

## Contact Information

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## Professional Appointments

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August 2014-present Assistant Professor, CE, MSU, Bozeman Montana  
 July 2010 – August 2014 Research Engineer, CBE, MSU, Bozeman, Montana  
 Jan 2008 – June 2010 Senior Associate Engineer, ENVIRON International, Newark, New Jersey  
 Nov 2004 – Dec 2007 Research Engineer, CBE, MSU, Bozeman, Montana  
 Mar 2001 – Nov 2004 Associate Environmental Engineer, Fluidyne Inc. Bozeman, Montana

## Professional Preparation

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Ph.D. in Engineering (Environmental)      Montana State University      December 2013

**Committee Chair:** Dr. Robin Gerlach

**Dissertation:** *Biofilm-induced calcium carbonate precipitation: Application in the subsurface*

**Research:** Injection strategies were developed to spatially and temporally control biofilm-induced calcium carbonate precipitation with the goal of reducing permeability in fractures and porous media. Those injection strategies were then used to reduce permeability in fractures under meso-scale and high pressure conditions as might be observed in the deep subsurface. This technology could improve the security of geologically stored gases (carbon dioxide, natural gas) or seal hydraulic fractures.

M.S. Environmental Engineering      Montana State University      December 2003

**Committee Chair:** Dr. Warren Jones      **Co-Mentor:** Thomas Kallenbach, PE

**Professional Paper:** *Development & analysis of new trickling filter media for on-site wastewater systems*

**Research:** The patented lightweight trickling filter media MetaRocks®, was developed and tested for use in the on-site wastewater treatment system known as Eliminite® (Belgrade, Montana). The study assessed the long term suitability of MetaRocks® to support biofilms and treat wastewater as compared to the use of natural rock media. MetaRocks® compared favorably and offer the ability to pre-package and economically ship the Eliminite® units to other states, expanding the market for the product.

BA Political Science (Pre-Med concentration)      Carroll College, Helena, Montana      May 1998

## Awards and Honors

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Center for Biofilm Engineering Outstanding Faculty Award July 2016  
 Montana State University Alumni Foundation Faculty/Staff 2016 Award for Excellence for Mentoring  
 McNair Scholars Program Mentor Acknowledgement of Achievement April 2015  
 Center for Biofilm Engineering Student Citizen Award July 2013  
 American Geophysical Union Outstanding Student Presenter Award December 2012

## Teaching Experience

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Montana State University Civil Engineering Department

*Instructor of Record*, EENV 447: Hazardous Waste Management, Spring Semesters 2015-2018

Course Outline: This course covered the major environmental pollution laws and regulations, the various types of pollutants, and contemporary environmental issues. The focus of the course was to gain knowledge about contaminants in the environment, the regulations associated with environmental pollution and to also develop technical communication skills.

*Instructor of Record*, EENV 443: Air Pollution Control, Fall Semester 2014, 2016

Course Outline: This course covered the major air pollution laws and regulations, the various types of air pollutants, and the design, performance and economics of the major types of air pollution control technologies. The focus of the course was the design of major air pollution control equipment.

*Instructor of Record*, EENV 445: Hazardous Waste Treatment, Fall Semester 2013, 2015

Course Outline: This course covered the major hazardous waste laws and regulations, hazardous waste management and remediation or cleanup processes. Topics discussed were related to the assessment, investigation, and design phases of contaminated site remediation with a focus on chemical, physical, biological and thermal treatment processes.

*Faculty Mentor* EENV 490: *Undergraduate Research Experience (Ana Paulo Coelho)*, Summer 2015

*Faculty Mentor* MBIO 490: *Undergraduate Research Experience (Colleen McFarland)*, Fall 2015

*Guest Lecturer*, EENV 566 Fundamentals of Biofilm Engineering, Fall Semester 2016

Lecture title: “An overview of biomineralization and its engineering applications”

*Guest Lecturer*, EARTH 505 Geomicrobiology, Spring Semester 2016

Lecture title: “Biomineralization and its Engineering Applications”

*Guest Lecturer*, EENV 534: Environmental Engineering Investigations, Fall Semester 2015

Lecture title: “Environmental Auditing and Sampling- Environmental Sleuthing”

*Guest Lecturer*, EENV 534: Environmental Engineering Investigations, Fall Semester 2013

Lecture title: “Reporting and permitting of greenhouse gases in the US”

*Guest Lecturer*, EENV 443: Air Pollution Control, Fall Semester 2012

Lecture titles: “Reporting and permitting of greenhouse gases in the US” and “Biofilm-induced calcium carbonate (CaCO<sub>3</sub>) precipitation: Application in the subsurface”

## Publications

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*Peer-Reviewed (# indicates student author)*

1. Kirkland, CM<sup>#</sup>, Zanetti, S<sup>#</sup>, Grunewald, E, Walsh, DO, Codd, SL, **Phillips, AJ**. (2017) Detecting microbially induced calcite precipitation (MICP) in a model well-bore using downhole low-field NMR *Environmental Science and Technology* 2017, 51 (3), pp 1537–1543 <http://pubs.acs.org/doi/abs/10.1021/acs.est.6b04833> DOI: 10.1021/acs.est.6b04833
2. **Phillips AJ**, Cunningham, A, Gerlach, R, Hiebert, R, Hwang, C, Lomans, B, Westrich, J, Mantilla, C, Kirksey, J, Esposito, R, and Spangler, L. (2016) Fracture sealing with microbially-induced calcium carbonate precipitation: A field study. *Environmental Science and Technology*, 50 (7), pp 4111–4117 <http://pubs.acs.org/doi/abs/10.1021/acs.est.5b05559> DOI: 10.1021/acs.est.5b05559
3. Cunningham, AB, Gerlach, R, **Phillips, AJ**, Lauchnor, E, Rothman, A<sup>#</sup>, Hiebert, R, Busch, A, Lomans, B, and Spangler, L. (2015) Assessing potential for biomineralization sealing in fractured shale and the Mont Terri Underground Research Facility, Switzerland, *Carbon*

