

# Michael H. Gardner

## Research Interests

Rock Mechanics ♦ Slope Stability ♦ Fluid-Solid Interaction ♦ Open Source Software ♦ High Performance Computing ♦ Multiscale Simulations ♦ Discrete Element Method ♦ Lattice Boltzmann Method ♦ Remote Sensing

## 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

- 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

## Research Experience

### University of California, Berkeley

- August 2018 – present **Stochastic Seismic and Wind Load Generation.**
- Implement stochastic loading module for deployment in NHERI SimCenter Workflow to allow for stochastic generation of wind and seismic loading time histories for large scale regional natural hazard analysis. Additionally, add functionality to allow for random field generation to account for spatial variability in site response when considering seismic loading.
  - **Result** (In Progress): Extensible, modular library allowing for easy addition of different stochastic loading models for both seismic and wind loading. Additionally, library provides functionality for random field generation to account for spatial variability in soil properties and how this affects site response.
  - *Publications*: [9, 10, 11, 12]
  - *Collaborators*: Sanjay Govindjee, George Deodatis, Pedro Arduino, Frank McKenna

- August 2013 – **Numerical Modeling of Rock-Fluid Interaction.**  
 present
  - Coupled three-dimensional discrete element method (DEM) with three-dimensional Lattice Boltzmann Method (LBM) to directly simulate and evaluate hydrodynamic forces acting on polyhedral rock blocks in unlined dam spillways. Fluid computations were accelerated using both central processing units (CPUs) and graphics processing units (GPUs) through the Kokkos Programming EcoSystem.
  - **Result:** A new algorithm for simulating fluid-solid interaction between fluid and three-dimensional polyhedral particles. Open-source software implementing this algorithm that is capable of capturing three-dimensional kinematics of a fractured rock mass interacting with water.
  - *Publications:* [1, 2, 4, 5]
  - *Collaborators:* Nicholas Sitar
- July 2016 – **Large-Scale Fractured Rock Mass Generation.**  
 May 2017
  - Developed open-source, parallel and scalable fractured rock mass generation program by taking advantage of advances made in big data analytics and Cloud Computing.
  - **Result:** Parallel implementation gives orders of magnitude speedup compared to serial solution of large problems. Program is able to generate approximately 8 million blocks in same time as serial implementation takes to generate approximately 60 thousand blocks.
  - *Publications:* [6]
  - *Collaborators:* John Kolb, Nicholas Sitar
- June 2016 – **Contact detection of Convex Polygonal and Polyhedral Particles.**  
 February 2017
  - Derive fast direct search algorithm to increase efficiency of contact detection between convex particles in both two and three dimensions.
  - **Result:** The fast direct search algorithm produces significant speed-up compared to other contact detection algorithms in various benchmark tests.
  - *Publications:* [7]
  - *Collaborators:* Fei Zheng, Yu-Yong Jiao, Nicholas Sitar

## Teaching Experience and Research Mentoring

### Instruction

- Summer 2015 **Engineering Geomatics (CE 174),**  
*Department of Civil and Environmental Engineering, University of California, Berkeley.*
- Spring 2014 **Advanced GeoEngineering Testing and Design (CE 273),**  
*Department of Civil and Environmental Engineering, University of California, Berkeley.*
- Fall 2011 &  
 Fall 2013 **Groundwater and Seepage (CE 173),**  
*Department of Civil and Environmental Engineering, University of California, Berkeley.*

### Research Mentoring

- 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

## Academic Service

- 2016 - present **Journal referee.**  
 ○ Computers and Geotechnics
- 2018 - present **Journal referee.**  
 ○ Rock Mechanics and Rock Engineering
- 2019 - present **Journal referee.**  
 ○ International Journal for Numerical and Analytical Methods in Geomechanics

