

ANNA L. HERRING, PhD

ARC Discovery Early Career Research Fellow

Department of Applied Mathematics
Research School of Physics
The Australian National University
Garran Road, Building 58
Canberra ACT 2601, Australia

anna.herring@anu.edu.au

ORCID: orcid.org/0000-0002-9403-9779

EDUCATION

- Ph.D. Environmental Engineering, Oregon State University** 2015
Dissertation: An Investigation into the Pore-Scale Mechanisms of Capillary Trapping:
Application to Geologic CO₂ Sequestration
GPA: 3.95/4.00
- M.S. Environmental Engineering, Oregon State University** 2012
Thesis: Saturation, morphology, and topology of nonwetting phase fluid in Bentheimer
sandstone; application to geologic sequestration of supercritical CO₂
GPA: 3.97/4.00
- B.S. Environmental Engineering, University of Colorado at Boulder** 2010
GPA: 3.97/4.00

WORK EXPERIENCE

- The Australian National University – Canberra, Australia** May 2015-Present
Postdoctoral Research Associate & Discovery Early Career Research Fellow
Design and implement experimental system for multiphase flow experiments integrating flow
rate control, pressure and temperature measurement, and x-ray data acquisition; utilize novel
characterization methods to describe the physics and structure of fluid flows and porous media;
supervise post-graduate student research projects
- Oregon State University – Corvallis OR, USA** Aug 10-Dec 2014
Graduate Research Assistant
Design and build high-pressure experimental system for supercritical CO₂ flow experiments;
conduct multi-phase flow experiments in order to characterize flow regimes and capillary
trapping mechanisms in geologic systems; utilize computed x-ray microtomography and 3-D
imaging techniques to visualize fluid distribution inside sandstone samples
- Geomega Environmental Consulting, Inc. – Boulder CO, USA** May 07-Aug 10
Technical Intern
Technical support; implement chemical forensics tools to identify contaminant sources;
characterize natural attenuation capacity of contaminated sites and transport of contaminants
- University of Colorado at Boulder– Boulder CO, USA** Aug 08-May 09
Undergraduate Research Assistant
Aid in characterization of metal sorption and transport via iron oxyhydroxide colloids in acid
mine drainage-affected environments; perform laboratory synthesis of amorphous iron
oxyhydroxides

GRANTS AND FELLOWSHIPS

CI for ARC Training Centre for Multiscale 3D Imaging, Modelling and Manufacturing	2019
ARC Discovery Early Career Research Award: "How does geochemical alteration impact CO ₂ stability in the subsurface?", AUD \$367,446	2018-2021
OSU Perry Swanson Memorial Fellowship, \$2500	2012- 2013
NSF East Asia and Pacific Summer Institute, \$5000	2012
Australian Academy of Science East Asia and Pacific Summer Institute, \$3200	2012
OSU Subsurface Biosphere Initiative Fellowship, \$5000	2010-2011

HONORS

Oregon State University Outstanding Graduate Student in Chemical Engineering	2015
University of Colorado Engineering Dean's List	2006- 2010
Tau Beta Pi Engineering Honors Society	2009-Present

CERTIFICATIONS

NCEES Engineer in Training	2010
40-Hour OSHA HAZWOPER Certification	2009

HIGHER DEGREE RESEARCH STUDENT SUPERVISION

Ongoing

Primary Supervisor: Huang, R. Master of Philosophy Research Thesis: *Using 3D Tomography to Understand Fluid-Fluid Interface Evolution in Porous Media for Carbon Sequestration Applications*. The Australian National University.

Completed Projects

Primary Supervisor: Huang, R. Bachelor of Science Honours Research Thesis: *Imaging Fluid Configuration in Porous Media*. The Australian National University, 2019.

Primary Supervisor: Kemis, A. Bachelor of Engineering Honours Research Thesis: *Characterisation of Mechanical Properties and Mineralisation of Reactive Magnesia Concrete*. The Australian National University, 2019.