- Dioxide Capture for Storage in Deep Geologic Formations* Vol. 4, Chapter 48 pg 887-903  
[http://www.co2captureproject.org/reports/CCP3v4\\_full\\_version.pdf](http://www.co2captureproject.org/reports/CCP3v4_full_version.pdf)
4. Kirkland, C<sup>#</sup>, Hiebert, R, **Phillips, AJ**, Grunewald, E, Walsh, D, Seymour, J, Codd, S. (2015) Biofilm detection in a model well-bore environment using low-field NMR, *Groundwater Monitoring and Remediation*, July 2015  
<http://onlinelibrary.wiley.com/doi/10.1111/gwmr.12117/abstract> DOI: 10.1111/gwmr.12117
  5. Hommel, J<sup>#</sup>, Lauchnor EG, **Phillips AJ**, Gerlach R, Cunningham AB, 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*. Volume 51, Issue 5 May 2015 Pages 3695–3715 <http://onlinelibrary.wiley.com/doi/10.1002/2014WR016503/full> DOI: 10.1002/2014WR016503
  6. **Phillips, AJ**, Eldring, J, Hiebert, R, Lauchnor, E, Mitchell, AC, Cunningham, A, Spangler, L, Gerlach, R. (2015), Design of a meso-scale high pressure vessel for the laboratory examination of biogeochemical subsurface processes, *Journal of Petroleum Science and Engineering*, 126: 55-62 <http://www.sciencedirect.com/science/article/pii/S0920410514004136> DOI:10.1016/j.petrol.2014.12.008
  7. **Phillips AJ**, Gerlach, R, Lauchnor, E, Mitchell, AC, Cunningham, A, Spangler, L. (2013), Engineered applications of ureolytic biomineralization: a review, *Biofouling*, 29: 715-733 (Invited) <http://www.tandfonline.com/doi/abs/10.1080/08927014.2013.796550> DOI:10.1080/08927014.2013.796550
  8. Cunningham, A, Lauchnor, E, Eldring, J, Esposito, R, Mitchell, AC, Gerlach, R, **Phillips, AJ**, Ebigbo, A, and Spangler, L. (2013), Abandoned well CO<sub>2</sub> leakage mitigation using biologically induced mineralization: current progress and future directions, *Greenhouse Gas Science & Technology*, 3:40–49 <http://onlinelibrary.wiley.com/doi/10.1002/ghg.1331/abstract> DOI: 10.1002/ghg.1331
  9. Mitchell, AC, **Phillips, AJ**, Parks, S<sup>#</sup>, Schultz, L, Cunningham, A, Gerlach, R. (2013), Microbial CaCO<sub>3</sub> mineral formation and stability in an experimentally simulated high pressure saline aquifer with supercritical CO<sub>2</sub>, *International Journal of Greenhouse Gas Control*, 15:86-96 <http://www.sciencedirect.com/science/article/pii/S1750583613000662> DOI:10.1016/j.ijggc.2013.02.001
  10. **Phillips, AJ**, Lauchnor, E, Eldring, J, Esposito R, Mitchell, AC, Gerlach, R, Cunningham, A, and Spangler, L. (2013), Potential CO<sub>2</sub> leakage reduction through biofilm-induced calcium carbonate precipitation, *Environmental Science & Technology*, 47 (1):142-149 <http://pubs.acs.org/doi/abs/10.1021/es301294q> DOI: 10.1021/es301294q
  11. Ebigbo, A\*, **Phillips, AJ\***, Gerlach, R, Helmig, R, Cunningham, A, Class, H and Spangler, L. (2012), Darcy-scale modeling of microbially induced carbonate mineral precipitation in sand columns, *Water Resources Research*, 48, W07519 (\*Equal contribution authors) <http://onlinelibrary.wiley.com/doi/10.1029/2011WR011714/abstract> DOI: 10.1029/2011WR011714
  12. Codd, SL, Vogt, SJ<sup>#</sup>, Hornemann, JA<sup>#</sup>, **Phillips, AJ**, Maneval, J, Romanenko, KR, Hansen, L, Cunningham, AB, Seymour, JD. (2011), NMR relaxation measurements of biofouling in model and geological porous media, *Organic Geochemistry*, 42 (8): 965-971 <http://www.sciencedirect.com/science/article/pii/S0146638011000684> DOI:10.1016/j.orggeochem.2011.03.014
  13. Mitchell, AC, **Phillips, AJ**, Hiebert, R, Gerlach, R, Cunningham, A, Spangler, L. (2009), Biofilm enhanced geologic sequestration of supercritical CO<sub>2</sub>, *International Journal of Greenhouse Gas Control*, 3: 90-99 <http://www.sciencedirect.com/science/article/pii/S1750583608000406> DOI:10.1016/j.ijggc.2008.05.002
  14. Mitchell, AC, **Phillips, AJ**, Kaszuba, J, Hollis, HK, Gerlach, R, Cunningham, A. (2008), Resilience of planktonic and biofilm cultures to supercritical CO<sub>2</sub>, *Journal of Supercritical*

*Fluids*, 47: 318-325 <http://www.sciencedirect.com/science/article/pii/S0896844608002040>  
DOI:10.1016/j.supflu.2008.07.005

### ***In Review***

1. Cunningham, A, Class, H, Egbibo, A, Gerlach, R, **Phillips, AJ**, Hommel, J. Field-scale modeling of microbially induced calcite precipitation, *Computational Geosciences* (Submitted February 2018)
2. Mitchell, AC, SL Parks<sup>#</sup>, **AJ Phillips**, EG Lauchnor, AB Cunningham, R Gerlach. Kinetics of calcite precipitation by ureolytic bacteria under aerobic and anaerobic conditions. (Submitted March, 2014) *Ecological Engineering*.

### ***Manuscripts in Preparation***

1. Schultz, L, Worum, B<sup>#</sup>, Deverna, K<sup>#</sup>, Cunningham, A, Gerlach, R, and Phillips, AJ. Thermal hydrolysis of urea and cation inhibition in solutions at 100-150 C (*In preparation* for the *International Journal of Chemical Kinetics*)
2. Schultz, L, Worum, B<sup>#</sup>, Deverna, K<sup>#</sup>, Kirkland, C, Cunningham, A, Gerlach, R, and Phillips, AJ. Subsurface control of thermally-induced carbonate precipitation (TICP): Cementing fractures and altering porous media, (*In preparation* for *ACS Sustainable Chemistry and Engineering*)
3. Kirkland, C, Norton, D<sup>#</sup>, Cunningham, A, Gerlach, R, Hiebert, R, Kirksey, J, Spangler, L, **Phillips, AJ**. Biomineralization and wellbore integrity: a microscopic solution to subsurface fluid migration (*In preparation* for *Energy Procedia*)
4. Kirkland, C, Thane, A, Cunningham, A, Gerlach, R, Hiebert, R, Kirksey, J, Spangler, L, **Phillips, AJ**. Permeability modification using Microbially-Induced Calcite Precipitation (MICP) to enhance wellbore integrity: a field demonstration (*In preparation*)
5. Kirkland, C, Norton, D<sup>#</sup>, Firth, O<sup>#</sup>, Gerlach, R, and **Phillips, AJ**. Applying X-ray  $\mu$ -CT to enhance MICP for cement fracture leakage mitigation. (*In preparation*)
6. **Phillips, AJ**, Troyer, E, Hiebert, R, Kirksey, J, Rowe, W, R, Gerlach, R, Cunningham, A, Esposito, R, Spangler, L. Biomineralization as a tool to remediate wellbore integrity: field application (*in preparation* for the *Journal of Petroleum Technology*)
7. Feder, M, Morasko, V<sup>#</sup>, Gerlach, R, **Phillips, AJ**. Plant-based ureolysis kinetics and urease inactivation at elevated temperatures for use in engineered mineralization applications (*In preparation*)
8. Meslé, M, Davis, K<sup>#</sup>, Hodgskiss, L<sup>#</sup>, Dobeck, L, Eldring, J, Hiebert, R, Cunningham, A, Gerlach, R, **Phillips, AJ** and Fields, M. Stimulation of microbial coal bioconversion into methane in small-scale reactor systems (*In preparation*)
9. Meslé, M, **Phillips, AJ**, Hodgskiss, L, Barnhart, E, Dobeck, L, Eldring, J, Hiebert, R, Cunningham, A, Gerlach, R, and Fields, M. Evaluating the time delay to the bioconversion of coal to methane at a meso-scale under field relevant pressure conditions (*In preparation*)

### ***Conference Proceedings***

1. **Phillips, AJ**, Gerlach, R, Hiebert, R, Kirksey, J, Spangler, L, Esposito, R, and Cunningham, AB. Biological influences in the subsurface: A method to seal fractures and reduce permeability with microbially-induced calcite precipitation. American Rock Mechanics Association 49th Annual Meeting Proceedings, June 28-July 1, 2015, San Francisco, CA. <https://www.onepetro.org/conference-paper/ARMA-2015-490>
2. Cunningham, A\*, **Phillips, AJ\***, Troyer, E<sup>#</sup>, Lauchnor, E, Hiebert, R, Gerlach, R, Spangler, L. (2014) Wellbore leakage mitigation using engineered biomineralization, *Energy Procedia*, 63:

- 4612-4619 (\* *Equal contribution authors*) DOI:10.1016/j.egypro.2014.11.494  
<http://www.sciencedirect.com/science/article/pii/S1876610214023091>
3. Cunningham, A, Gerlach, R, Spangler, L, Mitchell, AC, Parks, S<sup>#</sup> and **Phillips, AJ**. (2011), Reducing the risk of well bore leakage of CO<sub>2</sub> using engineered biomineralization barriers, *Energy Procedia*, 4:5178-5185 DOI:10.1016/j.egypro.2011.02.495  
<http://www.sciencedirect.com/science/article/pii/S1876610211007740>
  4. Troyer, E, West, C, Berninghaus, A, Joyce, J, Gerlach, R, **Phillips, AJ**, 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) <https://www.onepetro.org/conference-paper/ARMA-2017-0460>
  5. Beser, D, West C, Daily, R, Cunningham, A, Gerlach, R, Fick, D, Spangler, L and **Phillips, AJ**. Assessment of ureolysis induced mineral precipitation material properties compared to oil and gas well cements. American Rock Mechanics Association 51st Annual Meeting Proceedings, June 25-28, 2017, San Francisco, CA. (Paper # 588) <https://www.onepetro.org/conference-paper/ARMA-2017-0588>
  6. Thane, A, Troyer, E<sup>#</sup>, Gallagher, B, **Phillips, AJ**. Remediation of coal combustion residuals using microbially-induced calcite precipitation. World of Coal Ash Conference 2017 Proceedings <http://www.flyash.info/2017/138-Thane-woca2017p.pdf>

## Presentations

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### Oral Presentations: (underline indicates presenter)

“Mineral precipitation in energy-related applications” Phillips, AJ, Cunningham, A, Gerlach, R, Spangler, L. ERI Day March 20, 2018, Bozeman, MT

“Urease: a journey from the laboratory to the Field” Phillips, AJ, Kirkland, C, Daily, R, Frieling, Z, Morasko, V. CBE Seminar Series, February 15, 2018, Bozeman, MT

“Design and Demonstration of Meso-Scale Coal-Dependent Methanogenesis Under Pressurized Flow Conditions in situ Temperature and Pressure” Meslé, M, Phillips, AJ, Eldring, J, Hodgkiss, L, Dobeck, L, Davis, K, Gerlach, R, Hiebert, R, Barnhart, E, Cunningham, A, Spangler, L, Fields, M. International Society for Subsurface Microbiology 2017 Conference, November 6-10, 2017

“Methods to Enhance Wellbore Cement Integrity with Microbially-Induced Calcite Precipitation (MICP)” Phillips, AJ, Cunningham, A, Gerlach, R, Spangler, L. 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.

