Department of Structural Engineering
University of California, San Diego
SE Special Seminar

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"Extracting Heat from the Earth - Why does Micromechanics Matter"

Friday, March 17, 2017
11:00 am - 12:00 pm, SME Building, Room 448

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Abstract

Geothermal energy extraction via Enhanced Geothermal Systems (EGS) is being explored at the pilot level, but still faces technical challenges related to hydraulic fracturing of rock, as well as placement of proppant into rough fractures to maintain a stable aperture for successful long-term operation. This presentation focuses on the role of micro-mechanical analyses in gaining a better understanding of the complex, coupled behavior associated with EGS development. The particular micro-mechanics tool used in this study is the Discrete Element Method (DEM). First, the Bonded Particle Model (BPM) in DEM is used to simulate granite behavior and hydraulic fracturing. The BPM was improved to investigate hydro-thermo-mechanical fracturing processes by implementing a novel convective-conductive heat transport model. Second, DEM coupled with Computational Fluid Dynamics (DEM-CFD) is used to study horizontal proppant flow and transport in narrow fracture zones and proppant settling in a narrow rough granite fracture. A new particle contact model was implemented into DEM-CFD to account for the effects of the fluid lubrication force on particle collisions and the dissipation of particle kinetic energy.

Novel contributions to the understanding of EGS formation using these micro-mechanical analyses in DEM will be presented, along with validation using recent laboratory results. First, a new understanding of the effect of frequent particle collisions on flow and transport of granular slurry (mixtures of proppant and viscous fluid) will be presented. A particularly interesting finding is that in high viscosity fluid, particles remain in close vicinity form agglomerates. Fluid may flow around these agglomerates in rough fractures, which may lead to clogging or settling before reaching the desired location. Second, a new understanding of hydraulic fracturing of rock will be presented, including the effects of

fracturing fluid properties on fracture shape, branching, and secondary fracture formation, and the effects of a temperature difference between the fracturing fluid and surrounding rock on fracture initiation and propagation.

Biography

Dr. Ingrid Tomac is researcher at the UCSD Jacobs School of Engineering, Department of Structural Engineering. Her main research area is numerical modeling in rock mechanics focused on geothermal reservoirs and mechanical damage during CO_2 sequestration, as well as, numerical and experimental investigation of fundamental behavior of dense phase particle-fluid slurry flow and transport. Dr. Tomac received her PhD in Engineering from Colorado School of Mines, Golden, CO, in 2014. Prior to pursuing her academic career, Dr. Tomac worked as a consultant from 2000 to 2010, and designed major geotechnical projects in Croatia. She holds Engineering Diploma (2000) degree in Structural Engineering and Masters of Science (2007) degree in Geotechnical Engineering from the Department of Civil Engineering, University of Zagreb, Croatia. Dr. Tomac is active in service being associate editor of Geotechnical Testing Journal, a member of two committees of the ASCE (Rock Mechanics and Earth Retaining Structures) and two committees of the ISSMGE (Energy Geotechnics; Geo-Mechanics from Micro to Macro).

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Sponsored by Professor Gilberto Mosqueda
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