bioengineering*. 101(6):1150-1162.
- Towler, B.W., A. Cunningham, P. Stoodley, and L. McKittrick. 2007. A Model of Fluid-biofilm Interaction Using a Burger Material Law, *Biotechnol. Bioeng.*, Vol. 96, No. 2.
- Cunningham, A.B., R.S. Sharp, F. Caccavo Jr., and R. Gerlach, 2007. Effects of Starvation on Bacterial Transport Through Porous Media, *Adv. Water Resour.* (30), 1583-1592.
- Komlos, J., A.B. Cunningham, A.K. Camper and R.R. Sharp. 2006. Effect of Substrate Concentration on the Dual-Species Population Density of *Burkholderia cepacia* PR1-pTOM_31c and *Klebsiella oxytoca* in Porous Media. *Biotechnology and Bioengineering*, 93. 434-442.
- Cunningham A B., R. Gerlach, A. Phillips, and L. Spangler, Microbially enhanced geologic sequestration of supercritical CO₂. 2005. *Proceedings: USDOE Fourth Annual Conference on Carbon Capture and Sequestration*, Hilton Alexandria Mark Center. Alexandria, Virginia. May 2-5, 2005.
- Eberhard, J.P., Y. Efendiev, R. Ewing and A. Cunningham. 2005. Coupled Cellular Models for Biofilm Growth and Hydrodynamic Flow in a Pipe. *Jour. for Multiscale Computational Eng.* 3(4).
- Komlos J., A. B. Cunningham, A. K. Camper and R. R. Sharp. 2005. Interaction of *Klebsiella oxytoca* and *Burkholderia cepacia* in dual-species batch cultures and biofilms as a function of growth rate and substrate loading. *Microl Ecol* 49: 114-125.
- Sharp, R.R., P.Stoodley, M. Adgie, R. Gerlach, and A B. Cunningham. 2005. Visualization and Characterization of Dynamic Patterns of Flow, Growth and Activity of Biofilms Growing in Prous Media. *Water Science and Technology*, Vol 52, No 7, 85-90.
- Lomesh, D, E. Nuttall, A. Cunningham, G. James, R. Hiebert. 2005. In Situ Biofilm barriers: Case Study of a Nitrate Ground water Plume, Albuquerque, New Mexico. Remediation Autum 2005, Published online in Wiley Interscience (www.interscience.wiley.com). DOI:10.1002/rem.20063.

- Dutta, L., H.E. Nuttall, A. Cunningham, G. James, and R. Hiebert, *In Situ* Biofilm Barriers: Case Study of a Nitrate Groundwater Plume, Albuquerque, New Mexico. 2005. *Remediation*, 15(4):101-111.
- Sharp, R., G. James, A. Cunningham, and J. Komlos. 2005. Novel Subsurface Biobarriers to Contain and Remediate Contaminated Ground Water. *Contaminated Soils*, Vol. 10.
- Komlos, J., A.B. Cunningham, A.K. Camper and R. Sharp. 2004. Biobarriers to contain and degrade trichloroethylene (TCE). *Environ. Progress*. 23 (1), 69-77.
- Sharp R., Gerlach, R., Cunningham, A.B., Adgie, M., Stoodley, P. 2004: Use of Bioluminescence to Study Reactive Solute Transport and Biofilm Growth and Activity in Porous Media. Eos Trans. AGU, 85(47), Fall Meet. Suppl., Abstract H13I-03, 2004.
- Cunningham, A.B, R. R. Sharp, R. Hiebert and G. James, 2003. Subsurface Biofilm Barriers for the Containment and Remediation of Contaminated Groundwater. *Bioremediation Journal*.7(3/4) 151-164.
- Towler, B.W., C.J. Rupp, A.B. Cunningham, and P. Stoodley, 2003. Viscoelastic Properties of a Mixed Culture Biofilm from Rheometer Creep Analysis, *Biofouling*, 19(5): 279-285.
- Sharp. R., M. Adgie, and A. Cunningham.,2003. Influence of Biofilm Accumulation on Flow and Reactive Transport in Porous media. Geophys. Res. Ab. Vol. 5.
- Chadam J., A.B. Cunningham, R.E. Ewing, P. Ortoleva, and M.F. Wheeler. 2002. Confinement and Remediation of Environmental Hazards. In *Resource Recovery, Confinement, and Remediation of Environmental Hazards*, Springer.
- Kern, E. A., R.H. Veeh, H.W. Langner, R.E. Macur, and A.B. Cunningham. 2002. Characterization of methyl *tert*-butyl ether (MTBE)-degrading bacteria from a gasoline-contaminated aquifer. *Bioremediation Journal* 6(2):113-124.
- Nyman, J.L., A.B. Cunningham, F. Caccavo, Jr. and R. Gerlach, 2002 Biogeochemical Elimination of Chromium (VI) from Contaminated Water. *Bioremediation Journal* 6(1):39-55
- Borch,T.,R. Gerlach, A.B. Cunningham,B. Peyton, W.A.. Apel, 2002. Influence of Biogenically Produced Fe(II) and Humic Acid Analogs on the Fate of 2,4,6-Trinitrotoluene (TNT). Eos Trans. AGU, 83(47), Fall Meet. Suppl., Abstract B22E-11.
- Hiebert, R., R.R. Sharp, A.B Cunningham, and G. James. 2001. Development and Demonstration of Subsurface Biofilm Barriers Using Starved Bacterial Cultures. Association of Environmental Health and Sciences (AEHS) *Contaminated Soil Sediment & Water*, 14-17 August, 2001, International Issue, 45-50.
- Komlos, J., A.B. Cunningham, A.K. Camper and R.R. Sharp. 2001. Varying substrate concentration to enhance TCE degradation in dual-species bioreactors. *Proc. Sixth In Situ and On-Site Bioremediation Symposium*, June 4-7, 2001, San Diego, CA.
- Sharp, R., R. Gerlach, and A. Cunningham. 2001. Microbial Transport Issues Related to Biobarrier Design and Development. In: *Engineering Approaches for In Situ Bioremediation of Chlorinated Solvent Contamination*. Eds. A.M. Leeson and B. Alleman. Battelle Press.
- Sharp, R., R. Heibert, A. Cunningham, and G. James. 2001. Demonstration of Starved Cell Subsurface Biofilm Barrier Technology." *Contaminated Soil, Sediment & Water*. Vol. 101, pp. 45 - 49. August, 2001.

- Komlos J., A. Cunningham, R. Sharp and A. Camper. 2001. Enhancement of TCE Degradation Using a Dual-Species Bioreactor. In: Engineering Approaches for In Situ Bioremediation of Chlorinated Solvent Contamination. Eds. A.M. Leeson and B. Alleman. Battelle Press.
- Bouwer, E.J., H.H.M. Rijnaarts, A.B. Cunningham, and R. Gerlach. 2000. Biofilms in porous media. In *Bryers, J.D. (Ed.): Biofilms II: Process Analysis and Applications*. Wiley-Liss, Inc. pp. 123-158.
- Cunningham, A.B. and R. Hiebert. 2000. Subsurface biofilm barriers (biobarriers) for the containment of contaminated groundwater. *Groundwater Currents*, Issue No 36.
- Gerlach, R., A.B. Cunningham, and F. Caccavo, Jr. 2000. Biogeochemical processes involving dissimilatory iron-reducing bacteria can influence the transformation of carbon tetrachloride by iron metal. In: *Preprints of Extended Abstracts, 220th ACS National Meeting, Division of Environmental Chemistry*, August 20-24, 2000, Washington, D.C. Vol. 40, No 2. pp. 355-357.
- Gerlach, R., A.B. Cunningham, and F. Caccavo, Jr. 2000. Dissimilatory iron-reducing bacteria influence the performance of zero-valent iron. *Environmental Science and Technology*, 34, 2461-2464.
- Gerlach, R., J.L. Nyman, F. Caccavo Jr., and A.B. Cunningham 2000. Iron-reducing bacteria facilitate the geochemical elimination of Cr(VI) from contaminated water. In *Preprints of Extended Abstracts, 220th ACS National Meeting*, Division of Environmental Chemistry, August 20-24, 2000, Washington, D.C. Vol. 40, No 2. pp. 397-400.
- James G.A., B.K. Warwood, R. Hiebert, and A.B. Cunningham. 2000. Microbial Barriers to Stop the Spread of Pollution. In *Bioremediation*. Kluwer Academic pp. 1-14
- Komlos, J., A.B. Cunningham, A.K. Camper and R.R. Sharp 2000. Effect of substrate concentration on growth rate and population dynamics in a dual-species biofilm. Submitted to *Biotechnology and Bioengineering*.
- Gerlach, R., A.B. Cunningham, and F. Caccavo, Jr. 1999. Chromium elimination with microbially reduced iron: Redox-reactive biobarriers. In *Leeson, A.L. & Alleman, B.C., Eds.: Bioremediation of metals and inorganic compounds, Proc. Fifth In Situ and On-Site Bioremediation Symposium*, April 19-22, 1999, San Diego, CA; Battelle Press: Columbus, Richland, pp 13-18.
- Jordan, R.N and A.B. Cunningham. 1999. Surfactant-enhanced bioremediation: a review of the effects of surfactants on the bioavailability of hydrophobic organic chemicals in soils. In: *Bioavailability of Organic Xenobiotics in the Environment and Practical Consequences for Bioremediation*, J.-C. Block, P. Baveye, and V. V. Goncharuk (Eds.). Kluwer Academic Publishers.
- Jordan, R.N., E.P. Nichols, and A.B. Cunningham. 1999. The role of (bio)surfactant sorption in promoting the bioavailability of nutrients localized at the solid-water interface. *Wat. Sci. Tech.*, Vol. 39, No. 7, 91-98.
- Komlos, J., A.B. Cunningham, and R.R. Sharp. 1999. Population dynamics in a multi-species biofilm for the creation of a reactive biobarrier, *Proc. 1999 Conference on Hazardous Waste Research*, pp 158-166.
- Sharp, R., A.B. Cunningham, J. Komlos, and J. Billmeyer. 1999. Observation of thick biofilm accumulation and structure in porous media and corresponding hydrodynamic and mass transfer effects. *Wat. Sci. Tech*, Vol.. 39, No. 7, 195-201.
- Sharp, R.R., R. Gerlach, and A.B. Cunningham. (1999). Bacterial transport issues related to subsurface biobarriers, In: Alleman, B.C. and Leeson, A.L. (eds.), Engineered approaches for in situ bioremediation of chlorinated solvent contamination, *Proc. Fifth In Situ and On-Site Bioremediation Symposium*, held April 19-22, 1999 in San Diego, CA, Battelle Press, Columbus, Richland, pp. 211-216.