“Wellbore Leakage Mitigation Using Advanced Mineral Precipitation Strategies” Phillips, AJ, Cunningham, A, Gerlach, R, Spangler, L. 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.

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

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

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

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

“Low-field Borehole NMR as a Monitor for Subsurface Engineering Applications”. Kirkland, C, Phillips, AJ, Codd, S. SAGEEP 2017, March 19-23, 2017, Denver Colorado

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

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

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

“Methods to Enhance Wellbore Cement Integrity with Microbially-Induced Calcite Precipitation (MICP)” Phillips, AJ, Gerlach, R, Cunningham, AB, Spangler, L. Department of Energy, Mastering the Subsurface through Technology Innovation & Collaboration: Carbon Storage & Oil & Natural Gas Technologies Review Meeting, August 17, 2016, Pittsburgh PA

“Wellbore Leakage Mitigation Using Advanced Mineral Precipitation Strategies” Phillips, AJ, Gerlach, R, Cunningham, AB, Spangler, L. Department of Energy, Mastering the Subsurface through Technology Innovation & Collaboration: Carbon Storage & Oil & Natural Gas Technologies Review Meeting, August 17, 2016, Pittsburgh PA

“Advancing ureolysis driven mineral sealing strategies for environmental engineering applications”, Feder, M.; Phillips, A.J.; Gerlach, R. (2016): Platform Presentation. Goldschmidt Conference. June 26-July 01, 2016. Yokohama (Japan)

“Biofilm-Mediated Mineral Precipitation Technology – From the Microscale to the Field-Scale.” Gerlach R., Phillips, A.; Cunningham, A.B.; Spangler, L. (2016): Platform Presentation. Goldschmidt Conference. June 26-July 01, 2016. Yokohama (Japan)

“Methods to Enhance Wellbore Cement Integrity with Microbially-Induced Calcite Precipitation (MICP)” Phillips, AJ, Gerlach, R, Hiebert, R, Cunningham, AB, Spangler, L. Department of Energy, National Energy Technology Laboratory, DOE Headquarter’s Executive Committees, June 21, 2016 Webinar, Bozeman MT via Morgantown WV

“Biom mineralization Sealing Technology: A Promising Technology Developed in Montana” Phillips, AJ, Gerlach, R, Cunningham, AB, Spangler, L. Montana Energy Conference, March 30, 2016 (Invited Speaker) Billings, Montana

“Methods to Enhance Wellbore Cement Integrity with Microbially-Induced Calcite Precipitation (MICP)” Phillips, AJ, Gerlach, R, Hiebert, R, Cunningham, AB, Spangler, L. Department of Energy, National Energy Technology Laboratory, Selected Wellbore Integrity Projects Presentation to USGS, DOE, and EPA Executive Committees, January 21, 2016 Webinar, Bozeman MT via Morgantown WV

“Wellbore Leakage Mitigation Using Advanced Mineral Precipitation Strategies” Phillips, AJ, Gerlach, R, Cunningham, AB, Spangler, L. Department of Energy, National Energy Technology Laboratory, Carbon Storage Division, December 3, 2015 Pittsburgh, PA

“Field Test and Evaluation of Engineered Biom mineralization Technology for Sealing Existing wells” Phillips, AJ, Gerlach, R, Cunningham, AB, Spangler, L. Department of Energy, National Energy Technology Laboratory, Storage Capacity & Well Remediation Quarterly Webinar, July 17, 2015, Bozeman MT via Morgantown WV

“Overview of biofilm mediated mineralization and engineering applications” Phillips, AJ, Cunningham, AB, Gerlach, R, Spangler, L. Montana Biofilm Meeting July 2015, Bozeman MT

“Biological influences in the subsurface: A method to seal fractures and reduce permeability with microbially-induced calcite precipitation” Phillips, AJ, Gerlach, R, Hiebert, R, Kirksey, J, Spangler, L, Esposito, R, and Cunningham, AB. June 28- July 1, 2015, American Rock Mechanics Association 49th Annual Meeting, San Francisco, CA

“Advancing technologies for mitigating subsurface gas leakage” Phillips, AJ, Cunningham, AB, Gerlach, R, Spangler, L. June 4, 2015 Darcy Lecture Introductory Session, Bozeman, MT

“Field demonstration of biom mineralization sealing technology” Phillips, AJ, Hiebert, R, Kirksey, J, Esposito, R. Cunningham, AB, Gerlach, R, Spangler, L. Energy Research Institute Research Day, May 2015, Bozeman MT.

“Microbially-induced CaCO<sub>3</sub> precipitation: engineering applications” Phillips, AJ, Cunningham, AB, Gerlach, R, Spangler, L. Montana State University College of Engineering Seminar Series, April 2015, Bozeman, MT

“Field Test and Evaluation of Engineered Biom mineralization Technology for Sealing Existing wells” Phillips, AJ, Gerlach, R, Cunningham, AB, Spangler, L. Department of Energy, National Energy Technology Laboratory, Storage Capacity & Well Remediation Quarterly Webinar, April 2015, Bozeman MT via Morgantown WV

“Microbially-induced calcite precipitation (MICP) - A technology for managing flow and transport in porous and fractured media” Phillips, AJ, Gerlach, R, Cunningham, AB, Spangler, L. December 2014, American Geophysical Union Fall Meeting, San Francisco, CA

“Wellbore leakage mitigation with microbially-induced CaCO<sub>3</sub> precipitation” Phillips, AJ, Gerlach, R, Hiebert, R, Cunningham, AB, Spangler, L. October 2014, 81st Annual Fall Water School for Water & Wastewater Operators & Managers, Bozeman MT

“Wellbore leakage mitigation using engineered biomineralization” Cunningham, AB, Phillips, AJ, Troyer, E, Lauchnor, E, Hiebert, R, Gerlach, R, Spangler, L. October 7, 2014, The International Conference on Greenhouse Gas Technologies (GHGT-12), Austin TX.

“Field-scale plugging of hydraulic fractures using ureolytic bacteria” Phillips, AJ, Gerlach, R, Cunningham, AB. July 2014, Montana Biofilm Meeting, Bozeman, MT

“Investigation of Microbially Induced Calcite Precipitation for Leakage Mitigation in Underground Gas Storage” Cunningham, AB, Gerlach, R.; Phillips, AJ; Lauchnor, E.; Spangler, L.; Hommel, J. June 09-13, 2014, Computational Methods Water Research Stuttgart, Germany.

“Biofilm-induced calcium carbonate (CaCO<sub>3</sub>) precipitation: application in the subsurface and well cement” Phillips, AJ, Gerlach, R, Cunningham, AB. April 2013, Center for Biofilm Engineering Spring Seminar Series, Bozeman MT

“Controlling permeability reduction in the subsurface through biofilm-induced mineral precipitation: A multi-scale approach” Phillips, AJ, Gerlach, R, Cunningham, AB. July 2013, Montana Biofilm Meeting, Bozeman, MT

“Examination of scCO<sub>2</sub> effects against *Bacillus mojavensis* biofilms” Phillips, AJ, Gerlach, R, Mitchell A, Cunningham, AB. July 2007, Center for Biofilm Engineering Technical Advisory Committee Conference, Bozeman, MT

“High-pressure core testing system for investigating biotic and abiotic issues associated with geologic sequestration of CO<sub>2</sub>” Phillips, AJ, Gerlach, R, Mitchell A, Hanson, L, Cunningham, AB. October 2006, Zero Emissions Research and Technology Fall Seminar Series, Bozeman, MT

“Geologic CO<sub>2</sub> sequestration: Opportunities for biofilm research” Phillips, AJ, Cunningham, AB. November 2006, Center for Biofilm Engineering Fall Seminar Series, Bozeman, MT

Poster Presentations: (underline indicates presenter, #indicates student author)

Morasko, V, Feder, M, Phillips, AJ, Gerlach, R. “Temperature-Dependent Kinetics of Urea Hydrolysis Catalyzed by Jack Bean Meal” Montana State University 125<sup>th</sup> Birthday Celebration Research Symposium, February 16, 2018, Bozeman, MT.

