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Michael H. Gardner

Research Interests

Rock Mechanics ◆ Slope Stability ◆ Fluid-Solid Interaction ◆ Natural Hazards ◆ Open Source Software ◆ High Performance Computing ◆ Multiscale Simulations ◆ Discrete Element Method ◆ Lattice Boltzmann Method ◆ Uncertainty Quantification ◆ Remote Sensing

Academic Positions

2020 – present **Assistant Professor**, *Department of Geological Sciences and Engineering*, University of Nevada, Reno.

2018 – 2019 **Postdoctoral Scholar**, *NHERI SimCenter*, University of California, Berkeley.

Education

2018 **Ph.D., Civil and Environmental Engineering**, *University of California, Berkeley*.

Title: *Development of a Coupled 3-D DEM-LBM Model for Simulation of Dynamic Rock-Fluid Interaction*
Minors: Numerical Mathematics, Mechanics
Advisor: Professor Nicholas Sitar

2012 **M.S., Civil and Environmental Engineering**, *University of California, Berkeley*.

2010 **B.S., Civil and Environmental Engineering**, *University of California, Berkeley*.

High Honors

Professional Licenses

2014 - Present **Licensed Professional Engineer**, *California*.

Honors and Awards

2022 **Finalist**, LaMay Award for Excellence in Teaching, College of Science.
University of Nevada, Reno

2018 **Best Paper**.
52nd US Rock Mechanics/Geomechanics Symposium

2018 **Presidential Management Fellow**.
A highly selective leadership development program (~7% acceptance rate)

2012 **Outstanding Graduate Student Instructor Award**.
Awarded for outstanding work in teaching course on groundwater and seepage (CE 173)

2008 – 2010 **Regents' and Chancellor's Scholarship**.
Most prestigious scholarship offered by UC Berkeley to entering undergraduates

Publications

Thesis

[1] **M. Gardner**, *Development of a Coupled 3-D DEM-LBM Model for Simulation of Dynamic Rock-Fluid Interaction*. PhD thesis, University of California, Berkeley, 2018

Journal Articles

[2] **M. Gardner**, "Toward a Complete Kinematic Description of Hydraulic Plucking of Fractured Rock," *ASCE Journal of Hydraulic Engineering*, 2023

[3] **M. Gardner**, E. Nichols, N. Stark, A. Lemnitzer, and D. Frost, "Multispectral Imaging for Identification of High-Water Marks in Post-Disaster Flood Reconnaissance," *ASCE Natural Hazards Review*, 2023

[4] S. Feehan, S. McCoy, J. Scheingross, and **M. Gardner**, "The influence of variability in lift, drag, protrusion, friction angle, and particle and fluid density on incipient sediment motion," *JGR: Earth Surface*, In review, 2022

[5] **M. Gardner** and N. Sitar, "Modeling of Dynamic Rock–Fluid Interaction Using Coupled 3-D Discrete Element and Lattice Boltzmann Methods," *Rock Mechanics and Rock Engineering*, Invited paper, 2019

[6] **M. Gardner** and N. Sitar, "Coupled three-dimensional discrete element-lattice Boltzmann methods for fluid-solid interaction with polyhedral particles," *International Journal for Numerical and Analytical Methods in Geomechanics*, 2019

[7] **M. Gardner**, J. Kolb, and N. Sitar, "Parallel and scalable block system generation," *Computers and Geotechnics*, vol. 89, pp. 168 – 178, 2017. DOI: `https://doi.org/10.1016/j.compgeo.2017.05.001`

[8] F. Zheng, Y.-Y. Jiao, **M. Gardner**, and N. Sitar, "A fast direct search algorithm for contact detection of convex polygonal or polyhedral particles," *Computers and Geotechnics*, vol. 87, pp. 76 – 85, 2017. DOI: `https://doi.org/10.1016/j.compgeo.2017.02.001`

Conference Papers (Refereed)

[9] Y. Keissar, I. Brown, N. Sitar, and **M. Gardner**, "DEM Modeling of 3-D Kinematics in Rock Slope Failure," in *ARMA*, (Houston, Texas), April 18 - 19 (2023, In Review)

[10] A. Lemnitzer, N. Stark, **M. Gardner**, E. Nichols, J. Mueller, and N. Brilli, "Geotechnical and Geo-environmental damage and its impact on critical infrastructure during the 2021 Western European Floods," in *9th International Congress on Environmental Geotechnics*, (Chania, Crete), June 23 - 27 (2023, In Review)