- Stoodley, P., J. Boyle, A.B. Cunningham, I. Dodds, H.M.Lappin-Scott, and Z. Lewandowski. 1999. Biofilm structure and influence on biofouling under laminar and turbulent flows. In: *Biofilms in the Aquatic Environment*, pp. 13-24, C.W. Keevil, A. Godfree, D. Holt, C. Dow (Eds.). The Royal Society of Chemistry Press, Cambridge.
- Beaudoin, D.L., J.D. Bryers, A.B. Cunningham, and S.W. Peretti 1998. Mobilization of a broad host range plasmid from *Pseudomonas putida* to established biofilm of *Bacillus azotoformans*: Part I-- Experiments. *Biotechnol. Bioeng.* 57: 272-279.
- Beaudoin, D.L., J.D. Bryers, A.B. Cunningham, and S.W. Peretti. Mobilization of a broad host range plasmid from *Pseudomonas putida* to established biofilm of *Bacillus azotoformans*: Part II-- Theory, *Biotechnol. Bioeng.* 57: 280-286, 1998.
- Cunningham A.B., and P.J. Sturman. 1998. In situ bioremediation process engineering concepts. invited Chapter, *Bioremediation: Principles and Practice*, Technomics Publishers, Vol 1.
- Lewandowski, Z.L. and A.B. Cunningham, 1998. Biofilm process fundamentals. Invited chapter, *Bioremediation: Principles and Practice*, Technomics Publishers, Vol 1.
- Gerlach, R., A.B. Cunningham, and F. Caccavo, Jr. 1998. Formation of redox-reactive subsurface barriers using dissimilatory metal-reducing bacteria. In Ericksen, L.E. and Rankin, M.M. (eds.): *Proc. of the 1998 Conference on Hazardous Waste Research - Bridging Gaps in Technology and Culture*. Snowbird, UT, May 18-21, 1998. Great Plains/Rocky Mountain Hazardous Substance Research Center. Manhattan, Kansas. pp. 209-223.
- Komlos, J., A.B. Cunningham, B. Warwood, and G. James. 1998. Biofilm barrier formation and persistence in variable saturated zones, *Proc. of the 1998 Great-Plains Rocky Mountains Conference on Hazardous Waste Research*, Snowbird, UT, pp. 200-208.
- Cunningham A.B., B.K. Warwood, P.J. Sturman, K. Horrigan, G. James, J.W. Costerton and R. Hiebert. 1997. Biofilm processes in porous media--practical applications. In *Microbiology of the Terrestrial Deep Subsurface*, Edited by Amy and Halderman, CRC Press Inc. 325-347.
- Cunningham, A.B. Building biobarriers to control the spread of hazardous wastes.1997. Centerpoint (a publication of the USEPA Hazardous Substance Research Centers), Vol 4, No 1.
- Cunningham, A.B., and B. Chen,1997. "Evaluation and modeling of subsurface biobarrier formation and persistence. *Proc. 12th Annual Conference on Hazardous Waste Research*, sponsored by the Great Plains/Rocky Mountain Hazardous Substance Center, Kansas City KS, May 19-22.
- Mirpuri R., W. Sharp, S. Villaverde, W. Jones, Z. Lewandowski, A. Cunningham. 1997. A predictive model for toluene degradation in a vapor phase bioreactor. *ASCE Journal of Environmental Engineering*.
- Stoodley, P., J. Boyle, A.B. Cunningham, I. Dodds, H.M. Lappin-Scott, and Z. Lewandowski. 1997. Biofilm structure and influence on biofouling under laminar and turbulent flows. *Proc: Biofilms in Aquatic Systems Conference*, Warick UK.
- Sturman, P.J., C.W. Wemple, and A.B. Cunningham. 1997. Accelerating aerobic DRO biodegradation in stream bank sediments through oxygen enhancements: laboratory results and field pilot demonstration. *Proc: Petroleum Hydrocarbons and Organic Chemicals in Groundwater Conference: Prevention, Detection, and Remediation*, Houston, TX, National Ground Water Association, November 4-5, 1997.

- Chen, B., A.B. Cunningham, and E. Visser. 1996. Numerical simulation of biofilm growth in porous media at the microscale. *Proc: Eleventh International Conference on the Computational Methods in Water Resources*, Cancun Mexico, July 1996.
- Cunningham, A.B., B.K. Warwood, and G. James. Containment of heavy metal and chlorinated organic solvent contamination using subsurface biobarriers. *Proc. HRRS/WERC Joint Conference on the Environment*, Albuquerque, NM, May 21-23 1996.
- Jones W.L., R.G. Mirpuri, S. Villaverde, Z. Lewandowski, and A.B. Cunningham. 1996. The effect of bacterial injury on toluene degradation and respiration rates in vapor phase bioreactors. *Proc. IAWQ Specialty Conference on Biofilm Systems*, Copenhagen Denmark, August 24-27 1996.
- Wilderer, P.A., Cunningham, A. and Schindler, U. 1995. Hydrodynamics and Shear Stress: report from the Discussion Session. *Wat.Sc.Techn.*, 32, 8, 271-272
- Cunningham, A.B., E. Visser, Z. Lewandowski, and M. Abrahamson. 1995. Evaluation of a coupled mass transport-biofilm process model using dissolved oxygen microsensors. *Proc. International IAWQ Conference on Biofilm Structure, Growth and Dynamics*, Noordwijkerhout, The Netherlands, Aug 30 - Sept 1, 1995.
- James, G.A., B.K. Warwood, A.B. Cunningham, P.J. Sturman, R. Hiebert and J.W. Costerton. Evaluation of subsurface biobarrier formation and persistence. *Proc. 10th Annual Conference on Hazardous Waste Research*, Manhattan, KS May 23-24, 1995, pp 82-91.
- Mirpuri R. and A. Cunningham. A predictive model for toluene degradation in a flat plate vapor phase bioreactor. *Proc. 1995 USC-TRG Conference on Biofiltration*. University of Southern California, LA, CA. October 5, 1995.
- Mirpuri, R. and A. Cunningham. 1995. A modeling approach for scale-up of vapor phase bioreactors. *Proc. 1995 Five Centers' Research Conference*, Hazardous Substance Research Center, Glendon Beach, Oregon. July 23-26, 1995.
- Sturman, P.J., A.B. Cunningham, S.L., Niehaus, and J.H. Wolfram. 1995, "Mass Transport in Physical and Biological BTEX Removal in a Sandy Aquifer," In: *Applied Bioremediation of Petroleum Hydrocarbons*, R.E. Hincee, J.A. Kittel, and H.J. Reisinger (Eds.), Battelle Press, p. 461-466.
- Sturman, P.J., R.R. Sharp, J.B. DeBar, P.S. Stewart, A.B. Cunningham, and J.H. Wolfram. 1994. Scale-up implications of respirometrically determined microbial kinetic parameters. In: *Applied Biotechnology for Site Remediation*, R.E. Hincee, D.B. Anderson, F.B. Meeting Jr. and G.D. Sayles (Eds.), CRC Press, p. 300-304.
- Sturman, P. J., P.S. Stewart, A.B. Cunningham, E.J. Bouwer, and J.H. Wolfram. 1995. Engineering scale-up of in situ bioremediation processes: a review. *Journal of Contaminant Hydrology*, Vol 19, No 3, 171-203.
- Wanner, O., A.B. Cunningham, and R. Lundman. 1995. Modeling biofilm accumulation and mass transport in a porous medium under high substrate loading. *Biotech. and Bioeng.*, Vol 47, 703 – 712.
- Bouwer, E.J., N. Durant, L. Wilson, W. Zhang, and A.B. Cunningham. 1994. Degradation of xenobiotic compounds *in_situ*: capabilities and limits. *FEMS Microbiological Reviews* 15, 307 -317.
- Chen, B., A. Cunningham, R. Ewing, R. Peralta, and E. Visser. 1994. Two-dimensional modeling of microscale transport and biotransformation in porous media. *Numerical Methods for Partial Differential Equations*, 10, 65-83.