Primary Supervisor: Mahdini, F. Bachelor of Engineering Honours Research Thesis: *4D Structural Characterization of Carbon-Sequestering Cements*. The Australian National University, 2019.

Primary Supervisor: Butz, I. Master of Science Research Thesis: *Growing Plants in Space: Manipulating Medium Wettability to Create Optimal Saturation Conditions*. MS Thesis. ETH Zurich and the Australian National University, 2018.

Primary Supervisor: Gilby, F. J. Bachelor of Science Honours Research Thesis: *Quantitative Characterisation of Flow Regimes in Three-Dimensional Porous Media*. The Australian National University, 2016.

F.J. Gilby was awarded First Class Honours for her research project.

Assistant Supervisor: Fobi, S. Honors Baccalaureate of Science Thesis: *Viscous Effects of Wetting and Non-Wetting Fluids on Capillary Trapping Mechanism: A Climate Change Mitigation Strategy*. Oregon State University, 2012.

TEACHING

Guest lecturer, PHYS 2205: Physics for Future Leaders.	2018, 2019, 2020
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SERVICE ACTIVITIES

Participation in University Committees

ANU Energy Change Institute - Carbon Capture and Storage Research Cluster	2017 – present
ANU Climate Change Institute - Negative Emissions working group	2017 – present
ANU-UNSW Oil & Gas Consortium	2015 – present
Applied Mathematics Fluid Flow in Porous Media journal discussion group	2015 – present

Editor for Peer-Reviewed Journals

Guest Associate Editor for *Frontiers in Water: Water and Critical Zone*, Special Topic "Pore-scale Microstructure, Mechanisms, and Models for Subsurface Flow and Transport"

Professional Associations

American Geophysical Union, Australian Microscopy and Microanalysis Society, International Association of Computed Tomography, International Society for Porous Media

Conference Organization

Local Organizing Committee for the International Conference on Tomography of Materials & Structures 2019; Cairns, Australia; 22-26 July 2019

Local Organizing Committee for the Elizabeth and Frederick White Conference 2018: *Frontiers in Gas-Solid Processes from the Atomic Scale to the Parsec*; Canberra, ACT, Australia; 5 – 7 Sept 2018

Convened Sessions at Conferences

AGU 2017- H111: Persistent Problems in Multiphase Flow and Transport in Porous Media: From Pore- to Continuum-Scale

Referee in Peer-Reviewed Journals

Geophysical Review Letters, *Journal of Colloid and Interface Science*, *Vadose Zone Journal*, *Advances in Water Resources*, *Environmental Science & Technology*, *Hydrology Research*, *International Journal of Greenhouse Gas Control*, *Transport in Porous Media*, *Water Resources Research*, *Special Topics & Reviews in Porous Media - An International Journal*, *Journal of Petroleum Science and Engineering*, *Journal of Visualized Experiments*, *Fuel*

Referee for Australian Research Council Grants

Schemes: Discovery Project; Discover Early Career Researcher Award, Linkage Infrastructure, Equipment and Facilities

FULL LIST OF RESEARCH OUTPUTS

Invited Seminars and Presentations

Herring, A. L. "CO₂ and brine flows in heterogeneous geologic systems" **Invited Keynote** presented at the State of Energy Research Conference, Canberra, Australia; 2019.

Herring, A. L. "Breaking the Black Box: Using 3D Imaging to Understand and Optimize Multiphase Fluid Transport in Porous Materials", **Invited Seminar** presented to the Peter Cook Centre for CCS research, Melbourne, Australia; 2019.

Herring, A.L. "Pore-scale fluid topology and nonwetting phase capillary trapping" **Invited talk** presented at the 2014 Gordon Research Seminar on Flow & Transport in Permeable Media; Lewiston, ME; 2014

Peer-Reviewed Publications

Impact factors are sourced from the Thompson Reuters 2016 JCR (5 year impact factors)
Citation numbers from Google Scholar as of 13 Sept 2019

C. Sun, J.E. McClure, P. Mostaghimi, **A.L. Herring**, D.E. Meisenheimer, D. Wildenschild, S. Berg, R.T. Armstrong. "Characterization of wetting using topological principles", *J. Colloid Interface Sci.* (2020).