[11] N. Stark, A. Lemnitzer, K. W. Franke, **M. Gardner**, J. Hubler, B. Lingwall, E. Nichols, B. Quinn, C. Thom, K. Markert, and D. Harman, "The role of gravel shoals on scour and erosion in the Yellowstone River during the 2022 flood event - initial observations," in *11th International Conference on Scour and Erosion (ICSE 11)*, (Copenhagen, Denmark), September 17 - 21 (2023, In Review)

[12] E. Nichols, A. Lemnitzer, N. Stark, **M. Gardner**, and J. Mueller, "Impact of 2021 Western European Flooding on Geo-Structures," in *9th ASCE Forensic Engineering Congress*, (Denver, CO), November 4 - 9 (2022)

[13] **M. Gardner**, "Modeling the Mechanics of Rock Scour in Unlined Dam Spillways," in *ASCE GeoCongress*, (Charlotte, North Carolina, USA), March 20 - 23 (2022)

[14] A. Lemnitzer, N. Stark, J. Mueller, E. Nichols, **M. Gardner**, G. Anoyatis, H. Schuettrumpf, , J. Stamm, M. George, M. van Marle, A. Mavritsakis, L. Leunge, and K. van Ginkel, "Initial geo-structural performance observations of critical infrastructure components during the 2021 Western European Floods," in *ICONHIC*, (Athens, Greece), July 5 - 7 (2022)

[15] **M. Gardner** and N. Sitar, "Modeling Rock Scour Using Coupled 3D Discrete Element and Lattice Boltzmann Methods," in *ASCE International Conference on Scour (ICSE10)*, (Virtual), October 18 - 21 (2021)

[16] **M. Gardner** and N. Sitar, "Modeling of Rock Scour using Coupled 3-D Discrete Element and Lattice Boltzmann Methods," in *Proceedings of the 52nd US Rock Mechanics/Geomechanics Symposium*, (Seattle, Washington), American Rock Mechanics Association, 2018

Technical Reports

[17] A. Lemnitzer and K. Franke, "Geotechnical Reconnaissance of the 2022 Yellowstone Floods," techreport, Geotechnical Extreme Events Reconnaissance Association, In press, 2022. (**Contributing Author**)

[18] A. Lemnitzer and N. Stark, "Geotechnical Reconnaissance of the 2021 Western European Floods," techreport, Geotechnical Extreme Events Reconnaissance Association, 2022. (**Contributing Author**)

[19] G. G. Deierlein and e. Adam Zsarnóczay, "State of the Art in Computational Simulation for Natural Hazards Engineering," tech. rep., Feb. 2021. (**Corresponding Author in Chapters 3 & 5**)

[20] G. G. Deierlein and A. Zsarnóczay, "State-of-Art in Computational Simulation for Natural Hazards Engineering," tech. rep., Feb. 2019. (**Contributing Author in Sections 1.2, 1.3 & 1.4**)

[21] **M. Gardner** and N. Sitar, "Coupled 3-D DEM-LBM Model for Simulation of Dynamic Rock-Fluid Interaction," tech. rep., University of California, Berkeley, 2018. DOI: `https://doi.org/10.13140/RG.2.2.21301.73441`

[22] J. Bray, J. Cohen-Waeber, T. Dawson, T. Kishida, and N. Sitar, "Geotechnical Engineering Reconnaissance of the August 24, 2014 M6 South Napa Earthquake," techreport, Geotechnical Extreme Events Reconnaissance Association, 2014. (**Contributing Author in Sections 5 & 6**)

Published Software

[23] F. McKenna, S. ri Yi, A. B. Satish, A. Zsarnoczay, **M. Gardner**, and W. Elhaddad, "The Quantified Uncertainty with Optimization for the Finite Element Method (quoFEM) application: Version 3.2.0," Oct. 2022. https://doi.org/10.5281/zenodo.7131444

[24] F. McKenna, K. Zhong, **M. Gardner**, A. Zsarnoczay, C. Wang, and W. Elhaddad, "NHERI-SimCenter Earthquake Engineering with Uncertainty Quantifcation (EE-UQ) Application," Oct. 2022. https://doi.org/10.5281/zenodo.7131474

[25] F. McKenna, P. Mackenzie-Helnwein, W. Elhaddad, **M. Gardner**, J. Wan, and D. K. Kwon, "NHERI-SimCenter Wind Engineering with Uncertainty Quantification (WE-UQ) Application," July 2019. http://doi.org/10.5281/zenodo.3274228