- Sturman P., A. Cunningham, J. Wolfram, and S. Niehaus. 1994. Physical and biological BTEX removal in a sandy aquifer. *Proc. 9TH Annual Conference on Hazardous Waste Remediation*, Center for Biofilm Engineering, Montana State University, Bozeman MT, June 8-10, 1994.
- Zhang W., E. Bouwer, and A. Cunningham. 1994. Quantifying the effect of sorption on bioavailability of hydrophobic organic contaminants. *Proc. 9TH Annual Conference on Hazardous Waste Remediation*, Center for Biofilm Engineering, Montana State University, Bozeman MT, June 8-10, 1994.
- Zhang W., E.J. Bouwer, A.B. Cunningham, and G.A. Lewandowski. 1995. Influence of sorption on organic contaminant biodegradation and implications for *in_situ* treatment. *Proc. Bi-Annual Conference on In_Situ and On-Site Bioreclamation*, San Diego, Battelle Memorial Institute, Butterworth-Heinemann, May 1995.
- Camper, A., J.T. Hayes, P.J., Sturman, W. Jones, and A.B. Cunningham. 1993. The effects of motility and adsorption velocity on the transport of bacteria through saturated porous media. *Journ. Appl. Environ. Micro.*, Vol 59 No.10, 3455-3462.
- Cunningham, A.B. 1993. Effects of biocolloids on hydrodynamic properties of porous media. *Proc. Mantao III Conference, Concepts in Manipulation of Groundwater Colloids for Environmental*, Mantao, NC, October 15-18,1990
- Cunningham, A.B. and O. Wanner. Modeling microbial processes in porous media with application to biotransformation, *Hydrochemistry 1993*, IAHS Publication no. 217, 1993. *Proc. International Symposium on Hydrological, Chemical, and Biological Processes of Transformation and Transport of Contaminants in Aquatic Environments*, Rostov-on-Don, Russia., Lewis Publishers. May 24-29, 1993.
- Sturman P.J., P. Stewart, R. Sharp, J. Wolfram and A.B. Cunningham. 1993. Determining consortial kinetic parameters from respirometry. *Proc. Second International Symposium on In_Situ and On-Site Bioreclamation*, San Diego CA, April 5-8, 1993.
- Sturman P.J., A. B. Cunningham, and P. Stewart. 1993. A scale-up approach for the design and operation of in situ bioremediation systems. *Proc. Eight Annual Conference on Hazardous Waste Research*, Great Plains-Rocky Mountain Region HSRC, Kansas State University, Manhattan KS, May 24-27, 1993.
- Szego S., P. Cinnella, and A. Cunningham. 1993. Numerical simulation of biofilm processes in closed conduits. *J. Computational Physics*, vol.108, No 2.
- Sturman, P.J., W.L. Jones, W.G. Characklis, and A. B. Cunningham. 1992. Interspecies competition in colonized porous pellets. *Proc. Conference on Hazardous Waste Research*, Boulder CO, Sponsored by the U.S. EPA Hazardous Substance Research Center, Kansas State University, Manhattan KS, June 1-3, 1992.
- Cunningham, A.B., W.G. Characklis, F. Abedeen, and D. Crawford. 1991. Influence of biofilm accumulation on porous media hydrodynamics. *Environmental Science & Technology*, Vol. 25, No. 7, 1305-1310.
- Cunningham, A.B., R. Lundman, and O. Wanner. 1991. Modeling biofilm accumulation and activity in porous media. *Proc., Hazardous Waste Research Conference*, Kansas State University, Manhattan KS, May 22-23, 1991.
- Hunter, R.M., W.A. Hunt, and A.B. Cunningham. 1991. A portable flowmeter for sewers that surcharge. *Water Environment and Technology*, 48-52.

- Cunningham, A.B., E.J. Bouwer, and W.G. Characklis. 1990. Biofilms in porous media. In: *Biofilms*, W.G. Characklis and K.C. Marshall, editors, John Wiley and Sons, 692-732.
- Characklis, W.G., J. T. Sears, and A. B. Cunningham. 1990. Real problems are the framework for cross-disciplinary research, *Proc. AICHE National Meeting*, Chicago II, November 1990.
- Cunningham, A.B. and E.J. Bouwer. Biofilm accumulation in porous media. 1990 *Proc., Hazardous Waste Research Conference*, Kansas State University, Manhattan, Kansas, May 21-22, 1990.
- Jones, W.L., P.J. Sturman, C. Ellison, A.K. Camper, W.P. Inskeep, S.J. Rogers, and A.B. Cunningham. 1990. Use of soil column test apparatus for evaluation of in situ bioremediation potential. *Proc. Conference on Hazardous Waste Research*, Kansas State University, Manhattan, KS, May 21, 1990.
- Larsen, R.L. and A.B. Cunningham. 1990. Microbial transport and biotransformation processes in porous media. *Proc. AICHE Conference*, San Diego CA, August 19-22, 1990.
- Warwood B., T. Ranf, A.B. Cunningham, and W. G. Characklis. 1990. Fouling and performance in service water systems. *Proc. ASME Joint Power Generation Conference*, Boston MA, October 4-5 1990.
- Cunningham, A.B. 1989. Influence of microbial transport on the *in situ* bioremediation of organic groundwater contaminants. *Proc., Hazardous Waste Research Conference*, Kansas State University, May 23-24, 1989.
- Cunningham, A.B. 1989. Fluid dynamics and solute transport at the fluid-biofilm interface. Invited Chapter for Structure and Function of Biofilms, Dahlem Workshop Reports, Life Science Research Report 46, John Wiley and Son, 19-31.
- Cunningham, A.B., and J. Amend. 1988. Water management using interactive simulation. invited chapter in *Handbook of Civil Engineering*, Technomic Publishing, NJ, 71-85.
- Cunningham, A.B., W.G. Characklis, and D. Crawford. 1988. Modeling microbial transport in porous media. *Wat. Sci. Tech.*, Vol. 20, No. 11/12, 509-511.
- Cunningham, A.B., W.G. Characklis, and E.J. Bouwer. 1988. Influence of microbial transport on the *in situ* biodegradation of organic ground water contaminants. *Proc. Petroleum Hydrocarbons and Organic Chemicals in Ground Water: Prevention Detection and Restoration*. The Association of Ground Water Scientists and Engineers and the American Petroleum Research Institute, Houston TX, November 9-11 1988, 669-685
- Cunningham, A.B., C. Anderson, and H. Bouwer. 1986. Effects of streambed processes on channel bed hydraulic conductivity. *Amer. Soc. Civ. Eng. Jnl. of Irrigation and Drainage Division*.
- Cunningham, A.B. and J. Amend. 1986. Interactive simulation applied to water resources system analysis. *Amer. Soc. Civ. Eng. Jnl. of Wtr. Res. Mngmt.*, Vol. 112, No. 3, July 1986.
- Cunningham, A.B. and J. Amend. 1985. Role of interactive computer simulation in water resource system management. Invited Chapter, *Computer-Aided Processed Instruction and Research*, edited by George C. Beakley and C.R. Haden, Academic Press.
- Cunningham, A.B. and D. Peterson. 1984. Small scale hydropower design optimization. *Proc., Amer. Soc. Civ. Eng. Hydraulics Division Specialty Conference*, Coeur d'Alene, ID, August 1984.
- Cunningham, A.B. and J. Amend. Interactive simulation-application to water resources management. *Amer. Soc. Civ. Eng. Jnl. of Wtr. Res. Mngmt.*, July 1984.