Sun, C., J.E. McClure, P. Mostaghimi, **A.L. Herring**, S. Berg, R.T. Armstrong. "Probing Effective Wetting in Subsurface Systems", *Geophys. Res. Lett.* (2020).

Sun, C., J. E. McClure, P. Mostaghimi, **A. L. Herring**, M. Shabaninejad, S. Berg, and R. T. Armstrong. "Linking continuum-scale state of wetting to pore-scale contact angles in porous media", *J. Colloid and Interface Science* (2019).

Impact Factor: 6.361

Butz, I., and **Herring, A.** "Growing Plants in Space: Manipulating Medium Wettability to Create Different Saturation Conditions", *Transp. Porous Media* (2019).

Impact Factor: 1.997

Øren, P. E., Ruspini, L. C., Saadatfar, M., Sok, R. M., Knackstedt, M., and **Herring, A.**, "In-situ pore-scale imaging and image-based modelling of capillary trapping for geological storage of CO₂", *Int. J. Greenh. Gas Control* (2019).

Impact Factor: 4.397

Citations: 2

Herring, A. L., Robins, V., & Sheppard, A. P. "Topological Persistence for Relating Microstructure and Capillary Fluid Trapping in Sandstones", *Water Resources Research* (2018).

Impact Factor: 4.397

Citations: 1

Andersson, L., **Herring, A. L.**, Schlüter, S., & Wildenschild, D. "Defining a novel pore-body to pore-throat 'Morphological Aspect Ratio' that scales with residual non-wetting phase capillary trapping in porous media", *Advances in Water Resources* (2018).

Impact Factor: 4.072

Citations: 2

Herring, A. L., F. J. Gilby, Z. Li, J. E. McClure, M. Turner, J. P. Veldkamp, L. Beeching, and A. Sheppard. "Observations of nonwetting phase snap-off during drainage", *Advances in Water Resources* (2018).

Impact Factor: 4.072

Citations: 7

Herring, A. L., Middleton, J., Walsh, R., Kingston, A., & Sheppard, A. "Flow Rate Impacts on Capillary Pressure and Interface Curvature of Connected and Disconnected Fluid Phases during Multiphase Flow in Sandstone", *Advances in Water Resources* (2017).

Impact Factor: 4.072

Citations: 14

Liu, Z., **Herring, A. L.**, Arns, C., Berg, S., & Armstrong, R. T. Pore-Scale Characterization of Two-Phase Flow Using Integral Geometry, *Transp. Porous Media* (2017)

Impact Factor: 2.205

Citations: 30

Herring, A. L., Andersson, L., & Wildenschild, D. "Enhancing residual trapping of supercritical CO₂ via cyclic injections." *Geophysical Research Letters* (2016)

Impact Factor: 4.520

Citations: 24

Herring, A. L., Sheppard, A., Andersson, L., & Wildenschild, D. "Impact of wettability alteration on nonwetting phase transport and trapping." *International Journal of Greenhouse Gas Control* (2016)

Impact Factor: 4.764

Citations: 37

Herring, A. L., Andersson, L., Schlüter, S., Sheppard, A., & Wildenschild, D. "Efficiently engineering pore-scale processes: force balance and topology during nonwetting phase trapping in porous media." *Advances in Water Resources*. (2015)

Impact Factor: 4.072

Citations: 49

Harper, E. J., **Herring, A.L.**, Armstrong, R.T., Lunati, I., Bay, B.K., Wildenschild, D. "Experimental characterization of nonwetting phase trapping and implications for geologic CO₂ sequestration." *International Journal of Greenhouse Gas Control* (2015)

Impact Factor: 4.764

Citations: 24

Note: A.L. Herring is the corresponding author for this publication

Herring, A. L., Andersson, L., Newell, D., Carey, J.W., & Wildenschild, D. "Pore-scale observations of supercritical CO₂ drainage in Bentheimer sandstone by Synchrotron x-ray imaging." *International Journal of Greenhouse Gas Control* (2014)