Morasko, V, Feder, M, Phillips, AJ, Gerlach, R. “Temperature-Dependent Kinetics of Urea Hydrolysis Catalyzed by Jack Bean Meal” Montana State University Graduate Student Research Rendezvous, October 19, 2017, Bozeman, MT. Vincent Morasko was awarded second place in the poster presentation competition.

[http://www.montana.edu/gradschool/professionaldevelopment/rendezvous\\_summit/index.html](http://www.montana.edu/gradschool/professionaldevelopment/rendezvous_summit/index.html)

Frieling Z#, Akyel A#, Gerlach R, Phillips, AJ. “Urease Transport and Distribution to Better Understand its Subsurface Behavior”. Montana Biofilm Meeting, July 18, 2017, Bozeman, MT.

Morasko, V#, Feder, M, Phillips, AJ, Gerlach, R. “Temperature-Dependent Kinetics of Urea Hydrolysis Catalyzed by Jack Bean Meal” Montana Biofilm Meeting, July 18, 2017, Bozeman, MT.

Beser, D#, West C#, Daily, R#, Cunningham, A, Gerlach, R, Fick, D, Spangler, L and Phillips, AJ. Assessment of ureolysis induced mineral precipitation material properties compared to oil



and gas well cements. Montana Biofilms Meeting, July 18, 2017, Bozeman, MT. (Awarded Best Poster Presentation)

Beser, D<sup>#</sup>, West C<sup>#</sup>, Daily, R<sup>#</sup>, Cunningham, A, Gerlach, R, Fick, D, Spangler, L and Phillips, AJ. Assessment of ureolysis induced mineral precipitation material properties compared to oil and gas well cements. American Rock Mechanics Association 51st Annual Meeting Proceedings, June 25-28, 2017, San Francisco, CA.

Frieling Z<sup>#</sup>, Akyel A<sup>#</sup>, Gerlach R, Phillips, “Urease Transport and Distribution to Better Understand its Subsurface Behavior”. MSU Student Research Celebration, April 21, 2017 Bozeman, Montana

Park, RM<sup>#</sup>, Meslé, M., Phillips, AJ, Fields, M. “Effect of Coal Particle Size on Microbial Methanogenesis in the Presence of Oxygen”. MSU Student Research Celebration, April 21, 2017 Bozeman, Montana

Park, RM<sup>#</sup>, Meslé, M., Phillips, AJ, Fields, M. “Effect of Coal Particle Size on Microbial Methanogenesis in the Presence of Oxygen”. 31st Annual National Conference on Undergraduate Research, University of Memphis, April 6-8, 2017, Memphis Tennessee

Filanoski, B<sup>#</sup>, Phillips, AJ. “Microbial Induced Calcium Carbonate Precipitation of Coal Combustion Residuals”. 31st Annual National Conference on Undergraduate Research, University of Memphis, April 6-8, 2017, Memphis Tennessee

Norton, D<sup>#</sup>, Gerlach, R, Eldring, J, Thane, A, Hiebert, R, Cunningham, A, Spangler, L, Phillips, AJ “Visualizing and Quantifying Biomineralization in a Wellbore Analog Reactor”. Geologic Society of America Annual Meeting, September 25-28, 2016, Denver, Colorado.

Kirkland, CM<sup>#</sup>, Zanetti, S<sup>#</sup>, Phillips, AJ, Grunewald, E, Walsh, DO, Codd, SL “Detecting Microbially Induced Calcite Precipitation (MICP) in a Model Well-bore Using Downhole Low-field NMR” September 4-8, 2016, 13th International Bologna Conference on Magnetic Resonance in Porous Media, Bologna, Italy

Norton, D<sup>#</sup>, Gerlach, R, Eldring, J, Thane, A, Hiebert, R, Cunningham, A, Spangler, L, Phillips, AJ “Visualizing and Quantifying Biomineralization in a Wellbore Analog Reactor”. Montana State University Research Rendezvous, September 14, 2016, Bozeman, Montana. (2<sup>nd</sup> place in poster presentation competition in the Mathematics, Engineering, and Physics division)

Thane A, Phillips, AJ, Troyer, E<sup>#</sup>, Gallagher, B, Lee Spangler. “Remediation of Coal Combustion Residuals Using Microbially-Induced Calcite Precipitation” July 19, 2016, Montana Biofilm Meeting, Bozeman MT

Kirkland, CM<sup>#</sup>, Zanetti, S<sup>#</sup>, Phillips, AJ, Grunewald, E, Walsh, DO, Codd, SL “Detecting Microbially Induced Calcite Precipitation (MICP) in a Model Well-bore Using Downhole Low-field NMR” July 19, 2016, Montana Biofilm Meeting, Bozeman MT

Norton, D<sup>#</sup>, Gerlach R, Eldring J, Thane A, Hiebert R, Cunningham AB, Spangler L, Phillips, AJ “Visualizing and Quantifying Biomineralization in a Wellbore Analog Reactor” July 19, 2016, Montana Biofilm Meeting, Bozeman MT

Phillips, AJ, Gerlach, R, Cunningham, AB, Troyer, E<sup>#</sup>, West, C<sup>#</sup>, Norton, D<sup>#</sup>, Hiebert, R, Kirksey, J, Rowe, W, Esposito, R, and Spangler, L. “Biom mineralization: a promising method to improve wellbore integrity” July 12-13 2016, Workshop on Natural Gas Storage in Depleted Reservoirs or Aquifers, US DOE National Laboratories, Broomfield, CO (*Invited*)

Filanoski, B<sup>#</sup>, Troyer, E<sup>#</sup>, and Phillips AJ. “Microbial Induced Calcium Carbonate Precipitation of Coal Combustion Residuals” April 2016, Montana State University Undergraduate Research Celebration, Bozeman, MT

Filanoski, B<sup>#</sup>, Troyer, E<sup>#</sup>, and Phillips AJ. “Microbial Induced Calcium Carbonate Precipitation of Coal Combustion Residuals” November 2015, Montana State University McNair Scholars Program Research Celebration, Bozeman, MT

Gerlach, R, Cunningham, A, Phillips, AJ, Hiebert, R, Lauchnor, E, Mitchell, AC and Spangler, L “Biofilm-mediated mineral precipitation technology- from the microscale to the field” October 2015, 7<sup>th</sup> American Society of Microbiology Biofilms Conference, Chicago, IL

Thane, A<sup>#</sup>, Phillips, AJ, Schultz, L., Gerlach, R. July 2015 “Sealing Subsurface Fractures with Biom mineralization in Ludox® Gels” Montana Biofilm Meeting, Bozeman, MT

Coelho, APB<sup>#</sup>, Kirkland, C<sup>#</sup>, Codd, S, Phillips, AJ. July 2015 “A comparison of microbiologically and abiotically induced calcium carbonate precipitation” Montana Biofilm Meeting, Bozeman, MT

Gerlach R, Cunningham AB, Spangler L, Phillips AJ. November 18-19, 2014 “Biofilm-Mediated Mineral Precipitation Technology – from the Microscale to the Field-Scale” Reservoir Microbiology Forum – London

Phillips, AJ, Eldring, J, Lauchnor, E, Gerlach, R, Mitchell, AC, Esposito, R, Cunningham, AB. July 2014, “Applicability of MICP in subsurface and fractured environments” Montana Biofilm Meeting, Bozeman, MT.

Bender, A<sup>#</sup>, Kirkland, C<sup>#</sup>, Phillips, AJ, Hiebert, R, Codd, S. July 2014, “Developing copious biofilm growth in porous media with low-cost nutrient” Montana Biofilm Meeting, Bozeman, MT.