- Cunningham, A.B. 1983. A procedure for estimating flow duration curves for ungaged mountainous and high plains streams. Project Report Submitted to Office of Water Research and Technology, June 1983.
- Cunningham, A.B. 1983. The role of hydrologic simulation modeling in deciding water use and appropriation issues, *Proc.*, Amer. Soc. Civ. Eng. National Specialty Conference on Water Supply and Management, Tampa, FL, March 1983.
- Cunningham, A.B. 1982. Montana Hydropower: A manual for site developers. Montana Water Resources Center, Montana State University, September 1982.
- Cunningham, A.B. 1981. Montana Hydropower - A guide to permitting and licensing. Dept. of Energy and Montana Dept. of Natural Resources and Conservation, December 1981.
- Cunningham, A.B. 1981. Application of hydrologic modeling techniques to water rights investigations in Montana, Engineering Experiment Station, Montana State University, August 1981.
- Cunningham, A.B. 1980. A procedure for forecasting daily streamflow for intermountain basins. *Office of Water Research and Technology*, August 1980.
- Cunningham, A.B. 1980. Development of a procedure for forecasting small scale hydroelectric power potential in intermountain regions. Engineering Experiment Station, Montana State University, August 1980.
- Cunningham, A.B. and J. Amend. 1980. A public education program in water resource management. *Western Planner*. Published by Missouri River Basin Commission, April 1980.
- Cunningham, A.B. and J. Fordham. 1980. Hybrid energy system: Wind and water. *Water Resource Center Publication No. 41602*, Desert Research Institute, University of Nevada, Reno, February 1980.
- Cooley, R. and A.B. Cunningham. 1979. Consideration of total energy loss in the theory of flow to wells. *J. Hydrology*, Vol. 43, No. 1/4 129-148.
- Cunningham, A.B. and P.J. Sinclair. 1979. Application and analysis of a coupled surface and groundwater model. *J. Hydrology*, Vol. 43, No. 1/4 129-149.
- Gladwell, J., A.B. Cunningham, and L. Heitz. 1979. A resource survey of low-head hydroelectric potential Pacific Northwest region. *Phase I Project Report Submitted to U.S. Dept. of Energy*, March 1979.
- Gladwell, J., A.B. Cunningham, and L. Heitz. 1979. Hydropower resource survey of the Pacific Northwest, U.S.A.. *III Congress Mundial Sobre Aprovechamientos Hidraulicos Comité Organizador*, Mexico City, Mexico, April 1979.
- Cunningham, A.B. 1977. Synthesis of Snowmelt Runoff Hydrographs. *J. Hydraulics Division*, ASCE, HY1.
- Cunningham, A.B. and J. Warburton. 1977. Precipitation runoff investigation for Truckee River Basin, California. *Proc.*, American Soc. Civ. Eng. Irrigation and Drainage Specialty Conference, Reno, NV, July 1977.
- Watson, P. and A.B. Cunningham. 1977. Reconstruction of water levels for Pyramid Lake, Nevada, 1945-1904 A.D. Through Dendrochronology. *Proc.*, American Water Resources Association Conference, Tucson, Arizona, October 1977.

Bateman, R.L., A.B. Cunningham, and J. Fordam. 1975. Arid basin management model with concurrent quality and flow constraints, Phase II. Center for Water Resources Research, Desert Research Institute, Project Report #19.

Cunningham, A.B. 1975. Evaluation of flood peak prediction methods in semi-arid regions in relation to dam safety. Center for Water Resources Research, Desert Research Institute, Project Report #19, 1975.

Bateman, R.L., A.B. Cunningham, and J.A. Wesphal. 1974. Arid basin management model with concurrent quality and flow constraints, Phase I. Center for Water Resources Research, Desert Research Institute, Project Report #40.

Theses

Cunningham, A.B. Modeling and analysis of hydraulic interchange of surface and groundwater. Ph.D. Dissertation, Hydrology Program, University of Nevada, Reno, 1977.

Cunningham, A.B. Analysis and synthesis of streamflow and precipitation data. M.S. Thesis, Montana State University, Bozeman, MT, 1971.

APPENDIX 3. Symposia presentations prior to 2012 (160 total)

Gerlach, R.; Mitchell, A.C.; Ebigbo, A.; Phillips, A.J.; Cunningham, A.B. (2011): Potential of Microbes to Increase Geologic CO₂ Storage Security. Poster presentation, *Fall Meeting American Geophysical Union*. San Francisco, CA. December 05-09, 2011

Gerlach, R.; Mitchell, A.C.; Ebigbo, A.; Phillips, A.J.; Cunningham, A.B. (2011): Potential of Microbes to Increase Geologic CO₂ Storage Security. Poster Presentation, *Fall Meeting American Geophysical Union*. San Francisco, CA. December 05-09, 2011

Ebigbo, A.; Helmig, R.; Gerlach, R.; Cunningham, A.B.; Phillips, A.J. (2011): Modelling microbially induced carbonate precipitation and its influence on CO₂ and water flow in the subsurface. Poster Presentation. *Fall Meeting American Geophysical Union*. San Francisco, CA. December 05-09, 2011

Mitchell, A.C.; Phillips, A.J.; Schultz, L.N.; Lauchnor, E.; Gerlach, R.; Cunningham, A.B. Engineered Biofilm and Bio-mineral Plugging of Leakage Pathways. 17th Reservoir Microbiology Forum 2011 (RMF2011). Session: Fluid transport and reservoir and biofilm modelling., Energy Institute, London. UK. November 22-23, 2011.

Gerlach, R. (2011): Utility of Biofilms and Biologically-Induced Mineralization in Biotechnology and Geologic Carbon Sequestration. 8th European Congress of Chemical Engineering/1st European Congress of Applied Biotechnology, Berlin, Germany, September 25-29, 2011,

Gerlach, R.; Schultz, L.N.; Mitchell, A.C.; Cunningham, A.B. (2011): Bacterially Induced Calcite Precipitation and Strontium Co-Precipitation under Flow Conditions in a Porous Media System. 242nd ACS National Meeting & Exposition, Denver, Colorado, August 28-September 1, 2011

Gerlach, R.; Mitchell, A.C.; Cunningham, A.B.; Spangler, L.H.; Zhang, T.; Klapper, I. Ebigbo, A.; Helmig, R. (2011): Microbially Enhanced Carbon Capture and Storage - Pore and Core Scale Experiments and Modeling. 242nd ACS National Meeting & Exposition, Denver, Colorado August 28-September 1, 2011

Gerlach, R. (2011): Investigating and Modeling the Influence of Biofilm Formation and Biofilm-Mediated Mineral Formation on Reactive Transport in Porous Media. Platform Presentation. Environmental

