Biography

I am a postdoctoral fellow at the Lawrence Berkeley National Laboratory (LBNL). I received BEng in civil engineering in 2010 and PhD in geotechnical engineering in 2016. During my PhD, I spent two years at the LBNL under the supervision and help of Jonny Rutqvist, and developed a series of models and codes based on the numerical manifold method (NMM), including

- A model for efficiently solving free-surface flow
- A second-order model for accurately and efficiently solving high-gradient, nonlinear flow
- A Lagrange multiplier method model for accurate modeling of heterogeneous flow
- A jump function method model for flow across material interface
- A practical model for fluid flow in Discrete-Fracture Porous Media containing multiple discrete fractures with non-conforming mesh
- A fully coupled hydro-mechanical (HM) model for dominant fractures/faults, considering the direction coupling and nonlinear indirect coupling
- A fully coupled HM model for rock with multiple fractures considering opening and slip of fractures, and flux exchange between fractures and porous rock, which can be used for hydraulic fracturing analysis with pre-described fractures

The main contributions of this work is the development of NMM model for fully coupled HM in complex fractured and porous media, with important applications to a wide range of energy geosciences applications. Details of this work can be found in the published journal papers listed below.

Research Interest

At the LBNL, I am very interested in model development and application of coupled thermal-hydro-mechanical (THM) processes in energy-geosciences-associated activities. My research topic covers two main parts, i.e., (1) numerical model development, based on finite volume method (FVM), and numerical manifold method, and (2) multi-scale, long-term analysis of the THM processes in nuclear waste disposal, CO2 sequestration, and other energy-geosciences applications with the newly developed numerical models, and well-built TOUGH-FLAC simulator. Currently, my work is focused on the following specific research topics:

- Model development of fully coupled THM, dual-continuum, dual-mesh model based on FVM for multi-component, multi-phase flow interacting with mechanical and thermal fields
- Model development for analyzing hydraulic fracturing and its interaction with existing natural discrete fractures based on NMM, FVM
- THM analysis of large-scale, long-term performances of nuclear waste disposal in salt formation considering the brine inclusion migration under thermal gradient, with the FVM and TOUGH-FLAC

Education

PhD, Hohai University, 2016
Visiting PhD student, Lawrence Berkeley National Laboratory, 2012-2014
BEng, China University of Mining and Technology, 2010

Work Experience

Postdoctoral Fellow, Lawrence Berkeley National Laboratory, 2016-Present

Selected Awards

2016, Spot Recognition Award for outstanding contributions to the field of coupled processes modeling, Lawrence Berkeley National Laboratory
2015, The National Scholarship, the Ministry of Education, China.
2014, The National Scholarship, the Ministry of Education, China.
2008, The National Scholarship, the Ministry of Education, China. (Ranking 1/252)
2007, The National Scholarship, the Ministry of Education, China. (Ranking 2/252)
2015, Qian Jia-Huan Scholarship, 1st prize
2015, YAN Kai Scholarship
2014, Best PhD Student Training Program, Hohai University
2010, Outstanding Graduate, China University of Mining and Technology
2008, Pacemaker to Merit Student, China University of Mining and Technology

Scientific Research Project Awards

2015-2016, **PI**, the Fundamental Research Funds for the Central Universities, China. Model Development of Coupled Hydro-mechanical Processes in Fractured Rock Using Numerical Manifold Methods with Application to Geological Storage of CO2.
2012-2016, **PI**, Graduates Science Innovation Research Project, Jiangsu Province. Modeling of Coupled Hydro-mechanical Processes Associated with Geological Storage of CO2 Based on Modern Numerical Methods.

Scholarly Service

Reviewer, Rock Mechanics and Rock Engineering
Reviewer, Tunneling and Underground Space Technology
Reviewer, Journal of Hydrology
Reviewer, Applied Mathematical Modelling

Invited Talks

[1] **Mengsu Hu**. NMM model development for analysis of coupled hydro-mechanical processes in heterogeneous media. 51st meeting of Commission on DDA Application of Rock Engineering, Japan. December 17, 2015, Tokyo, Japan.
[2] **Mengsu Hu**. Model development of NMM for analysis of flow in heterogeneous media- with application to hydro-mechanical coupling in fractured rock masses. 5th Northeastern University Forum of Rock mechanics- Numerical Methods for Discontinuous Media. June 23, 2015, Shenyang, China.