Impact Factor: 4.764

Citations: 37

Herring, A. L., Harper, E. J., Andersson, L., Sheppard, A., Bay, B. K., & Wildenschild, D. "Effect of fluid topology on residual nonwetting phase trapping: implications for geologic CO₂ sequestration." *Advances in Water Resources*. (2013)

Impact Factor: 4.072

Citations: 115

Refereed Conference Papers

Herring, A. L., D. Wildenschild, L. Andersson, V. Robins, and A. Sheppard (2018), "The impact of cyclic injection cycles on capillary trapping: comparison of ambient and reservoir condition experiments", 14th International Conference on Greenhouse Gas Control Technologies, GHGT-14, Melbourne, Australia.

Herring, A. L., V. Robins, M. Saadatfar, B. Young, M. Knackstedt, and A. Sheppard (2018), "Topological Persistence of Heterogeneous Sandstone", International Symposium of the Society of Core Analysts, Trondheim, Norway.

Myers, G., Varslot, T., Kingston, A., **Herring, A.**, & Sheppard, A. "Ground-truth verification of dynamic x-ray micro-tomography images of fluid displacement." *SPIE Optical Engineering Applications*. (2012): 85060P-85060P. Citations: 5

Wildenschild, D., Armstrong, R. T., **Herring, A. L.**, Young, I. M., & William Carey, J. "Exploring capillary trapping efficiency as a function of interfacial tension, viscosity, and flow rate." *Energy Procedia*. 4. (2011): 4945-4952. Citations: 58

Scientific Book Chapters

Dalby, K. N. et al. (2018), "Analytical Techniques for Probing Small-Scale Layers that Preserve Information on Gas-Solid Interactions", in *Reviews in Mineralogy & Geochemistry*, Mineralogical Society of America. Citations: 6

Palm, A. B. et al. (2018), "Unravelling the Consequences of SO₂-Basalt Reactions for Geochemical Fractionation and Mineral Formation", in *Reviews in Mineralogy & Geochemistry*, Mineralogical Society of America. Citations: 11

Graduate Research Documents

Herring, A.L. *An Investigation into the Pore-Scale Mechanisms of Capillary Trapping: Application to Geologic CO₂ Sequestration*. Doctoral Dissertation. Oregon State University, 2015.

Herring, A.L. *Saturation, Morphology, and Topology of Nonwetting Phase Fluid in Bentheimer Sandstone; Application to Geologic Sequestration of Supercritical CO₂*. MS Thesis. Oregon State University, 2012.

Oral Presentations

Only personal presentations included

Herring A. L. "4D Structural and Chemical Characterization of Reactive Magnesium Cement-Based Concrete" Talk presented at the International Conference on Tomography of Materials & Structures 2019; Cairns, Australia; 2019.

Herring A. L. "Persistent Homology to Describe Multiphase Flow" Talk presented at the International Conference on Tomography of Materials & Structures 2019; Cairns, Australia; 2019.

Herring, A. L., V. Robins, M. Saadatfar, and A. Sheppard, "Persistent Homology to Describe Multiphase Fluid Flow", Talk presented at the Second Biennial Meeting of Australian Chapter of InterPore, Melbourne, Australia; 2018.

Herring, A. L., D. Wildenschild, L. Andersson, V. Robins, and A. Sheppard, "The impact of cyclic injection cycles on capillary trapping: comparison of ambient and reservoir condition experiments", Talk presented at the 14th International Conference on Greenhouse Gas Control Technologies, GHGT-14, Melbourne, Australia; 2018.