- Molecular Science Laboratory-Pore-scale Modeling Workshop. Richland, WA. August 09-10, 2011
- Gerlach, R. (2011): Controlling Carbonate Mineral Precipitation by Biofilms for Environmental and Industrial Benefit. Platform Presentation, 2011 Spring Meeting Materials Research Society. San Francisco, CA. April 25-29, 2011
- Gerlach, R.: Chromium (VI) reduction by environmental microbes – Influence of common soil constituents and carbon sources on chromium (VI) reduction and toxicity. Platform presentation. Montana Biofilm Meeting, Montana State University-Bozeman, July 12-14, 2011
- Barnhart, E., Wheaton, J., Ramsay, B., Cunningham, A., Fields, M. Characterization of Methane-Producing Communities in Deep Coal Seams, International Symposium on Applied Microbiology in Oil Systems (ISMOS-3), poster, Calgary, Canada, June 2011.
- Cunningham, A.B., Spangler, L.H.; Mitchell, A. C.; Phillips, A.J.; Gerlach, R. Controlling well bore leakage of CO₂ using engineered biomineralization barriers. Poster presentation. Montana Biofilm Meeting, Montana State University-Bozeman, July 12-14, 2011
- Cunningham A.B., A. Phillips, L. Spangler, A. C. Mitchell, R. Gerlach. Controlling well bore leakage of CO₂ using engineered biomineralization barriers. Proceedings of the 10th annual Carbon Capture and Sequestration, Pittsburg PA, May 10-13, 2011.
- Cunningham, A.B. Energy Related Biofilms. Presented at the Biofilm Science and Technology Meeting, Center for Biofilm Engineering, Montana State University, Bozeman MT, February 8-9, 2011.
- Barnhart, E., Wheaton, J., Ramsay, B., Cunningham, A., Fields, M., Characterization of Methane-Producing Communities in Deep Coal Seams, State Legislative Session, poster, Helena, MT, February 10, 2011
- Spangler, L. R. Gerlach, A.B. Cunningham, MSU Energy Research. Presented at the Biofilm Science and Technology Meeting, Center for Biofilm Engineering, Montana State University, Bozeman MT, February 8-9, 2011.
- Gerlach, R., L. Spangler, A. Mitchell, A.B. Cunningham. Utility of Biofilms and biologically induced mineralization in geologic carbon sequestration. Presented at the Biofilm Science and Technology Meeting, Center for Biofilm Engineering, Montana State University, Bozeman MT, February 8-9, 2011.
- Mitchell, A.C.; Spangler, L.H.; Cunningham, A.B.; Gerlach, R. (2010): Microbially enhanced carbon capture and storage – from pores to cores. Invited Platform Presentation. *Fall Meeting American Geophysical Union*. San Francisco, December 13-17, 2010.
- Gerlach, R.; Mitchell, A.C.; Spangler, L.H.; Cunningham, A.B. (2010): Utility of Biofilms and Biologically-Induced Mineralization in Geologic Carbon Sequestration. Poster Presentation. *Fall Meeting American Geophysical Union*. San Francisco, December 13-17, 2010
- Cunningham, A.B., R. Gerlach, L. Spangler, A.C. Mitchell, S. Parks, and A. Phillips. Reducing the risk of well bore leakage of CO₂ using engineered biomineralization barriers. Presented to GHGT10 Conference, Amsterdam, The Netherlands, September 22, 2010.
- Cunningham A.B., L. Schultz¹, R. Gerlach¹, S. Parks, L. Spangler, A. C. Mitchell. Microbially Enhanced Solubility and Mineral Trapping of Sequestered Supercritical CO₂. Presented to the 9th annual Carbon Capture and Sequestration, Pittsburg PA, May 10-13, 2010.

- Gerlach, R., A.C. Mitchell, L.H. Spangler, A.B. Cunningham. Biologically Enhanced Geologic Carbon Sequestration. Presented to European Geosciences Union General Assembly 2010, Vienna Austria, May 2-7, 2010.
- Gerlach, R., A.C. Mitchell, L.H. Spangler, A.B. Cunningham Role of Biofilms in Geological Carbon Sequestration. Presented to European Geosciences Union General Assembly 2010, Vienna Austria, May 2-7, 2010.
- Gerlach, R., A.C. Mitchell, L.H. Spangler, A.B. Cunningham .Bacterially Induced Calcite Precipitation and Strontium Co-Precipitation under Flow Conditions in a Porous Media System. Presented to European Geosciences Union General Assembly 2010, Vienna Austria, May 2-7, 2010.
- Gerlach, R., L. Schultz, A.C. Mitchell, A.B. Cunningham. Bacterially Induced Calcite Precipitation and Strontium Co-Precipitation under Flow Conditions in a Porous Media System. Poster Presentation. Poster presentation, Biofilm Science and Technology Meeting, Center for Biofilm Engineering, MSU, February 9-10, 2010.
- Gerlach, R., A.B. Cunningham, A.C. Mitchell. Utility of Biofilms in Geological Carbon Sequestration. Poster presentation, Biofilm Science and Technology Meeting, Center for Biofilm Engineering, MSU, February 9-10, 2010.
- Gerlach, R.; Cunningham, A.B.; Mitchell, A.C. Utility of Biofilms in Geological Carbon Sequestration. Poster Presentation. 5th AMS Conference on Biofilms, Cancun, Mexico, November 15-19, 2009
- Cunningham, A.B.; Schultz, L.; Gerlach, R.; Kaszuba, J.P.; Parks, S.; Spangler, L.; Mitchell, A.C. Microbially Enhanced Geologic Containment of Sequestered Supercritical CO₂. Poster Presentation. 8th Annual Conference on Carbon Capture & Sequestration, Pittsburgh, Pennsylvania, May 4-7, 2009
- Gerlach, R.; Cunningham, A.B.; G.F. Ferris; Mitchell, A.C.; Metal and carbon dioxide sequestration through biologically induced mineral precipitation: Influence of hydrodynamics. Platform Presentation. 237th ACS National Meeting. Division of Geochemistry. Coprecipitation of Metals during Chemically and Biologically Induced Mineral Precipitation. Salt Lake City, Utah. March 22-26, 2009.
- Gerlach, R., A.C. Mitchell, L. Schultz, and A.B. Cunningham. Biofilm Mediated calcite precipitation: controlling hydraulic conductivity, carbon sequestration, and the transport of radionuclides. Center for Biofilm Engineering Technical Advisory Conference, Montana State University, February 3-4, 2009.
- Cunningham, A.B., L. Dobeck, and L. Spangler: Overview of the Zero Emissions Research and Technology Center Research Program. Presented to Montana Congressman Denny Rehberg, Dustin Frost and Mike Dennison. Montana State University ZERT field site. September 13, 2008.
- Gerlach R., A. C. Mitchell, L. N. Schultz, R. R. Sharp, and A. B. Cunningham. Influence of microbial biofilms on reactive transport in porous media. ACS Paper #1199219 - 236th ACS National Meeting, Philadelphia, PA, August 17-21, 2008.
- Gerlach, R., A. Mitchell, L. Schultz, L. Spangler, and A.B. Cunningham. "Microbially Mediated Biomineralization: Fundamentals and Possible Applications". Center for Biofilm Engineering Technical Advisory Conference, Montana State University, July 15-17 2008.
- Mitchell A., A. Phillips, J. Kaszuba, W. Hollis, L. Spangler, A. B. Cunningham, R. Gerlach. Microbially Enhanced Carbonate Mineralization and the Geologic Containment of CO₂. Goldschmidt 2008 - "from Sea to Sky" , Vancouver, Canada, July 13 – 18, 2008.

- Cunningham A.B., Microbial Treatment of Wastewater: Applications of Floating Island Biofilms, Clean Water Symposium, Montana State University –Billings, July 10 -11, 2008.
- Cunningham, A.B., A. Mitchell, R Gerlach, L. Wheeler, L. Shultz, L. Spangler. Microbially Enhanced Geologic Carbon Storage. Invited paper presented at Workshop on Numerical Models for Carbon Dioxide Storage in Geological Formations, University of Stuttgart, Stuttgart Germany, April 2-4, 2008.
- Ebigbo, A., A.B Cunningham, R Helmig. Modeling Microbial Clogging in the Subsurface. Invited paper presented at the Workshop on Numerical Models for Carbon Dioxide Storage in Geological Formations, University of Stuttgart, Stuttgart Germany, April 2-4, 2008.
- Cunningham, A.B., Overview of the Zero Emissions Research & Technology (ZERT). Presented to representatives from the Montana State Office of Higher Education Commission and Montana State Legislature, March 27, 2008.
- Mitchell, A.C., A. Phillips, R. Hiebert, R, Gerlach, J. Kaszuba, L. Spangler, A. Cunningham. Biofilm enhanced subsurface sequestration of supercritical CO₂. *2007 AGU Fall Meeting*, San Francisco, December, 2007
- Cunningham, A.B., and F. Stewart. Control of Microbial Processes for Enhanced Water Treatment using Floating Island Treatment Systems. Poster for the Montana Board of Research and Commercialization Technology, Helena MT, February 10, 2009
- Schultz, L., Gerlach, R. A.B. Cunningham, A. Mitchell, S. Parks. Biofilm mediated calcite precipitation – controlling hydraulic conductivity, carbon sequestration, and the transport of radionuclides. Poster for Technical Advisory Conference, Center for Biofilm Engineering, Montana State University, February 2-4, 2009.
- Cunningham A.B., R. Gerlach, L. Spangler, L. Schultz and A.C. Mitchell. Microbially Enhanced Geologic Containment of Sequestered Supercritical CO₂. Poster presented at the 9th International Conference on Greenhouse Gas Technologies, Omni Shorehouse Hotel, Washington D.C, November 16-20, 2008.
- Mitchell, A.C., A. Phillips, L. Wheeler, L. Schultz, R. Hiebert, R. Gerlach, L. Spangler, and A.B. Cunningham. Microbially Enhanced Geologic Containment of Sequestered Supercritical CO₂ Technical Advisory Conference, Center for Biofilm Engineering, Montana State University, July 15-17, 2008.
- Mitchell A., A.B. Cunningham, R. Gerlach, L. Schultz, L. Wheeler, L. Spangler. Microbially Enhanced Geologic Containment of Sequestered Supercritical CO₂, Poster number 826, Seventh Annual Carbon Capture and Sequestration Conference, Pittsburgh, PA, May 5 – 8, 2008.
- Mitchell, A.C., A. Phillips, R. Hiebert, R, Gerlach, J. Kaszuba, L. Spangler, A. Cunningham. Biofilm enhanced subsurface sequestration of supercritical CO₂. Poster for Technical Advisory Conference, Center for Biofilm Engineering, Montana State University, February 4-7, 2008.
- Cunningham, A.B., L Dobeck, and L. Spangler: “ Overview of the Zero Emissions Research and Technology Center Research Program”. Presented to Montana Congressman Denny Rehberg, Dustin Frost and Mike Dennison. Montana State University ZERT field site. September 13, 2008.
- Gerlach, R., A. Mitchell, L. Schultz and A.B. Cunningham. “Microbially Mediated Biomineralization: Fundamentals and Possible Applications”. Center for Biofilm Engineering Technical Advisory Conference, Montana State University, July 15-17 2008,