## Work Experience

- Jan. 2020 -  
 present **Assistant Professor, Department of Geological Sciences and Engineering, University of Nevada, Reno, NV.**
- Aug. 2018 -  
 Dec. 2019 **Postdoctoral Scholar, NHERI SimCenter, UC Berkeley, Berkeley, CA.**
- 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.
- March 2005 *Commendations*:
- Two Army Commendation Medals
  - National Defense Medal
  - Global War on Terrorism Expeditionary Medal
  - Global War on Terrorism Campaign Medal
  - Army Service Ribbon

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## Short Courses and Workshops Attended

- May 2018 **NHERI SimCenter User Workshop**, *Workshop*, University of California, Berkeley, United States, May 18 (2018).
- May 2018 **Anura3D Workshop and Training Course**, *Workshop*, University of California, Berkeley, United States, May 8–9 (2018).
- June 2017 **1st Workshop on Large-Scale DEM-LBM**, *Workshop*, University of Cambridge, Cambridge, United Kingdom, June 22–23 (2017).
- September 2014 **International School on “LAndslide Risk Assessment and Mitigation” (LARAM)**, *Short Course*, University of Salerno, Salerno, Italy, September 1–13 (2014).

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## Course Work

### GeoEngineering

Advanced Geomechanics ♦ Geotechnical Earthquake Engineering ♦ Numerical Methods in Geomechanics ♦ Engineering Geology ♦ Advanced GeoEngineering Testing and Design ♦ Advanced Foundation Engineering ♦ Groundwater and Seepage ♦ Environmental Geotechnics

### Engineering

Dynamics of Structures ♦ Mechanics of Solids ♦ Finite Element Methods ♦ Hydrology

### Mathematics and Computer Science

Numerical Solution of Ordinary Differential Equations ♦ Numerical Solution of Partial Differential Equations ♦ Parallel Computing

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## Publications

- [1] **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
- [2] **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
- [3] G. G. Deierlein and A. Zsarnóczyay, “State-of-Art in Computational Simulation for Natural Hazards Engineering,” tech. rep., Feb. 2019. (**Contributing Author in Sections 1.2, 1.3 & 1.4**)
- [4] **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>
- [5] **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
- [6] **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>
- [7] 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>

- [8] 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**)

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## Published Software

- [9] 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>
- [10] **M. Gardner**, "NHERI-SimCenter smelt (Stochastic, Modular, and Extensible Library for Time histories)," May 2019. <https://doi.org/10.5281/zenodo.2697657>
- [11] F. McKenna, W. Elhaddad, **M. Gardner**, and C. Wang, "NHERI-SimCenter Earthquake Engineering with Uncertainty Quantification (EE-UQ) Application," Mar. 2019. <https://doi.org/10.5281/zenodo.2619616>
- [12] F. McKenna, A. Zsarnóczay, C. Wang, W. Elhaddad, and **M. Gardner**, "NHERI-SimCenter Performance-Based Engineering (PBE) Application," Apr. 2019. <https://doi.org/10.5281/zenodo.2619736>
- [13] F. McKenna, N. Padhye, C. Wang, P. Mackenzie-Helnwein, and **M. Gardner**, "NHERI SimCenter Uncertainty Quantification for the Finite Element Method (uqFEM) Application," Oct. 2018. <https://doi.org/10.5281/zenodo.1439497>
- [14] B. Simpson, F. McKenna, and **M. Gardner**, "NHERI-SimCenter Braced Frame Modeling (BFM) Application," Sept. 2018. <https://doi.org/10.5281/zenodo.1438554>
- [15] **M. Gardner**, J. Kolb, and N. Sitar, "SparkRocks," Nov. 2016. <https://doi.org/10.5281/zenodo.166103>

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## Conference and Workshop Presentations

- **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 (Host: Ezra Setiasabda)*, (University of California, Berkeley, United States of America), February 1 (2018)
- **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)

## Technical skills

- C++, Python, Scala programming
- Linux, LaTeX
- Apache Spark, Plaxis
- MPI, OpenMP, GPU parallelism
- LiDAR Scanning and Processing

## Language Skills

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