[26] **M. Gardner**, "NHERI-SimCenter smelt (Stochastic, Modular, and Extensible Library for Time histories)," May 2019. https://doi.org/10.5281/zenodo.2697657

[27] F. McKenna, A. Zsarnoczay, C. Wang, W. Elhaddad, and **M. Gardner**, "NHERI-SimCenter Performance-Based Engineering (PBE) Application," Apr. 2019. https://doi.org/10.5281/zenodo.2619736

[28] B. Simpson, F. McKenna, and **M. Gardner**, "NHERI-SimCenter Braced Frame Modeling (BFM) Application," Sept. 2018. https://doi.org/10.5281/zenodo.1438554

[29] **M. Gardner**, J. Kolb, and N. Sitar, "SparkRocks," Nov. 2016. https://doi.org/10.5281/zenodo.166103

Presentations

Seminar Presentations (Invited)

- **Michael Gardner**, "Kinematics of hydraulic plucking in fractured rock," in *Seminar Series (Host: Anne Lemnitzer)*, (University of California, Irvine, CA, United States of America), November 4, 2022
- **Michael Gardner**, "Modeling dynamic fluid-solid interaction in turbulent flow during rock scour," in *USGS Engineering Brownbag (Host: Ben Mason)*, (United States Geological Engineering, Golden, CO, United States of America), June 9, 2022
- **Michael Gardner**, "Modeling dynamic fluid-solid interaction in turbulent flow during rock scour," in *Graduate Seminar (Host: Michael Shields)*, (Johns Hopkins University, Baltimore, MD, United States of America), February 3, 2022
- A. Lemnitzer, E. Nichols, **Michael Gardner**, A. Mavritsakis, and M. van Marle, "GEER reconnaissance mission to Germany, Belgium and the Netherlands," in *Lunch Lecture (Host: Magreet van Marle)*, (Deltares, Delft, Netherlands), November 11, 2021
- **Michael Gardner**, "Modeling dynamic rock-fluid interaction applied to hydraulic plucking in dam spillways," in *AEG Great Basin Chapter Meeting (Host: Merrily Graham)*, (AEG Great Basin Chapter, Reno, NV, United States of America), October 14, 2021
- **Michael Gardner**, "Modeling dynamic rock-fluid interaction," in *Distinguished Lecturer Series (Host: Ye Zhang)*, (University of Wyoming, Laramie, WY, United States of America), April 12, 2021
- **Michael Gardner**, "Modeling dynamic rock-fluid interaction," in *Lunchtime Talk (Host: Kirk Ellison)*, (Arup, San Francisco, CA, United States of America), April 10, 2020
- **Michael Gardner**, "Large-scale C++ programming and parallelisation frameworks," in *1st Workshop on Large-Scale DEM-LBM (Host: Krishna Kumar)*, (University of Cambridge, Cambridge, United Kingdom), June 23 (2017)
- **Michael Gardner**, "Numerical modelling of rock-fluid interaction," in *Geotechnical Seminar (Host: Stefano Utili)*, (Newcastle University, Newcastle upon Tyne, United Kingdom), June 21 (2017)
- **Michael Gardner**, "Numerical modeling of fractured rock," in *Association of Environmental and Engineering Geologists Student Night (Host: Julien Cohen-Waeber)*, April 11 (2017)

Conference Presentations

- **M. Gardner**, N. Stark, A. Lemnitzer, N. Brilli, E. Nichols, M. Grilliot, J. Zdebski, J. Mueller, and M. George, "Geotechnical and geophysical investigations of river-infrastructure interaction in response to the 2021 Ahr Valley flood," in *American Geophysical Union Fall Meeting*, (Chicago, Illinois, USA), December 12 - 16 (2022)