- Andrew C. Mitchell, Adrienne J. Phillips, John P. Kaszuba, W. Kirk Hollis, Alfred B. Cunningham, Robin Gerlach. "Microbially Enhanced Carbonate Mineralization and the Geologic Containment of CO₂". Goldschmidt 2008 - "from Sea to Sky" , Vancouver, Canada, July 13 – 18, 2008.
- Cunningham A.B., Microbial Treatment of Wastewater: Applications of Floating Island Biofilms, Clean Water Symposium, Montana State University –Billings MT, July 10 -11, 2008.
- Mitchell A., A.B. Cunningham, R. Gerlach, L. Schultz, L. Wheeler, L. Spangler. Microbially Enhanced Geologic Containment of Sequestered Supercritical CO₂, Poster number 826, at the Seventh Annual Carbon Capture and Sequestration Conference, Pittsburgh, PA. May 5 – 8, 2008.
- Cunningham, A.B., A. Mitchell, R Gerlach, L. Wheeler, L. Shultz, L. Spangler. Microbially Enhanced Geologic Carbon Storage. Invited paper presented at Workshop on Numerical Models for Carbon Dioxide Storage in Geological Formations, University of Stuttgart, Stuttgart Germany. April 2-4, 2008.
- Ebigbo, A., A.B Cunningham, R Helmig. Modeling Microbial Clogging in the Subsurface. Invited paper presented at the Workshop on Numerical Models for Carbon Dioxide Storage in Geological Formations, University of Stuttgart, Stuttgart Germany, April 2-4, 2008.
- Cunningham, A.B. Overview of the Zero Emissions Research & Technology (ZERT). Presented to representatives from the Montana State Office of Higher Education Commission and Montana State Legislature, March 27, 2008.
- Mitchell, A.C., A. Phillips, R. Hiebert, R. Gerlach, J. Kaszuba, L. Spangler, A. Cunningham. Biofilm enhanced subsurface sequestration of supercritical CO₂. 2007 *AGU Fall Meeting*, San Francisco, California. 10-14 December 10-14, 2007,
- Phillips A., A.B. Cunningham, R. Gerlach. Supercritical CO₂ Disinfection. Center for Biofilm Engineering Technical Advisory Conference, Montana State University July 24-26, 2007.
- Cunningham, A.B. " Biofilms", Keynote presentation, European Bioperspectives 25th Annual Convention of Biotechnologists, Cologne Germany, May 30-June 1, 2007.
- Cunningham, A.B., Research Capabilities of the Center for Biofilm Engineering, Second Annual Doha Conference on Applied mathematic and Computational Science, Texas A & M University at Qatar, Doha Qatar, May 20-21, 2007.
- Cunningham, A.B. Overview of CBE Biofilm Research Program, Department of Applied Mathematics, University of Bergen , Bergen Norway, January 25, 2007.
- Cunningham, A.B. and A. Phillips, CO₂. Sequestration: Opportunities for Biofilm Research, CBE seminar series, November 2, 2006.
- Cunningham, A.B. and L. Spangler. Opportunities for International Collaboration with the Zero Emissions Research and Technology (ZERT) program. Institute of Hydraulic Engineering, University of Stuttgart, Stuttgart Germany. September 21, 2006.
- Cunningham, A.B. and A. Phillips, A high-pressure core testing system for investigating biotic and abiotic issues associated with geologic sequestration of CO₂. MSU Zero Emissions Research and Technology seminar series, September 6, 2006.
- Cunningham, A.B. Overview of the Center for Biofilm Engineering. Invited Seminar at Utah State University, March 16, 2006.

- Cunningham A B., Microbial Considerations in the Geologic Sequestration of Supercritical CO₂. Seminar for the University of Stuttgart Water Resources Department, February 23, 2006.
- Cunningham A.B., B. Klayman, A. Camper, J. Harwood. A Conceptual Model for Migration of Pathogens in Surface and Ground water. 2005 Joint AGU/NABS Assembly, New Orleans. May 23- 27 2005.
- Cunningham A B., R. Gerlach, A. Phillips, and L. Spangler. Microbially Enhanced Geologic Sequestration of Supercritical CO₂. Fourth Annual Conference on Carbon Capture and Sequestration. Hilton Alexandria Mark Center. Alexandria Virginia May 2-5, 2005.
- Sharp R.R., A. Cunningham, M Adgie, and P. Stoodley. Visualization of dynamic patterns of flow, growth, and activity of *Vibrio fischeri* growing in porous media. IWA Conference "Biofilms 2004", LasVegas NV, Oct. 24-26, 2004.
- Sharp, R.R.; Gerlach, R.; Cunningham, A.B., Adgie, M. Stoodley, P. Use of Bioluminescence to Study Reactive Solute Transport and Biofilm Growth and Activity in Porous Media. Platform Presentation at the 2004 American Geophysical Union Fall Meeting, San Francisco, CA, Dec 13-17, 2004.
- Gerlach, R.; Cunningham, A.B., Viamajala, Peyton, B.M., Apel, W.A. Influence of Carbon Sources, Electron Shuttling Compounds, and Iron Minerals on the Reduction of Oxidized Contaminants. Platform Presentation at the 4th INRA Subsurface Science Symposium, Spokane, WA, Sept 20-22, 2004.
- Gerlach, R.; Borch, T; Cunningham, A.B. Viamajala, S. Peyton, B.M.; Apel, W.A. Influence of Electron Shuttling Compounds and Iron Minerals on the Reduction of Metals and Organics. International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Monterey, CA, May 24-27, 2004.
- Cunningham A. Subsurface Biofilm Barriers for Containment and Remediation of Contaminated Groundwater. Subsurface Science Symposium. Sponsored by INRA/INEEL. Salt Lake City, UT October 6-8, 2003,
- Harwood J., R. Gerlach, A. Cunningham. Modeling the Interaction of Biological Agents in Drinking Water Systems Using AQUASIM. Center for Biofilm Engineering Technical Advisory Meeting Meeting, July 23-25, 2003
- Borch T., R. Jordan, A. Cunningham, R. Gerlach Use of High Performance Liquid Chromatography–Diode Array Detection for the Improved Analysis of 2,4,6–Trinitrotoluene and Its Reduced Metabolites., CBE TAC Meeting , February 3-4, 2003
- Viamajala S., R. Gerlach, R. Sani, W. Smith, B. Payton, J. Petersen, A. Cunningham, W. Apel, Direct and Fe(II)–Mediated Microbial Chromate Reduction by *Cellulomonas* spp. Center for Biofilm Engineering Technical Advisory Meeting Meeting, February 3-4, 2003.
- Cunningham A, Microbial Process Research for the Commercialization of Subsurface Biofilm Barrier Technology, Center for Biofilm Engineering Technical Advisory Meeting Meeting, February 3-4, 2003.
- Cunningham A.B. and R. R. Sharp. Influence of Biofilm Accumulation on Flow and Mass Transport in Porous Media, AGU Annual Symposium, Washington D.C, May 28-30, 2002.
- Borch, T., R Jordan, A. Cunningham, and R. Gerlach. Use of High Performance Liquid Chromatography – Diode Array Detection for the Improved Analysis of 2,4,6 Trinitrotoluene and its Reduced Metabolites.. Second Annual INRA Subsurface Science Symposium, Boise, Idaho. October 13-16, 2002.

