

Expertise

- **High performance computing (C/C++17, OpenMP, CUDA, and CMake):** independently developed three lattice Boltzmann method-based simulators (a single-phase flow simulator, a two-phase flow simulator and a convection-diffusion simulator) and a reservoir scale simulator (a density-driven flow simulator). An LBM-based simulator for reactive flow in porous media and a reservoir-scale three-component simulator is under development. The efficiency of reservoir scale simulators exceeds commercial software.
- **Numerical simulation – pore scale:** LBM-based simulation on fluid flow in porous media, such as solute transport in porous media, two-phase flow in porous media, reactive flow in porous media, etc.
- **Numerical simulation – reservoir scale:** density-driven flow in porous media, fluid flow in well bore or drilling tools, thermal integrity profiling, etc.
- **Machine learning:** deep learning-based permeability and flow field prediction, micro-CT image segmentation, physics informed neural networks.
- **Experiments:** mass transport in porous media (Hele Shaw cell), proppant transport in fractures, micro-CT scanning, water flooding, etc.
- **Software skills:** COMSOL, Fluent, AutoCAD, ParaView, Tecplot, etc.
- **Programming language:** C/C++ 17, Python, MATLAB

Education

- 2018 - 2022 Virginia Tech, Blacksburg, USA, Ph.D. in Mining Engineering
2016 - 2018 Missouri S&T University, Rolla, USA, Research Assistant in Geotechnical Engineering
2005 - 2010 China University of Petroleum, Beijing, China, Ph.D. in Petroleum Engineering
2001 - 2005 China University of Petroleum, Dongying, China, B. Eng. in Mechanical Engineering

Professional Experience

- 2024 - present The Bureau of Economic Geology, University of Texas at Austin, Postdoc, Research on microfluidics and underground hydrogen storage.
2022 - 2024 Stevens Institute of Technology, Postdoc, Research on fluid flow in porous media in subsurface energy systems.
2010 - 2016 SINOPEC Research Institute of Petroleum Engineering, Senior Engineer, Deputy Chief Researcher, Research and development on ultradeep horizontal drilling technology and downhole tools.

Research Projects

- 2023 Investigation of mechanochemical interactions of hydrogen with earth materials in a subsurface gas storage. U.S. Department of Energy project. Major researcher. Experimental evaluation of H₂ adsorption in rock.
- 2022-2024 Fundamentals of Particulate Amendment Transport and Compaction in Hydraulic Fractures and the Application to Effective Remediation in Low-Permeability Clay. U.S. Department of Defense project. Design and construction of experimental setup, indoor testing to evaluate proppant transport in complex fractures.
- 2019 - 2022 Using a Well-Controlled Heterogeneous Permeability Field to Study Its Role on Miscible Density-Driven Convection in Porous Media. U.S. NSF Project. Major researcher, Conducted the experiments and data analysis.
- 2019 - 2022 Understanding Relative Permeability, Residual Saturation, and Porosity in Reservoirs to Reduce Uncertainty in Long-Term CO₂ Storage and Efficiency. U.S. DOE-NETL project. Major researcher. Conducted lattice Boltzmann multi-phase flow modeling and collaborated with the NETL Geo-Imaging Laboratory.
- 2014 - 2016 Research on Horizontal Drilling Technology in Fuling Shale Gas Fields. SINOPEC Key Project. **Co-Principal Investigator.**

- 2012 - 2013 Technical Tracking and Analysis on Horizontal Drilling and Staged Fracturing technology. SINOPEC Project. **Principal investigator**.
- 2011 - 2012 Pilot Experiment of Ultra-deep Horizontal Drilling Technology in Yuanba Gas Field. SINOPEC Project. **Co-Principal Investigator**.
- 2011 - 2012 Development of Drilling Optimization Design and Drilling Geological Environmental Factors Description Software. SINOPEC Project. Major researcher, Programming on horizontal drilling technology related models.
- 2011 - 2013 Research on Ultra-deep Horizontal Drilling and Completion Technology in Yuanba Gas Field. SINOPEC Key Project. Major researcher, Project leader assistant, R&D in horizontal drilling technology and downhole tool.
- 2010 - 2013 High-efficient Drilling Technology for Ultra-deep Well in Yuanba Gas Field. SINOPEC Top-ten Major Projects. **Principal investigator assistant** and major researcher.
- 2010 - 2016 Technical Support for Ultra-Deep Horizontal Drilling and Drilling Fluid Technology in Yuanba Gas Field. SINOPEC Field Project. On-site technical support for six ultra-deep horizontal wells (YB103H, YB121H, YB272H, YB101-1H, YB1-1H, SB1-1H, etc.).