Troyer, E<sup>#</sup>, Lauchnor, E, Phillips, AJ, Gerlach, R. April 2014, “Optimization of media for the hydrolysis of urea and precipitation of calcium carbonate with *S. pasteurii*” Montana State University Student Research Celebration, Bozeman, MT.

Phillips, AJ, Eldring, J, Lauchnor, E, Gerlach, R, Mitchell, AC, Esposito, R, Cunningham, AB. December 2013, (*Invited*) “Applicability of MICP in subsurface and fractured environments” American Geophysical Union Fall Meeting, San Francisco, CA.

Phillips, AJ, Eldring, J, Lauchnor, E, Gerlach, R, Mitchell, AC, Esposito, R, Cunningham, AB. February 2013, “Biofilm-induced calcium carbonate precipitation: Application in the subsurface” Montana Biofilm Meeting, Bozeman, MT.

Phillips, AJ, Eldring, J, Lauchnor, E, Gerlach, R, Mitchell, AC, Esposito, R, Cunningham, AB, Spangler, L. December 2012, “Biofilm-induced calcium carbonate precipitation: Application in the subsurface” American Geophysical Union Fall Meeting, San Francisco, CA.

Gerlach, R, Phillips, AJ, Lauchnor, E, Ebigbo, A, Connolly, J<sup>#</sup>, Mitchell, AC, Helmig, R, Cunningham, AB, Spangler, LH. December 2012, “Improving control of microbially-induced mineral precipitation in flow systems - experiments and modelling” American Geophysical Union Fall Meeting, San Francisco, CA.

Cunningham, AB, Gerlach, R, Phillips, AJ, Eldring, J, Lauchnor, E, Klapper, I, Ebigbo, A, Mitchell, AC, Spangler, LH. December 2012, “The potential of microbial activity to increase the efficacy of geologic carbon capture and storage” American Geophysical Union Fall Meeting, San Francisco, CA.

Lauchnor, E, Phillips, AJ, Cunningham, AB, Gerlach, R. December 2012, “Laboratory-scale column studies to evaluate ureolytically driven CaCO<sub>3</sub> mineralization” American Geophysical Union Fall Meeting, San Francisco, CA.

Phillips, AJ, Eldring, J, Lauchnor, E, Gerlach, R, Mitchell, AC, Esposito, R, Cunningham, AB. July 2012, “Biofilm-induced calcium carbonate precipitation: Application in the subsurface” Montana Biofilm Meeting, Bozeman, MT

Lauchnor, E, Phillips, AJ, Cunningham, AB, Gerlach, R. July 2012, “Laboratory-scale column studies to evaluate ureolytically driven CaCO<sub>3</sub> mineralization” Montana Biofilm Meeting, Bozeman, MT

Gerlach, R, Connolly, J<sup>#</sup>, Ebigbo, A, Klapper, I, Lauchnor, E, Mitchell, AC, Phillips, AJ, Schultz, L, Spangler, LH, Zhang, T, Cunningham, AB. June 2012, “The potential of microbial activity to increase the efficacy of geologic carbon capture and storage” 4th International Conference on Porous Media and its Applications in Science, Engineering and Industry, Potsdam, Germany.

Morris, D<sup>#</sup>, Lauchnor, E, Phillips, AJ, Gerlach, R. April 2012, “Optimization and kinetics of ureolysis by *Sporosarcina pasteurii*” Montana State University Student Research Celebration, Bozeman, MT

Stringam, J<sup>#</sup>, Lauchnor, E, Phillips, AJ, Gerlach, R. April 2012, “Continued development of an injection strategy for homogenous calcium carbonate plugging by *Sporosarcina pasteurii*” Montana State University Student Research Celebration, Bozeman, MT

Gerlach, R, Mitchell, AC, Ebigbo, A, Phillips, AJ, Spangler, L, Cunningham, AB. December 2011, “Potential of microbes to increase CO<sub>2</sub> storage security” American Geophysical Union Fall Meeting, San Francisco, CA.

Ebigbo, A, Helmig, R, Gerlach, R, Cunningham, AB, Phillips, AJ. December 2011, “Modelling microbially induced carbonate precipitation and its influence on CO<sub>2</sub> and water flow in the subsurface” American Geophysical Union Fall Meeting, San Francisco, CA.

Connolly, J<sup>#</sup>, Phillips, AJ, Bugni, S<sup>#</sup>, Gerlach, R. July 2011, “Imaging biofilm and microbially induced CaCO<sub>3</sub> precipitation in 2D porous media reactors” Montana Biofilm Meeting, Bozeman, MT.

Cunningham, AB, Spangler, L., Mitchell AC, Phillips, AJ, Gerlach, R. July 2011, “Controlling well bore leakage of CO<sub>2</sub> using engineered biomineralization barriers” Montana Biofilm Meeting, Bozeman, MT.

Bugni, S<sup>#</sup>, Phillips, AJ, Connolly, J<sup>#</sup>, Gerlach, R, Cunningham, AB. April 2011, “Controlling the distribution of microbially-induced calcium carbonate precipitation in 2-D porous media reactors under pulse-flow conditions” Montana State University Student Research Celebration, Bozeman, MT.

Stringam, J<sup>#</sup>, Phillips, AJ, Gerlach, R, Cunningham, AB. April 2011, “Development of an injection strategy for homogeneous calcium carbonate distribution by *Sporosarcina pasteurii*” Montana State University Student Research Celebration, Bozeman, MT.

Cunningham, AB, Gerlach, R, Spangler, L, Mitchell, AC, Parks, S, Phillips, AJ. September 2010, “Reducing the risk of well bore leakage of CO<sub>2</sub> using engineered biomineralization

barriers” International Conference on Greenhouse Gas Technologies, Amsterdam, The Netherlands.

Mitchell, AC, Phillips, AJ, Hiebert, R, Gerlach, R, Kaszuba, J, Hollis, WK, Cunningham, AB. February 2008, “Biofilm enhanced subsurface sequestration of supercritical CO<sub>2</sub>” Montana State University Molecular Biosciences Program Poster Session, Bozeman, MT.

Mitchell, AC, Phillips, AJ, Hiebert, R, Gerlach, R, Kaszuba, J, Hollis, WK, Cunningham, AB. December 2007, “Biofilm enhanced subsurface sequestration of supercritical CO<sub>2</sub>” American Geophysical Union Fall Meeting, San Francisco, CA.

Cunningham, AB, Gerlach, R, Phillips, AJ, James, G, Hiebert, R, and Spangler, L. July 2007, “Biofilm enhanced geologic sequestration of supercritical CO<sub>2</sub>” Center for Biofilm Engineering Technical Advisory Committee Conference, Bozeman, MT.

Phillips, AJ, Gerlach, R, Hiebert, R, James, G, Spangler, L, Cunningham, AB. March 2007, “Biofilm enhanced geologic sequestration of supercritical CO<sub>2</sub>” 4th ASM Conference on Biofilms, Quebec City, Canada.

Cunningham, AB, Gerlach, R, Phillips, AJ, James, G, Hiebert, R, and Spangler, L. July 2006, “Microbially enhanced geologic sequestration of supercritical CO<sub>2</sub>” Center for Biofilm Engineering Technical Advisory Committee Conference, Bozeman, MT.

## **Research Funding and Proposals**

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### Current Funding

PI: Adrienne Phillips Co-PI: Al Cunningham, Robin Gerlach, Richard Esposito

Project Director: Lee Spangler

Title: *Methods to Enhance Wellbore Cement Integrity with Microbially-Induced Calcite Precipitation (MICP)*

Source of support: Department of Energy DE-FE0024296

Total Award Amount: \$ 2,151,085

Period of Performance: 10/1/2014 – 9/30/2018

Funding Announcement: US Department of Energy 1076 “FY2014 FOA – Environmentally-Prudent Unconventional Resource Development”

PI: Adrienne Phillips Co-PI: Al Cunningham, Robin Gerlach, Project Director: Lee Spangler

Title: *Wellbore Leakage Mitigation using Advanced Mineral Precipitation Strategies*

Source of Support: US Department of Energy (DOE) DE-FE0026513

Total Award Amount: \$2,522,000

Period of Performance: 10/01/2015 – 9/30/2019

Funding Announcement: US DOE FY 2015 DE-FOA-001240 FOA Intelligent Monitoring Systems and Advanced Well Integrity and Mitigation

PI: Matthew Fields Co-PI: Adrienne Phillips, Al Cunningham Project Director: Lee Spangler

Title: *Optimization, Scale-up, and Design of Coal-Dependent Methanogenesis in Preparation for in situ Field Demonstration*

Source of Support: U.S. Department of Energy (DOE) DE-FE0026155

Total Award Amount: \$812,500

Period of Performance: Oct 1, 2015- September 30, 2018

Funding Announcement: US DOE FY 2015 FOA DE-FOA-0001233 Emerging Technologies for Methane Production via Biological In-Situ Coal Conversion and Low Cost Oxygen

Production for gasification, AOI 1: R&D Work Needed to Prepare for Bio-gasification Field Test

PI: Robin Gerlach Co-PI: Adrienne Phillips, Al Cunningham, Collaborators: R. Hiebert (Montana Emergent Technologies)

Title: *Developing Biomineralization Technology for Ensuring Wellbore Integrity.*

Source of Support: DOE-STTR Phase IIB (DE-FOA-0001646).