- J. Toller, **M. Gardner**, and K. Keegan, "Using the Lattice Boltzmann Method to Determine the Intrinsic Permeability of Polar Firn," in *American Geophysical Union Fall Meeting*, (Chicago, Illinois, USA), December 12 - 16 (2022)
- S. Feehan, S. McCoy, J. Scheingross, and **M. Gardner**, "Exploring the Controls on Riverbed Grain Size Distributions," in *American Geophysical Union Fall Meeting*, (Chicago, Illinois, USA), December 12 - 16 (2022)
- N. Stark, A. Lemnitzer, and **M. Gardner**, "Geotechnical and geophysical investigations of river-infrastructure interaction in response to the 2021 Ahr Valley flood," in *1st KAHR Science Conference*, (Virtual), June 29 - 30 (2022)
- **M. Gardner**, "Modeling the Mechanics of Rock Scour in Unlined Dam Spillways," in *ASCE GeoCongress*, (Charlotte, North Carolina, USA), March 20 - 23 (2022)
- **M. Gardner**, Y. Keissar, P. Wood, I. Brown, and N. Sitar, "Three-Dimensional Kinematics and Scaling Effects in Rock Slope Failure," in *American Geophysical Union Fall Meeting*, (New Orleans, LA, United States), December 13 - 17 (2021)
- J. Toller, **M. Gardner**, K. Keegan, S. Day, and Y. Chung, "The Importance of Image Thresholding in Computing Permeability of Firn using Micro-CT Images and the Lattice Boltzmann Method," in *American Geophysical Union Fall Meeting*, (New Orleans, LA, United States), December 13 - 17 (2021)
- J. Scheingross, W. Cao, J. DesOrmeau, **M. Gardner**, S. Gordon, C. D. Masi, P. Sheevam, and J. Toller, "Progress on DEI initiatives within the University of Nevada Reno (UNR) geosciences community," in *American Geophysical Union Fall Meeting*, (New Orleans, LA, United States), December 13 - 17 (2021)
- **M. Gardner**, "Modeling the Mechanics of Rock Scour in Unlined Dam Spillways," in *International Conference of Numerical Analysis and Applied Mathematics*, (Rhodes, Greece), September 20 - 26 (2021)
- **M. Gardner** and N. Sitar, "Modeling Rock Scour Using Coupled 3D Discrete Element and Lattice Boltzmann Methods," in *ASCE International Conference on Scour (ICSE10)*, (Virtual), October 18 - 21 (2021)
- **M. Gardner**, "Surrogate Model Development for Rock Slope Failures using quoFEM," in *PEER Annual Meeting*, (Berkeley, CA, United States), January 16 - 17 (2020)
- **M. Gardner** and N. Sitar, "Coupled Three-Dimensional Discrete Element-Lattice Boltzmann Methods for Fluid-Solid Interaction with Polyhedral Particles," in *Engineering Mechanics Institute Conference*, (Pasadena, California), June 18 - June 21 (2019)
- W. Elhaddad, F. McKenna, **M. Gardner**, A. Zsarnóczay, M. Schoettler, C. Wang, S. Govindjee, and G. Deierlein, "A Computational Framework for Regional Earthquake Loss Estimation," in *Engineering Mechanics Institute Conference*, (Pasadena, California), June 18 - June 21 (2019)
- **M. Gardner** and N. Sitar, "Modeling Rock Scour using Coupled Discrete Element and Lattice Boltzmann Methods," in *Engineering Mechanics Institute Conference*, (Boston, Massachusetts), May 29 - June 1 (2018)
- **Michael Gardner**, "Numerical modeling of rock-fluid interaction," in *1st Annual Geotechnical Research Symposium*, (University of California, Berkeley, United States of America), February 1 (2018)

Grants & Funding

Active Research Grants

2022 – 2025 ***Collaborative Research: Multi-Block System Response to Hydraulic Loads in Rock Scour***, *National Science Foundation, Principal Investigator, co-PI David Harbor (Washington & Lee University)*, $419,486 (UNR portion), 3 years.

2022 – 2023 ***RAPID: Collaborative Research: Geotechnical and geoenvironmental properties of the Ahr and Erft Rivers, Germany, and their role in structural damage during the 2021 Western European Floods***, *National Science Foundation, Principal Investigator, co-PIs Nina Stark (Virginia Tech) and Anne Lemnitzer (UCI)*, $77,558 (UNR portion, including supplement), 1 year.

2021 – 2024 ***Mafic magmatic enclaves as tracer of protracted mixing and hybridization***, *National Science Foundation, Co-Principal Investigator, PI Philip Ruprecht (UNR)*, $320,350, 3 years.

Completed Research Grants

June 2020 – Dec. 2020 ***Natural Hazards Engineering Research Infrastructure: Computational Modeling and Simulation Center (subaward)***, *National Science Foundation, Expand modularity of SimCenter `quoFEM` application*, $9,358.20, 6 months.