Awards and Honors

- 2022 Pratt Fellowship, Virginia Tech
- 2022 WAAIME West Virginia Southern Section Scholarship, SME
- 2021 Pratt Fellowship, Virginia Tech
- 2021 WAAIME Scholarship, SME
- 2017 Norbert Schmidt Fellowship, Missouri S&T University
- 2014 SRIPE Scientific and Technical Outstanding Progress Award, SINOPEC Research Institute of Petroleum Engineering
- 2014 Scientific and Technical Progress Award, SINOPEC Oilfield Service Corporation
- 2013 Outstanding researcher of SINOPEC Research Institute of Petroleum Engineering

Journal Papers

In Preparation/Under Review

- [1] **R. Guo**, L. Dalton, H. Wang, J. McClure, D. Crandall, & C. Chen. (2024). Modeling and reconstructing heterogeneous wettability of a natural rock. In preparation.
- [2] **R. Guo**, C. Chen. (2024). Reconstruction of density-driven flow in porous media with physics informed neural network model. In preparation.
- [3] **R. Guo**, H. Sun, H. Wang, Z. Li, Y. Liu, & C. Chen. (2024). Experimental investigation on density-driven convection in strongly heterogeneous porous media. To be submitted.
- [4] **R. Guo**, L. Zeng, C. Chen. (2024). Pore scale investigation on solute transport in unsaturated porous media. To be submitted
- [5] Z. Li, **R. Guo**, H. Wang, N. Ripepi, C. Fernandez, & C. Chen. (2024). Experimental and Numerical Investigation of Conductivity between Non-smooth Fracture with/without Proppant. Under review.

Published

- [1] Q. Zhao, X. Han, **R. Guo**, & C. Chen. (2023) A Computationally Efficient Hybrid Neural Network Architecture for Porous Media: Integrating CNNs and GNNs for Improved Permeability Prediction. arXiv:2311.06418.
- [2] Q. Zhao, **R. Guo**, N. K. Jha, M. Sarmadivaleh, M. Lebedev, A. Al-Yaseri, J. McClure, & C. Chen. (2024). Using X-ray computed tomography and pore-scale numerical modeling to study the role of heterogeneous rock surface wettability on hydrogen brine two-phase flow in underground hydrogen storage. Fuel, 366, 131414.
- [3] H. Qu, Y. Xu, Y. Liu, X. Wang, X. Liu, Z. Zeng, & **R. Guo**. (2023). Experimental study of fluid-particle flow characteristics in a rough fracture. Energy, 129380
- [4] **R. Guo**, H. Sun, H. Wang, Y. Teng, Y. Liu, & C. Chen. (2023). Using novel 3D printing to study the role of permeability heterogeneity on miscible density-driven convection in porous media. Advances in Water Resources, 178, 104496.