Requested Award Amount: \$1,000,000 (MSU: \$300,700).

Period of Performance: July 1, 2017 – July 2019

PI: Adrienne Phillips Co-PI: Robin Gerlach, Cat Kirkland, Al Cunningham

Title: *International Collaborative Research: MSU and the University of Stuttgart*

Source of Support: Thorson Excellence in Engineering Research (TEER) Grant

Amount (Requested): \$6,000

Period of Performance: 2018

Submitted and Pending

PI: Adrienne Phillips Co-PI: Robin Gerlach, Al Cunningham, Lee Spangler, Collaborators: Randy Hiebert, Montana Tech

Title: *Permeability control for enhanced oil and gas recovery in unconventional reservoirs using advanced mineral precipitation technologies*

Source of Support: DOE SBIR 2017 SBIR/STTR Phase I Release 1

Amount (Requested): \$150,000 (\$40,000 MSU)

Period of Performance: April 2018- March 2019 (Recommended for Funding)

PI: Adrienne Phillips Co-PI: Al Cunningham, Lee Spangler

Title: *Evaluating Biomineralization as a Method to Reduce Permeability and Grout a Leaking Hydroelectric Dam*

Source of Support: Southern Company

Requested Testing Agreement Amount (Requested): \$30,000

Period of Performance: Pending

PI: Adrienne Phillips Co-PI: Ellen Lauchnor, Al Cunningham, Collaborator: Randy Hiebert

Title: *Biomineral precipitation for dust suppression and contaminant immobilization as an alternative to water use*

Source of Support: DOE SBIR Opportunity DE-FOA-0001771, 2018 SBIR/STTR Phase I Release 2

Amount (Requested): \$150,000 (\$50,000 MSU)

Period of Performance: Pending

PI: Sarah Codd, Co-PI: Catherine Kirkland, Adrienne Phillips

Title: Exploring NMR to Monitor Remediation of Hydrocarbon Contamination in Porous Media

Source of Support: National Science Foundation

Period of Performance: Pending

Amount (Requested): \$309,633

PI: Al Cunningham, Co-PI: Robin Gerlach, Al Cunningham

Title: Biofilm and biomineralization methods development in support of CRC 1313 projects C04 and C05

Source of Support: University of Stuttgart: The Cooperative Research Center 1313

Amount Requested: \$67,901.00

Period of Performance: Pending

Previous Funding

PI: Kevin Hammonds and Adrienne Phillips Co-Investigators: Ed Adams, Dan Miller, Robin Gerlach and Christine Foreman

Title: *Expanding Cryo-materials & Bio-materials Research at Montana State University with the Acquisition of a Cryo-stage for the Zeiss Scanning Electron Microscope*

Source of Support: Thorson Excellence in Engineering Research (TEER) Grant

Amount (Requested): \$25,000

Period of Performance: 2017

PI: Adrienne Phillips Project Director: Lee Spangler

Title: *Coal Combustion Residuals (CCR or Fly Ash) Mineralization*

Source of Support: State of Montana, MT Research and Economic Development Initiative

Total Award Amount: \$159,387

Period of Performance: July 1, 2015- June 30, 2017

PI: Robin Gerlach Co-PI: Adrienne Phillips, Project Director: Lee Spangler

Title: *Expanding the Temperature and Pressure of Well Sealing Mineralization Technologies*

Source of Support: State of Montana, MT Research and Economic Development Initiative

Total Award Amount: \$187,000

Period of Performance: July 1, 2015- June 30, 2017

PIs: Adrienne Phillips, Al Cunningham, Ben Gallager

Title: *Effects of Ureolytic Biomineralization on Fly Ash and Related Materials of Interest to Southern Company*

Source of support: Southern Company

Total Award Amount: \$40,000

Award Period Covered: 7/1/2016- 12/31/2016

PIs: Adrienne Phillips, Al Cunningham, Ben Gallager, Kirk Ellison, Richard Esposito

Title: *Use of MICP for Treatment of Fly Ash Ponds and Flue Gas Desulfurization Waste at Coal-Fired Power Plants*

Source of support: Southern Company

Award Amount and Time Period: \$40,000

Award Period Covered: 7/10/2015 – 12/31/2015

PI: Dr. Al Cunningham Co-PIs: Dr. Robin Gerlach, Richard Esposito

Title: *Field Test & Evaluation of Engineered Biomineralization Technology for Sealing Existing Wells*

Source of Support: US Department of Energy (DOE) FE0009599

Award Amount and Time Period: \$ 1,927,000

Award Period Covered: 10/1/2012 – 9/30/2015

Role: Senior staff- contributed to proposal writing, collected preliminary data, contributed to the design and implementation of the field experiment, prepared manuscript for publication, served as PI for last 3 months of project

PI: Dr. Al Cunningham

Title: *Advanced CO<sub>2</sub> Leakage Mitigation using Engineered Biomineralization Sealing Technologies*

Source of Support: US Department of Energy (DOE) FE0004478

Award Amount: \$ 1,999,374

Award Period Covered: 10/1/2010 – 3/31/2015

Role: Senior staff – contributed to design and implementation of experiments and preparing publications

Other proposals (unfunded)

PI: Adrienne Phillips Co-PI: Sarah Codd  
Title: *NSF MRI: Acquisition of a NMR Rock Core Analyzer*  
Funding Announcement: NSF MRI January 2015  
Amount Requested: \$387,730

PI: Sarah Codd Co-PI: Adrienne Phillips  
Title: *Bioremediation and Biomineralization: Detection of Subsurface Processes with Low-field NMR*  
Funding Announcement: NSF Environmental Engineering October 2016  
Amount Requested: \$294,378

PI: Robin Gerlach Co-PI: Adrienne Phillips, Al Cunningham,  
Title: *In situ Calcium Carbonate Precipitation for Sealing Near Wellbore Fractures and Delaminations*  
Funding Announcement: Carbon Capture Project (CCP-4)

PI: Robin Gerlach Co-PI: Adrienne Phillips, Al Cunningham, Small Business Partner: Montana Emergent Technologies (MET)  
Title: *Developing Biomineralization Technology for Ensuring Well Compliance and Enhancing Oil Recovery*  
Funding Announcement: US Department of Energy Phase 2B STTR April 2016  
Amount Requested: \$305,768

PI: Adrienne Phillips Co-PI: Sarah Codd  
Title: *NSF MRI: Acquisition of a Rock Core Analyzer for energy, water and climate related research*  
Funding Announcement: NSF MRI January 2016  
Amount Requested: \$388,500

**News and Media**

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MSU students and mentors honored with annual Awards for Excellence (Laura Tochko, Adie Phillips)  
<http://www.montana.edu/news/15979/msu-students-and-mentors-honored-with-annual-awards-for-excellence>

MSU team shows biofilm and mineral-producing bacteria have potential for plugging oil and gas leaks  
<http://www.montana.edu/news/16313/msu-team-shows-biofilm-and-mineral-producing-bacteria-have-potential-for-plugging-oil-and-gas-leaks>

MSU's success in closing gender gap in STEM faculty featured in national publication  
<http://www.montana.edu/news/16441/msu-s-success-in-closing-gender-gap-in-stem-faculty-featured-in-national-publication>

Three Minute Thesis event set for March 3 at MSU- Drew Norton a finalist  
<http://www.montana.edu/news/16750/three-minute-thesis-event-set-for-march-3-at-msu>

CBE master's student (Drew Norton) earns Judges Prize at Three-Minute Thesis event  
<http://www.biofilm.montana.edu/news/article.html?id=16768>

MSU students (Rita Park and Brook Filanoski) present projects at national conference that promotes undergraduate research  
<http://www.montana.edu/news/16963/msu-students-present-projects-at-national-conference-that-promotes-undergraduate-research>

CBE undergraduate students present research at National Conferences on Undergraduate Research  
<http://www.biofilm.montana.edu/news/article.html?id=16986>

CBE students presented work at MSU's Research Celebration  
<http://www.biofilm.montana.edu/news/article.html?id=16827>

MSU team goes to the field to advance the well sealing technology  
<http://www.montana.edu/news/17399/msu-field-tests-push-well-sealing-technology-closer-to-commercial-application>

Three minute thesis event to be held March 1, 2018- Vincent Morasko a finalist  
<http://www.montana.edu/news/17485/msu-engineering-students-to-present-research-in-three-minutes-each>

### **Student Research Mentoring**

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Mentored undergraduate and graduate students in experimental design, reactor design and construction, laboratory techniques, method development, laboratory safety, and preparation of posters, reports, and manuscripts.