- Borch T., R. Gerlach, A. Cunningham, B. Peyton, W. Apel, W. Inskeep. Influence of Biogenically Produced Fe(II), Electron Shuttling, and Humic Acid on the Fate of 2,4,6-trinitrotoluene (TNT). Department of Chemistry, Lund University, Sweden December 19th, 2002.
- Borch T., R. Gerlach, A. Cunningham, B. Peyton, W. Apel, W. Inskeep. Influence of Biogenically Produced Fe(II) and Humic Acid Analogs on the Fate of 2,4,6-Trinitrotoluene (TNT). Platform presentation. Fall Meeting, American Geophysical Union, San Francisco, CA, December 6-10, 2002.
- Borch T., R. Gerlach, A. Cunningham, B. Peyton, W. Apel, W. Inskeep Use of High Performance Liquid Chromatography – Diode Array Detection for the Improved Analysis of 2,4,6-Trinitrotoluene and its Reduced Metabolites. Poster Presentation at the 2nd INRA Subsurface Science Symposium, Boise, ID, October 13-16, 2002
- Gerlach R., W. Apel, A. Cunningham, and B. Peyton. Iron Mediated Reduction of Reducible Contaminants by *Cellulomonas spp.* Platform Presentation at the 2nd INRA Subsurface Science Symposium, Boise, ID, October 13-16, 2002.
- Gerlach R., S. Viamajala, A. Cunningham, B. Peyton, and W. Apel. Direct and Indirect Microbial Reduction of Cr(VI) by *Cellulomonas spp.* in the presence of iron minerals. Poster Presentation at the 2nd INRA Subsurface Science Symposium, Boise, ID, October 13-16, 2002.
- Cunningham A., R. Gerlach, F. Caccavo. Explanation of Bacterial Transport Enhancement by Starvation. Poster presentation. 6th International Symposium on In Situ and On-Site Bioremediation Symposium, San Diego, CA, June 02–07, 2001.
- Borch T., R. Jordan, A. Cunningham, J. Harwood. Bioavailability of TNT and its Amine Metabolites. First Annual INRA Subsurface Science Symposium. September 6-7, 2001. Idaho Falls, Idaho. (Winner of Best Poster Award).
- Komlos J., A. Camper, R. Sharp, A. Cunningham. Development and control of multi-species biofilms in porous media. Presentation at the Hazardous Waste Research 2001 Conference in Salt Lake City Utah, July 2001.
- Gerlach R., F. Caccavo, A. Cunningham. Dissimilatory iron-reducing bacteria can influence the reduction of carbon tetrachloride by iron metal. Presentation at the Hazardous Waste Research 2000 Conference in Denver, CO, May 23-25, 2000.
- Komlos J., R. Gerlach, R. Sharp, A. Cunningham. Effects of substrate concentration on permeability reduction and TCE degradation in a multi-species biofilm. Presentation at the Hazardous Waste Research 2000 Conference in Denver, CO, May 23-25, 2000.
- Cunningham, A. Subsurface biofilm barriers: an emerging technology for containment and remediation of contaminated groundwater. Hazardous Waste Research 2000 Conference, in Denver, CO, May 23-25, 2000.
- Komlos, J. and A. Cunningham. Effects of nutrient concentration on species distribution in a dual-species biofilm. Center for Biofilm Engineering TAC Meeting. February 2000.
- Komlos J., A. Cunningham. Multi-species biofilms for reactive biobarrier formation. Center for Biofilm Engineering TAC Meeting February 2000
- Gerlach R., F. Caccavo, A. Cunningham. Chromium(VI)-elimination from contaminated groundwaters using redox-reactive biobarriers. Poster Presentation at 1999 Conference on Hazardous Waste Research – Gateways to Environmental Solutions. Great Plains/Rocky Mountain Hazardous Substance Research Center. St. Louis, MO, May 24-27, 1999.

- Jordan R. A. Cunningham. Surfactant sorption to soil organic matter: impact on contaminant bioavailability. Fifth International Symposium on In-Situ and On-Site Bioremediation, Battelle, April 19-22, 1999.
- Komlos J., A. Cunningham, R. Sharp, G. James and B. Warwood. Biofilm accumulation and activity in porous media: 1) Biobarriers 2) Dual-species bacterial interaction. Center for Biofilm Engineering TAC meeting. February 1999.
- Jordan R., A. Cunningham. Fundamentals of surfactant enhanced bioremediation (SEB), partitioning and mass transfer phenomena. Engineering Biological Processes for Environmental Enhancement, The 1998 Pacific Northwest Regional Meeting of the American Society of Agricultural Engineers, Fairmont, MT.
- Jordan R., A. Cunningham. Bioavailability of sorbed substrates to attached microorganisms: the role of biosurfactants and practical consequences for industrial water systems. International Association of Water Quality Specialty Conference on Microbial Ecology of Biofilms, Lake Bluff, IL, October 8-10, 1998.
- Sharp R. A. Cunningham. Observation of thick biofilm accumulation and structure in porous media and corresponding hydrodynamic and mass transfer effects, International Association of Water Quality, Chicago, IL. October 8-10 1998.
- Cunningham A. Bacterial transport and activity issues related to the formation of redox-reactive subsurface barriers. Presentation at Technical Advisory Committee Meeting, July 21-23, 1998, Center for Biofilm Engineering, Montana State University, Bozeman, MT.
- Cunningham A. Formation of reactive subsurface barriers using dissimilatory metal-reducing bacteria. Presentation at "Engineering Biological Processes for Environmental Enhancement". Annual Meeting of the Pacific Northwest Region of the ASAE in Fairmont Hot Springs, MT. Sept. 10-12, 1998.
- Cunningham A. J Komlos. Formation and persistence of a reactive biofilm barrier in variably saturated zones. 1998 Conference on Engineering Biological Processes for Environmental Enhancement, Fairmont, MT, September 10-12, 1998.
- Cunningham A. Biofilm barrier formation and persistence in variable saturated zones. 1998 Great Plains/Rocky Mountain Hazardous Waste Research Center Conference on Hazardous Waste Research, Snowbird, UT, July 1998.
- Komlos, J., J. Billmeyer, R. Sharp, A. Cunningham. Observation of thick biofilm accumulation and structure in porous media and corresponding hydrodynamic and mass transfer effects. CBE TAC meeting, July 1998.
- Gerlach R., F. Caccavo, A. Cunningham. Formation of redox-reactive subsurface barriers using dissimilatory metal-reducing bacteria. Presentation at the 1998 Conference on Hazardous Waste Research. Snowbird, UT, May 18-21, 1998.
- Jordan R., A. Cunningham. Bioavailability defined: Practical consequences for bioremediation. Conference on Hazardous Waste Research, Snowbird, UT, May 18-21, 1998.
- Jordan R., A. Cunningham. Predicting the effectiveness of surfactant-enhanced bioremediation. Battelle First International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Monterey, CA, May 18-21, 1998.

- Jordan R., A. Cunningham. Bioavailability defined and its practical consequences for surfactant-enhanced bioremediation. The Third Latin American Biodegradation and Biodeterioration Symposium, LABS 3. Florianopolis, Santa Catarina, Brazil. April 27-30 1998.
- Jordan R., A. Cunningham. Predicting the effects of surfactants on the bioavailability of hydrophobic organic chemicals in soils. American Institute of Chemical Engineers Spring Meeting, New Orleans, LA, March 8-12, 1998.
- Komlos, J., A. Cunningham, B. Warwood, G. James. Biofilm accumulation and activity in porous media biobarriers. CBE TAC meeting. February 1998
- Cunningham A., R. Sharp. Micro/Meso scale issues in the design of subsurface biobarriers. IBC Environmental Technology Symposium on Subsurface Barrier Technologies, Tucson AZ, January 26-27 1998.
- Cunningham A., R Jordan. Surfactant enhanced bioavailability of soil-sorbed organics. NATO Advanced Study Institute on Bioavailability of Organic Xenobiotics in the Environment, Jesenik, Czech Republic, Aug 18-29, 1997.
- Cunningham A., Evaluation and modeling of subsurface biobarrier formation and persistence. 12th Annual Conference on Hazardous Waste Research, sponsored by the Great Plains/Rocky Mountain Hazardous Substance Center, Kansas City KS, May 19-22, 1997.
- Cunningham A. Integration of Industry, Education, and Research: the Key to Sustainable Development. NSF site review and Industrial Associates meeting, Center for Biofilm Engineering, Montana State University, February 13-14, 1997.
- Cogan N. , A. Cunningham, M. Hamilton, E. Visser, C. Wend. Computational analysis of oxygen mass transport in biofilm systems. Center for Biofilm Engineering Technical Advisory Meeting Meeting Meeting, January 1997.
- Cunningham A. Biofouling in Reverse Osmosis Membrane Desalination Systems. Invited Seminar to Saline Water Conversion Company, Dhahran Saudi Arabia, January 6, 1997.
- Bouwer E., A. Cunningham. Analysis and modeling of biota sediment accumulation factor (BSAF) for polycyclic aromatic hydrocarbons (PAHs). New York Water Environment Association Annual Meeting, New York City, NY, October 1996.
- Cunningham A. Containment of Heavy Metal and Chlorinated Organic Solvent Contamination Using Subsurface Biobarriers. HRRS/WERC Joint Conference on the Environment, Albuquerque, NM, May 21-23 1996.
- Cunningham A. Formation and Persistence of Subsurface Biobarriers. IBC Conference on Novel Approaches to Bioremediation, Arlington VA, May 12-13 1996.
- Cunningham A. Microbial Processes in Porous media. Invited Seminar, VEGAS Groundwater Remediation Laboratory, University of Stuttgart, Stuttgart Germany, April 6, 1996.
- Cunningham A. Influence of Biofilm Accumulation on Porous Media Hydrodynamics. The 1995 Rocky Mountain Ground Water Conference, Jackson Hole Wyoming, October 4-6 1995.
- Cunningham A. Microbial Transport in Porous Media. The 1995 Rocky Mountain Ground Water Conference, Jackson Hole Wyoming, October 4-6 1995.
- Cunningham A. Process Engineering Considerations in In Situ Bioremediation. Amer. Pet. Inst. Bioremediation Focus group meeting, Montana State University, Bozeman MT, Aug 2-3, 1995.