- [5] H. Qu, C. Li, X. Chen, X. Liu, **R. Guo**, & Y. Liu. (2023). LN cooling on mechanical properties and fracture characteristics of hot dry granites involving ANN prediction. *Renewable Energy*, 119058
- [6] H. Qu, J. Hong, Y. Liu, Z. Zeng, X. Liu, X. Chen, & **R. Guo**. (2023). Experiment and simulation of slurry flow in irregular channels to understand proppant transport in complex fractures. *Particuology*, 83: 194-211
- [7] **R. Guo**, L. Dalton, H. Wang, J. McClure, D. Crandall, & C. Chen. (2022). Role of heterogeneous surface wettability on immiscible displacement, capillary pressure, and relative permeability in a CO₂-brine-rock system. *Advances in Water Resources*, 165, 104226.
- [8] H. Qu, Y. Hu, **R. Guo**, G. Lin, J. Xu, H. Jun, & X. Chen. (2023). Experimental study on pore structure alteration of deep shale under liquid nitrogen freezing based on nuclear magnetic resonance. *International Journal of Hydrogen Energy*, 48 (1): 51-66. (corresponding author)
- [9] H. Wang, L. Dalton, **R. Guo**, J. McClure, & D. Crandall. (2022) Unsupervised deep learning for image segmentation and in-situ contact angle measurements in a CO₂-water-rock multiphase flow system. *Advances in Water Resources*, 173, 104385
- [10] H. Wang, L. Dalton, M. Fan, **R. Guo**, J. McClure; D. Crandall, & C. Chen. (2022). Deep-learning-based workflow for boundary and small target segmentation in digital rock images using UNet++ and IK-EBM. *Journal of Petroleum Science and Engineering*, e110596.
- [11] **R. Guo**, H. Sun, Q. Zhao, Z. Li, Y. Liu, & C. Chen. (2021). A novel experimental study on density-driven instability and convective dissolution in porous media. *Geophysical Research Letters*, 48, e2021GL095619
- [12] **R. Guo**, L. Dalton, M. Fan, J. McClure, L. Zeng, D. Crandall, & C. Chen. (2020). The role of the spatial heterogeneity and correlation length of surface wettability on two-phase flow in a CO₂-water-rock system. *Advances in Water Resources*, 146, 103763
- [13] R. Zhong, **R. Guo**, & W. Deng. (2018). Optical-fiber-based smart concrete thermal integrity profiling: an example of concrete shaft. *Advances in Materials Science and Engineering*, 9290306
- [14] D. Ma, G. Li, **R. Guo**, & W. Wang. (2013). Numerical simulation of cutting-carrying law of ultra-short radius radial drilling technology with steering in the casing. *Fluid Machinery*, 11, 6-10
- [15] D. Ma, G. Li, **R. Guo**, & Z. Huang. (2013). Hydraulic jetting ultra-short radius radial horizontal well drilling rate equation. *Journal of China University of Petroleum (Edition of Natural Sciences)*, 3, 78-82
- [16] G. Yan, K. Liu, **R. Guo**, J. Liu, & H. Wu. (2013). Yuanba 272h well ultra-deep sidetracking drilling technology. *Petroleum Drilling Techniques*, 1, 113-117
- [17] G. Li, K. Liu, **R. Guo**, & Z. Song. (2012). Drilling techniques for the ultra-deep horizontal Yuanba 272H well. *Drilling and Production Technology*, 6: 116-120
- [18] **R. Guo**, K. Liu, X. Tao, W. Liu, C. Yang, & M. Li. (2012). Horizontal well penetration rate increasing technology in Daniudi gas field. *Oil Drilling and Production Technology*, 5, 49-52
- [19] H. Xu, K. Liu, **R. Guo**, N. Si, F. Yang, & R. Cai. (2012). Application of rotary steering technology in ultra-deep horizontal well in Yuanba gas field. *Drilling and Production Technology*, 2, 25-27
- [20] **R. Guo**, G. Li, Z. Huang, S. Tian, & H. Shi. (2010). Numerical simulation study on flow field of multi-hole jet bit. *Fluid Machinery*, 4, 13-17
- [21] **R. Guo**, G. Li, M. Liu, & Z. Huang. (2010). Mechanical models for flexible pipe in whipstock of radial drilling system. *China Petroleum Machinery*, 3, 24-27
- [22] **R. Guo**, G. Li, Z. Huang, S. Tian, & H. Shi. (2010). Investigation of factors affecting micro-hole's horizontal displacement. *Drilling Petroleum Techniques*, 2, 5-9
- [23] **R. Guo**, G. Li, Z. Huang, S. Tian, X. Zhang, & W. Wu. (2009). Theoretical and experimental study of the pulling force of jet bits in radial drilling technology. *Petroleum Science*, 4, 395-399

Conference Papers/Presentations/Posters

- [1] H. Wang, **R. Guo**, J. Leng, S. A. Hosseini, & M. Fan. (2023). A Comparative Study of Deep Learning Models for Fracture and Pore Space Segmentation in Synthetic Fractured Digital Rocks. *SPE ATCE 2023* (SPE-215117-MS)

- [2] **R. Guo**, L. Dalton, H. Wang, J. McClure, D. Crandall, & C. Chen. (2022). Comprehensive investigation on role of wettability heterogeneity in immiscible two-phase flow in sandstones. *AGU Fall Meeting*, MR55A-03
- [3] **R. Guo**, L. Dalton, H. Wang, J. McClure, D. Crandall, & C. Chen. (2022). Using In-situ Wettability Measurements to Reconstruct the Wetting Condition of a Natural Rock. *InterPore 2022*, Oral presentation, MS09
- [4] **R. Guo**, L. Dalton, M. Fan, J. McClure, L. Zeng, D. Crandall, & C. Chen. (2020). The impact of spatial variation and correlation length of wettability on scCO₂-brine immiscible displacement in 3D porous media. *AGU Fall Meeting*, MR023-0014
- [5] **R. Guo**, J. McClure, C. Chen and M. Fan. LBM-based simulation on impact of wettability heterogeneity on relative permeability in sandstone. *AGU Fall Meeting*, MR13C-0088
- [6] **R. Guo**, F. Jiang, & W. Deng. (2017). Lattice boltzmann simulation of seismic mobilization of residual oil in sandstone. *AGU Fall Meeting*, H11G-0583
- [7] **R. Guo**, G. Li, & Z. Huang. (2009). Study on flow field characteristics and rock-breaking mechanism of multi-hole jet bits. *The 6th Chinese National Conference on Deep Rock Mechanics*, 46-50

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