#### Undergraduate

Anna Martinson: October 2017-Present (USP Spring 2018)

Paige Tunby: October 2017- Present

Bjorn Worum: January 2017-present

Michael Steven Jones: October 2016-May 2017

Rita Park: February 2016- present (Undergraduate Scholars Program Scholarship USP 2016, 2017 Presenting Poster April 2017 NCUR Conference, Memphis, TN, Presenting Oral April 2018 NCUR Conference, Oklahoma City, OK)

Lexi Delridge: February 2016- August 2016

Vinny Morasko: February 2016- September 2016

Dicle Beser: August 2015- September 2016

Colleen McFarland: June 2015- December 2015

Ana Paulo Coehlo: April 2015- August 2015 (Summer Research Experience)

Brooke Filanoski: January 2015- December 2015 (McNair Scholar)

Abby Thane: October 2014- December 2015

Cody West: September 2014- May 2016

Eric Troyer: March 2013- December 2015 (Undergraduate Scholars Program (USP) Scholarship Recipient 2013, 2014)

Joshua Stringam: August 2010- August 2012 (Undergraduate Scholars Program (USP) Scholarship Recipient 2011, 2012)

John Barnick: January 2012- May 2012

Dayla Morris Topp: January 2011-October 2011 (USP Scholarship Recipient 2011)

Ty Gittins: July 2010- August 2010



Heidi Cicon: October 2005- May 2006  
David Stepler: October 2005- May 2006  
Adrianna Northcutt: March 2005- August 2005

Master's candidates

Zach Frieling: September 2017-present  
Ryenne Daily: January 2017- present  
Dicle Beser: September 2016- present  
Viny Morasko: September 2016- present (3MT finalist 2018)  
Kyle Deverna: July 2016-present  
Randall Casburn: November 2015-November 2016  
Arda Akyel: August 2015- present  
Sam Zanetti: August 2015- December 2015 (internship)  
Drew Norton: Jan 2015- July 2017 (Three Minute Thesis Winner March 2017)  
Steve Bugni: July 2010- May 2011  
Laura Wheeler: May 2007- December 2007  
Stacy Parks: December 2006- December 2007

Post-Doctoral Scholar

Marnie Feder: October 2015- January 2017  
Margaux Mesle: November 2015- present  
Catherine Kirkland: September 2017- present

Research Associates (Post Baccalaureate)

Ryenne Daily: June 2016-January 2017  
Abby Thane: January 2016- present  
Eric Troyer: December 2015- June 2016 (NSF GRFP 2016 Fellow)  
Logan Hodgkiss: September 2015- April 2016  
Laura Dobeck: July 2015- present  
Adam Rothman: December 2013- September 2015

## **Synergistic Professional and Research Activities**

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### **Professional Society Member:**

American Geophysical Union (2012-present)  
Air & Waste Management Association (2013-present)  
American Rock Mechanics Association (2015-present)  
International Society for Porous Media (2018-present)

**Journal Peer Review Activity:** Reviewed (or co-reviewed) manuscripts for (by date and number of papers):

*Environmental Science and Technology* (2012(1), 2013(1), 2014(2)),  
*Advances in Water Research* (2013(1)),  
*Biochemical Engineering Journal* (2013(1)),  
*Biofouling* (2013(1)),  
*ARMA Conference Proceedings* (2015(5)),

*Frontiers in Microbiology (2015(1)),*  
*Applied Soil Ecology (2015(1)),*  
*Environmental Technology (2015(1)),*  
*International Journal of Greenhouse Gas Control (2015(1)),*  
*Water Resources Research (2016(2))*  
*Geomicrobiology (2016(1))*  
*Energy and Fuels (2016(1))*  
*Geomicrobiology (2017(1))*  
*Water and Environment Journal (2017(1))*  
*Environmental Science and Technology (2017(1))*  
*Engineering in Life Sciences (2018(1))*

Engineer in Training: Montana #17593 (expired)

### **Service**

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1. 2011- 2015, served on the Center for Biofilm Engineering Operations Committee devoted to laboratory safety & operations decisions
2. December 2013, served on panel to assess MSU Senior Civil Engineering Design projects & proposals
3. February 2014, 2015, 2016, 2017, 2018 served as day volunteer guest project judge for the First Lego League Competition
4. Served as a community mentor for an engineering student (Oussama Trabelsi, Tunisia 2014) during the summer Middle Eastern Partnership Initiative Programs
5. Provided lab tour to 5 international engineering students for the 2014 MEPI program June 2014
6. Provided lab tour to 10 middle school students as part of the “Montana Science Olympiad”- November 2014
7. Provided lab tour to 2 visiting international researchers from Japan’s National Institute of Material Science (NIMS)- December 2, 2014
8. Serve as a reviewer for the MSU Undergraduate Scholars Program- September 2014, January 2015, March 2015, September 2015, September 2016, January 2017, March 2017, September 2017, December 2017, March 2018
9. Provided lab tour to ~40 high school students for the February 2015 Shadow an Engineer Day to promote students toward choosing STEM fields of study
10. Serve as Chair for the American Rock Mechanics Association 49<sup>th</sup> Annual Conference for the session “Thermal, Hydrological, Mechanical, Chemical and Biological Influences upon Rock” March 2015-June 2015 (review conference papers, lead session)
11. Served on panel discussion to help COE PhD students know what to expect and how to prepare for their comprehensive exams (4/3/15)
12. Served as a reviewer of a proposal submitted May 2015 to the NSF Geotechnical Engineering and Materials Division
13. Mentor 3 female undergraduate engineering students on laboratory demonstration project for July 8, 2015 faculty daughters exposure to engineering day.
14. Provided lab tour to 4 international engineering students for the 2015 MEPI program June 2015
15. Served as a community mentor for an engineering student (Ruba Qadi, West Bank Gaza, Summer 2015) during the summer Middle Eastern Partnership Initiative Program
16. Guided Montana’s Lt. Governor, Angela Mclean on a lab tour, November 16, 2015

17. Served on Civil Engineering Faculty Search Committee September 2015- February 2016.
18. Provided lab tour to ~25 high school students for the February 2016 Shadow an Engineer Day to promote students toward choosing STEM fields of study
19. Served as a community mentor for an engineering student (Maysa Alfrihiri, Libya, Summer 2016) during the summer Middle Eastern Partnership Initiative Program
20. Served as a facilitator (advise other faculty on the specifics of applying for DOE grants) at the Grant Writing Bootcamp September 21, 2016
21. Served as an NSF Engineering Research Center Site Team Visit Reviewer October 25-27, 2016
22. Provided laboratory tour and discussed energy related MSU research to Ryan Zinke and Steve Daines November 4, 2016
23. Organized graduate student Q&A session with Dr. Donna Riley March 6, 2017
24. Organized and led “Intro to Civil Engineering” demo day for 90 third graders from Morningstar School April 20, 2017
25. Chaired oral session for an invited speaker session at the 9<sup>th</sup> International Conference on Porous Media May 8-12, 2017 Rotterdam, Netherlands
26. Chaired poster session “Characterization of Interfaces and Pore-Scale Processes Influencing Properties of Porous Media American Geophysical Union December 2017, New Orleans, LA
27. Organized and chaired session “Biofilms in Porous Media” and co-organized and co-chaired session “Biochemical mineral precipitation for subsurface applications” for the 10<sup>th</sup> International Conference on Porous Media May 14-17, 2018, New Orleans, LA.