Journal Publications

[1] **Mengsu Hu**, Jonny Rutqvist, Yuan Wang. A fully coupled hydro-mechanical model for discrete fractured porous rock masses based on numerical manifold method. (under review)

[2] **Mengsu Hu**, Yuan Wang, Jonny Rutqvist. Fully coupled hydro-mechanical numerical manifold modeling of porous rock with dominant fractures. Acta Geotechnica. DOI: 10.1007/s11440-016-0495-z

[3] **Mengsu Hu**, Jonny Rutqvist, Yuan Wang. A Practical Model for Flow in Discrete-Fracture Porous Media by Using the Numerical Manifold Method. Advances in water resources. 2016, 97: 38-51.

[4] **Mengsu Hu**, Yuan Wang, Jonny Rutqvist. On Continuous and Discontinuous Approaches for Modeling Groundwater Flow in Heterogeneous Media Using the Numerical Manifold Method: Model Development and Comparison. Advances in Water Resources. 2015, 80: 17-29.

[5] **Mengsu Hu**, Yuan Wang, Jonny Rutqvist. Development of a Discontinuous Approach for Modeling Fluid Flow in Heterogeneous Media Using the Numerical Manifold Method. International Journal for Numerical and Analytical Methods in Geomechanics. 2015, 39: 1932-1952.

[6] **Mengsu Hu**, Yuan Wang, Jonny Rutqvist. An effective approach for modeling water flow in heterogeneous media using Numerical Manifold Method. International Journal for Numerical Methods in Fluids，2015; 77:459–476.

[7] Yuan Wang, **Mengsu Hu**, Quanlin Zhou, Jonny Rutqvist. Energy-work-based numerical manifold seepage analysis with an efficient scheme to locate the phreatic surface. International Journal for Numerical and Analytical Methods in Geomechanics. 2014; 38:1633–1650.

[8] Yuan Wang, **Mengsu Hu**, Quanlin Zhou, Jonny Rutqvist. A new Second-Order Numerical Manifold Method Model with an efficient scheme for analyzing free surface flow with inner drains. Applied Mathematical Modelling, 2016; 40: 1427–1445.

Conference Presentations

[1] **Mengsu Hu**, Jonny Rutqvist, Yuan Wang. A fully coupled hydro-mechanical model for discrete fractured porous rock masses based on numerical manifold method. 50th U.S. Rock Mechanics/Geomechanics Symposium, June 26- June 29, 2016, Houston, Texas, USA.

[2] **Mengsu Hu**, Yuan Wang, Jonny Rutqvist. Numerical Manifold modeling of coupled hydro-mechanical processes in fractured rock. 49th U.S. Rock Mechanics/Geomechanics Symposium, June 28- July 1, 2015, San Francisco, California, USA.

[3] **Mengsu Hu**, Yuan Wang, Jonny Rutqvist. On the new approaches for modeling water flow in heterogeneous media with numerical manifold method. The 13th International Symposium on Rock Mechanics, May 10-13, Montreal, Canada.

[4] **MS Hu**, Y Wang, J Rutqvist. Derivation and comparison of different new

approaches for boundary constraints in numerical simulation of water flow in heterogeneous media using Numerical Manifold Method. 48th U.S. Rock Mechanics/Geomechanics Symposium, June 1-4, 2014, Minneapolis, Minnesota, USA.
[5] Yuan Wang, **Mengsu Hu**, Jonny Rutqvist. Confined-Unconfined Seepage Analysis Using Numerical Manifold Method.11th International Conference on Analysis of Discontinuous Deformation, Aug. 27-29, 2013, Fukuoka, JAPAN.
[6] WANG Yuan, **HU Mengsu**, Jonny Rutqvist. Energy-Work-Based Confined-Unconfined Seepage Modeling Using Numerical Manifold Method. 47th U.S. Rock Mechanics/Geomechanics Symposium, June 23-26, 2013, San Francisco, California, USA.