Research Mentoring

Graduate Students

Spring 2023 – present **Jakob Scheel**, *Ph.D. Geology, University of Nevada, Reno.*
Project: Mafic magmatic enclaves as tracer of protracted mixing and hybridization (co-advised with Philipp Ruprecht)

Fall 2021 – present **Mohsen Tahkhtravan**, *Ph.D. Geological Engineering, University of Nevada, Reno.*
Project: Multi-Block System Response to Hydraulic Loads

Spring 2021 – present **Justin Toller**, *Ph.D. Geology, University of Nevada, Reno.*
Project: The impact of glacial firn microstructure on ice age-gas age difference (co-advised with Kaitlin Keegan)

Spring 2019 – present **Yuval Keissar**, *Ph.D. Civil Engineering, University of California, Berkeley.*
Project: Predictive models for dynamic analysis of rock slope response (co-advised with Nicholas Sitar)

Fall 2019 – Spring 2022 **Ingrid Suter**, *M.S. Geological Engineering, University of Nevada, Reno.*
Project: Mapping bed forces to granular flow properties (co-advised with Scott McCoy)

Undergraduate Students

Summer 2022 – present **Kevin Ostfeld**, *B.S. Geological Engineering, University of Nevada, Reno.*
Project: Multispectral Imaging for Identifying Erosional and Depositional Patterns During Extreme Flooding

Summer 2019 **Haley Hostetter**, *B.S. Civil Engineering, Southern Illinois University*,
NSF Research Experiences for Undergraduates Intern at the NHERI SimCenter.
Project: A Stochastic Ground Motion Simulation Model Developed for Shallow Crustal Earthquakes Evaluated in a Subduction Zone Setting

Teaching Experience

Legend: ‡: course designed or substantially renovated

Instruction

Spring 2022 – present **‡Geological Engineering Slope Stability (GE 483)**,
Department of Geological Sciences and Engineering, University of Nevada, Reno.

Spring 2021 – present **‡Numerical Methods for Geomaterials (GE 745)**,
Department of Geological Sciences and Engineering, University of Nevada, Reno.

Fall 2020 – present **‡Geological Engineering Data Analysis (GE 385)**,
Department of Geological Sciences and Engineering, University of Nevada, Reno.

Summer 2015 **Engineering Geomatics (CE 174) [course TA]**,
Department of Civil and Environmental Engineering, University of California, Berkeley.

Spring 2014 **Advanced GeoEngineering Testing and Design (CE 273) [course TA]**,
Department of Civil and Environmental Engineering, University of California, Berkeley.

Fall 2011 & Fall 2013 **Groundwater and Seepage (CE 173) [course TA]**,
Department of Civil and Environmental Engineering, University of California, Berkeley.

Service

2022 – Present **Review Panelist and Ad Hoc Reviewer**, *National Science Foundation.*

Summer 2021 – Present **Faculty Advisor**, *Association of Environmental and Engineering Geologists, UNR Student Chapter.*

Summer 2020 – present **Committee Member**, *Diversity, Equity, and Inclusion Committee, University of Nevada, Reno.*

Academic Year 2021 **Annual Evaluation Committee**, *Department of Geological Sciences and Engineering, University of Nevada, Reno.*

Academic Year 2020 **Faculty Search Committee**, *Department of Geological Sciences and Engineering, University of Nevada, Reno.*

2016 – present **Journal referee**.

- Computers and Geotechnics, Rock Mechanics and Rock Engineering, International Journal for Numerical and Analytical Methods in Geomechanics, Acta Geotechnica, Geofluids, Journal of Rock Mechanics and Geotechnical Engineering

Work Experience

Spring 2010 - Fall 2013 **Engineer**, *Geotechnics Group, Arup*, San Francisco, CA.

Summer 2009 **Geotechnical Intern**, *ENGEO Incorporated*, San Ramon, CA.

Summer 2007 **Engineering Intern**, *Zone 7 Water Agency*, Livermore, CA.

March 2003 - March 2005 **Combat Engineer**, *United States Army*, Honorably discharged at rank of Specialist, E-4.

Commendations:

- Two Army Commendation Medals
- National Defense Medal
- Global War on Terrorism Expeditionary Medal
- Global War on Terrorism Campaign Medal
- Army Service Ribbon

Professional Memberships

- American Society of Civil Engineers (ASCE)
- American Geophysical Union (AGU)
- Association of Environmental and Engineering Geologists (AEG)
- U.S. Society of Dams (USSD)
- International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE)
- Geotechnical Extreme Events Reconnaissance Association (GEER)
- United States University Council on Geotechnical Education and Research (USUCGER)

Language Skills

- English: fluent (speaking, reading, writing)
- Afrikaans: native (speaking, reading, writing)