### **Technical Skills**

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R&D reactor design and operation (including those related to biofilm, environmental engineering, and high pressure)

Up-scaling laboratory methods to pilot and field scale

Microbiology methods and techniques (for example: microscopy, aseptic technique, enrichment)

Analytical methods: Colorimetric: assay use and method development

Chromatography: use and method development (IC, HPLC, GC)

Laboratory management (inventory control, equipment maintenance)

Sampling and field methods (soil, water, and air quality related sampling)

Multi-media permitting and regulatory review with compliance support

Client relations and marketing engineering consulting services

Large collaborative proposal preparation and project management

### **Faculty Development**

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Attended workshops, seminars and lectures to develop teaching, proposal writing and research skills:

1. 2/6/14 “Finding Funding: Databases, Strategies, and Techniques” ADVANCE Project TRACS
2. 6/17/14 “Supervisor Safety Training” Montana State University Safety and Risk Management
3. 9/25/14 “Overview of teaching and learning resources at MSU” Center for Faculty Excellence
4. 10/8/14 “How to become a more effective speaker” offered by the Center for Biofilm Engineering Communications Director
5. 10/6/14 “Faculty advising at MSU” Center for Faculty Excellence
6. 10/7/14 “Strategic directions for MSU research” Vice President for Research: Center for Faculty Excellence, ADVANCE Project TRACS, Faculty Senate
7. 10/15/14 “Navigating New Media (promoting research through tools such as Twitter, Facebook)” Center for Faculty Excellence
8. 10/16/14 “Principal Investigator Training” Office of Sponsored Programs

9. 11/12/14 “Active Learning about Active Learning” Center for Faculty Excellence
10. 11/21/14 “Finding and Securing Funding Through Foundations” ADVANCE, Center for Faculty Excellence and Office of Sponsored Programs
11. 1/15/15 “Q&A Panel with Distinguished Women in STEM” ADVANCE Project TRACs
12. 1/15/15 “Harvard General Education Forum” Center for Faculty Excellence
13. 1/30/15 “NSF Career Grant Workshop” ADVANCE Project TRACs
14. 2/3/15 “Q&A with Karlene Hoo” ADVANCE Project TRACs
15. 2/13/15 “Ins and Outs of Faculty Start-up Packages” Center for Faculty Excellence
16. 2/19/15 Annual Women In Engineering Dinner, College of Engineering
17. 3/2/15 “Professional Cultures, Bias, and Inequality in STEM” Panel Discussion, College of Engineering
18. 3/25/15 “Publish and Flourish-For those already in Writing Groups” by Tara Grey Center for Faculty Excellence
19. 3/30/15 “Developing Excellence in Academic Leadership (DEAL): Leadership Nuggets from the Harvard MDP Program” Center for Faculty Excellence
20. 4/8/15 “Introduction to Resources for MSU Research Grant Writers”, Center for Faculty Excellence and ADVANCE Project TRACs
21. 4/21/15 “Advising Trends at MSU: Introducing the New CatCourse Scheduler and Views from the Latest Survey” Academic Advising Center, The Office of the Provost, and Center for Faculty Excellence
22. 4/23/15 ACIREMA: “Understanding the Experience of International Students at MSU” Training workshop, Office of International Programs
23. 8/25/15 ADVANCE/HR: “Search Committee HR Equity Training”
24. 9/1/15 ADVANCE: Snacks with Tracs Women in STEM Luncheon
25. 9/15/15 H<sub>2</sub>S, “Sour Gas Safety Training” with Scott Rogers with Environmental Solutions
26. 9/23/15 “Maximizing Meetings: Learn to Have Impactful Conversations with Students”, The Academic Advising Center, The Office of the Provost, and The Center for Faculty Excellence
27. 10/6/15 “Advising Graduate Students”, Center for Faculty Excellence
28. 10/27/15: “Teaching with Technology”, Center for Faculty Excellence
29. 11/16/15: NSF Program Managers: Structure and Funding Opportunities, College of Engineering
30. 11/18/15: “Learning Round Tables: Hot Topics in Teaching and Learning at MSU”, Center for Faculty Excellence
31. 2/19/16: “Balancing Service with your faculty position”, ADVANCE TRACS
32. 2/25/16: Women in Engineering Annual Dinner, College of Engineering
33. 2/26/16: Women in Science Empowerment Lunch, ADVANCE TRACS
34. 3/7/2016: “Using DegreeWorks Plans for Effective Advising”, Center for Faculty Excellence and Office of the Registrar
35. 3/8/2016: “Difficult Knowledge, Controversial Material”: Approaches to Teaching, Center for Faculty Excellence
36. 3/29/2016 “Transitioning to Online Teaching: Learn What it Takes from a Panel of Successful Online Instructors” Center for Faculty Excellence
37. 4/6/2016 “Better Science through Storytelling” Center for Faculty Excellence
38. 4/22/2016 Attended 21st Annual Society of Petroleum Engineers Symposium at Montana Tech, Butte Montana
39. 7/12/2016 Attended the DOE Workshop: Workshop on Storage Integrity for Natural Gas Storage in Broomfield Colorado
40. 9/12/16 COE Assistant Professor Forum: Department Head Panel: “Tips for success in P&T”, College of Engineering
41. 9/14/16 “Active Learning -Faculty Learning” Center for Faculty Excellence
42. 9/19/16 “Classroom Management Tips for maintaining a positive learning environment” Center for Faculty Excellence

43. 9/22/16 “Communicating your science” ADVANCE TRACS
44. 10/11/16 “Teaching with Technology Fair” Center for Faculty Excellence
45. 10/17/16 COE Assistant Professor Forum: Successful and Distinguished COE Professors Panel Discussion: “Establishing a Nationally Recognized Research Program”, College of Engineering
46. 10/18/16 “Core 2.0 - How to advise to enhance students' educational options” Center for Faculty Excellence
47. 11/4/16 “Teaching & Learning - Terry Doyle” Center for Faculty Excellence
48. 11/11/16 “Broader Impacts for your Grant Proposal” Center for Faculty Excellence
49. 11/14/16 COE Assistant Professor Forum: Panel discussion: “Teaching Innovations and general classroom tips”, College of Engineering
50. 11/30/16 “Learning Round Table -Creating Magic in the Classroom” Center for Faculty Excellence
51. 01/30/17 COE Assistant Professor Forum: Dean Topic: “Importance of Diversity and Inclusiveness in the COE”, College of Engineering
52. 2/2/17 “Effective Presentations” Center for Faculty Excellence
53. 2/2/17 “Diversity Summit” Office of the President
54. 2/23/17 Women in Engineering Annual Dinner, College of Engineering
55. 02/27/17 COE Assistant Professor Forum: Faculty known for their excellence in student mentoring Topic: “Tips for helping mentor students”, College of Engineering
56. 4/19/2017 “How Faculty can use Social Media to their Advantage Training” Center for Faculty Excellence
57. 4/21/2017 Attended 22st Annual Society of Petroleum Engineers Symposium at Montana Tech, Butte, Montana
58. 4/27/2017 CFE End of Year Celebration- Earned Certificate of Teaching Enhancement
59. 5/8/2017 Attended the 9<sup>th</sup> International Conference on Porous Media
60. 8/1/2017 Safe Zone Training Module 1 Montana State University
61. 8/14-16/2107 Attended the DOE Mastering the Subsurface through Science and Innovation Conference
62. 9/12/17 Teaching with Technology Fair, Center for Faculty Excellence
63. 10/13/17 Establishing the “Write” Habit, Center for Faculty Excellence
64. 11/3/17 Improving the epistemological beliefs of non STEM majors toward science, Center for Faculty Excellence
65. 12/11-14/2017 Attended the American Geophysical Union Conference
66. 1/11/18 Women in STEM Learning Community Lunch
67. 2/7/18 Women in STEM Learning Community Lunch
68. 2/8/18 Charting a Course in Learning Outcomes, Center for Faculty Excellence
69. 2/13/18 Academic Advisor workshop training, Center for Faculty Excellence, Office of Student Success
70. 2/15/18 Women in Engineering Annual Dinner, College of Engineering
71. 2/23/18 Active Learning Basics, Center for Faculty Excellence