Herring, A. L., Robins, V., Andersson, L., Wildenschild, D., & Sheppard, A. "Using 3D imaging to investigate CO₂-solid interactions during cyclic injections in sandstone," Talk presented at the 2018 Elizabeth and Frederick White Conference; Canberra, ACT, Australia; 2018

Herring, A. L., Schlüter, S., Andersson, L., & Sheppard, A. "3D connectivity metrics to describe multiphase fluid flow characteristics and porous medium structure," Talk presented at the 2016 Interpore Conference; Cincinnati, OH, USA; 2016

Herring, A. L., Andersson, L., & Wildenschild, D. "Pore-scale Evolution of Supercritical CO₂ within Bentheimer Sandstone during Multiple Drainage-Imbibition Cycles," Talk presented at the 2012 American Geophysical Union Fall Meeting; San Francisco, CA; 2014

Herring, A.L., Wildenschild, D., Andersson, L., Harper, E., Sheppard, A., & Carey, J.W. "Morphology and topology of nonwetting phase fluid in Bentheimer sandstone; application to geologic sequestration of supercritical CO₂," Talk presented at the 2012 American Geophysical Union Fall Meeting; San Francisco, CA; 2012

Poster Presentations

Only first-author presentations included

Herring, A. L., V. Robins, M. Saadatfar, B. Young, M. Knackstedt, and Sheppard, A. "Topological Persistence of Heterogeneous Sandstone", Poster and paper presented at International Symposium of the Society of Core Analysts; Trondheim, Norway; 2018

Herring, A. L., V. Robins, and Sheppard, A. "Persistent Homology to Describe Multiphase Flow", Poster presented at 2018 Gordon Research Seminar on Flow & Transport in Permeable Media; Newry, ME; 2018

Herring, A.L., Robins, V., Liu, Z., Armstrong, R., & Sheppard, A. "Persistent Homology to describe Solid and Fluid Structures during Multiphase Flow," Poster presented at the 2015 American Geophysical Union Fall Meeting; New Orleans, LA; 2017

Herring, A. L., Middleton, J., & Sheppard, A. "Curvature of Connected and Disconnected Fluid Ganglia during Two Phase Fluid Flow," Poster presented at the 2016 Gordon Research Seminar on Flow & Transport in Permeable Media; Girona, Spain; 2016

Herring, A.L., Andersson, L., Sheppard, A., Kimbrel, E.H., & Wildenschild, D. "Pore-scale Evaluation of Immiscible Fluid Characteristics and Displacements: Comparison Between Ambient- and Supercritical-Condition Experimental Studies," Poster presented at the 2015 American Geophysical Union Fall Meeting; San Francisco, CA; 2015

Herring, A. L., Andersson, L., Schlüter, S., & Wildenschild, D. "Impact of pore scale force balance and fluid connectivity during nonwetting phase trapping" Poster presented at the 2014 Gordon Research Conference on Flow & Transport in Permeable Media; Lewiston, ME; 2014

Herring, A. L., Andersson, L., Newell, D., Carey, J.W., & Wildenschild, D. "High Resolution X-ray CMT Imaging of Supercritical CO₂ in Porous Media: Experimental Challenges, Solutions, and Results," Poster presented at the 2013 American Geophysical Union Fall Meeting; San Francisco, CA; 2013

Herring, A.L., Harper, E.J., Andersson, L., Sheppard, A., Bay, B.K., & Wildenschild, D. "Effect of fluid topology on residual nonwetting phase trapping: implications for geologic CO₂ sequestration," Poster presented at the 2013 Interpore Conference; Prague, Czech Republic; 2013

Herring, A. L., Wildenschild, D., Harper, E.J., Armstrong, R.T., & Carey, J.W. "Quantifying the effects of fluid properties and flow rates on the effectiveness of capillary trapping of CO₂ in a Bentheimer sandstone," Poster presented at the 2011 American Geophysical Union Fall Meeting; San Francisco, CA; 2011

Herring, A. L., Wildenschild, D., Armstrong, R.T., Carey, J.W., & Young, I.M. "Exploring the effect of interfacial tension, viscosity, and flow rate on the effectiveness of capillary trapping of CO₂," Poster presented at the 2010 American Geophysical Union Fall Meeting; San Francisco, CA; 2010