- Cunningham A. Effects of Adsorption Rate Coefficient on the Transport of Bacteria through Saturated Porous Media. Third International Symposium on In Situ and On-Site Bioreclamation, San Diego CA, April 24-27 1995.
- Cunningham A. Overview of Biofilm Processes in Porous Media. Invited Seminar, College of Science, Texas A & M University, College Station TX, February 28, 1995.
- Cunningham A. R. Mupuri. Biofilm Processes in Vapor Phase Biofilters. Workshop on Biofilter Design and Development, South Coast Air Quality Management District Technology Advancement Office, Diamond Bar, California, January 27, 1995.
- Cunningham A. Biofilm Processes with Application to Drinking Water Systems. Seminar for Sydney Water Board, Sydney Australia, April 22, 1994.
- Cunningham A. A Process Engineering Approach to Controlling Nitrification in Drinking Water Systems. Seminar for AWT Science and Environment, Sydney Australia, April 8, 1994.
- Cunningham A. Bacterial Transport through Porous Media. Seminar for School of Microbiology and Immunology, New South Wales University, Sydney Australia, March 15, 1994.
- Cunningham A. An Overview of Microbial Processes Engineering. Invited seminar for The Monroe Center, School of Engineering, University of New South Wales, Sydney Australia, March 10, 1994.
- Cunningham A. Microbial Transport Processes in Porous Media. NSF ERC site review, Montana State University, 25-26 August 1993.
- Cunningham A. A Process Engineering Approach to Engineering Scale_up of *In_Situ* Bioremediation Systems. ERC Technical Advisory Committee Meeting, Montana State University, June 4-7, 1993.
- Cunningham A. Modeling Microbial Processes in Porous Media with Application to Biotransformation. Hydrochemistry 1993: International Symposium on Hydrological, Chemical, and Biological Processes of Transformation and Transport of Contaminants in Aquatic Environments, Rostov-on-Don, Russia, May 24-29, 1993.
- Cunningham A. Determining Consortial Kinetic Parameters from Respirometry. Second International Symposium on In_Situ and On_Site Bioreclamation, San Diego CA, April 5-8, 1993.
- Cunningham A. Engineering Scale-Up of In_Situ Bioremediation Processes. Invited presentation to Biofilms Conference, University of Calgary, Calgary Canada, March 18-19 1993.
- Cunningham A. In-Situ Bioremediation Workshop. Presented to Conoco Inc., Ponca City OK, September 24-25, 1992.
- Cunningham A. Importance of Interfacial Microbial Processes In In_Situ Bioremediation. Invited Presentation to the On-Site/In_situ Biotreatment of Hazardous Waste Symposium, sponsored by the New Jersey Institute of Technology, Newark NJ, September 16, 1992.
- Cunningham A. An Overview of ERC Programs. Center for Biofilm Engineering Technical Advisory Committee Meeting, 24-29 May 1993, June 3-4, 1992.
- Cunningham A. Modeling Microbial Processes in Porous media. Center for Biofilm Engineering Technical Advisory Committee meeting, June 3-4, 1992.

- Cunningham A. Cosolvent Effects on Transport and Degradation Rates of Naphthalene in Unsaturated Surface Soil. American Institute of Chemical Engineers Conference, Los Angeles CA. Nov. 19-22 1991.
- Cunningham A. Modeling Biofilm Accumulation and Activity in Porous Media. Hazardous Waste Research Conference, Kansas State University, Manhattan KS, May 22-23 1991.
- Cunningham A. Interfacial Microbial Process Engineering. Engineering Research Center for Computational Simulation, Mississippi State University, Dec. 9, 1990.
- Cunningham A. Effects of Biocolloids on Hydrodynamics of Porous Media. Mantao III Conference: Concepts in Manipulation of Groundwater Colloids for Environmental Restoration, Mantao, NC, Oct. 15-16, 1990.
- Cunningham A. Influence of Subsurface Microbial Processes on *In Situ* Bioremediation. presented to Northern Rocky Mountain Conference, Montana College of Mineral Science and Technology, Butte, MT, Oct. 1, 1990.
- Cunningham A. Microbial Transport and Biotransformation Processes in Porous Media. American Institute of Chemical Engineers, 1990 Summer Meeting, August 19-22, 1990.
- Cunningham A. Biofilm Accumulation in Porous Media. Hazardous Waste Research Conference, Kansas State University, Manhattan, KS, May 21-22, 1990.
- Cunningham A. The Centers Approach to Cross-Disciplinary Research, Keynote Address, Hazardous Waste Research Conference, Kansas State University, Mahanttan KS, May 21-22 1990.
- Cunningham A. W.G. Characklis. Biofilms in Ecology and Technology, Department of Genetics and Microbiology. University of Aberdeen, Aberdeen, Scotland, December 10, 1989.
- Cunningham A. Influence of Microbial Transport on the In Situ Bioremediation of organic groundwater contaminants. Hazardous Waste Research Conference, Kansas State University, Manhattan, KS, May 23-24, 1989.
- Cunningham A. Fluid Dynamics and Solute Transport at the Fluid-Biofilm Interface. Invited presentation, Dahlem Workshop on Structure and Function of Biofilms, Berlin, W. Germany, Nov. 27-Dec. 2, 1988.
- Cunningham A. Influence of Microbial Transport on *In Situ* Biodegradation of Organic Groundwater Contaminants. American Petroleum Institute Conference on Petroleum Hydrocarbons and Organic Chemicals in Groundwater, Houston, TX, Nov. 9-11, 1988.
- Cunningham A. E Visser. Modeling Microbial Fouling in Porous Media. International Conference on Groundwater Contamination, Amsterdam, The Netherlands, Oct. 27-29, 1987.
- Cunningham A. Biofilms in Porous Media. Amer. Geophysical Union Chapman Conference, Snowbird, UT, Oct. 1-2, 1986.
- Cunningham A. Small Scale Hydropower. Session Chairman, Amer. Soc. Civ. Eng. Hydraulics Div. Specialty Conference, Orlando, FL. Aug. 13-15, 1985.
- Cunningham A. Montana Hydropower - A Manual for Site Developers. Micro-Hydro Workshop, Missoula, MT, sponsored by Montana Dept. of Natural Resources and Conservation, Sept. 1981.
- Cunningham A. Development of a Procedure for Streamflow Forecasting in Intermountain Regions. Montana Water Resources Center Advisory Council, Helena, MT, Sept. 1980.

Cunningham A. Development of a Water Resources Management Simulator. Invited presentation to OWRD Directors Council and U.S. House of Representatives and Senate Staff, Washington, D.C., February 1980.

Cunningham A. Development of a Water Resources Management Simulator. Presented to Montana Water Resources Center Advisory Board, Fairmont Hot Springs, MT, October 1979.

Cunningham A. Development of a Water Resources Management Simulator. Presented to Water Pollution and Control Federation Conference, Houston, TX, October 1979.

Cunningham A. Development of a Water Resources Management Simulator. Invited presentation for the Western States Water Council meeting, Keystone, CO, October 1979.

Cunningham A. Development of a Streamflow Forecasting Procedure for Intermountain Basins. Presented to Montana Water Resources Research Center Advisory Board, Fairmont Hot Springs, MT, Oct. 1979.