ARMA Future Leader Webinar Series

Integrating Microstructural Analysis in Geothermal Geomechanics: Mechanistic insights into Thermal Damage and Hydraulic Fracture Dynamics

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Abstract

In geothermal energy systems, understanding the microstructural behaviour of reservoir rocks under thermal and hydraulic stress is critical to optimising performance and ensuring long-term stability. This presentation explores the integration of advanced microstructural analysis with computed tomography technology (CT) to investigate the mechanistic processes associated with thermal damage and hydraulic fracture dynamics. Cyclic thermal injections induce significant microstructural alterations, driving fracture propagation and stress redistribution, ultimately reshaping the fracture network architecture. Furthermore, comparative analyses of hydraulic fracturing fluids such as water, CO_2, and foam through CT-derived fracture surface imaging reveal critical fluid-rock interaction mechanisms that determine fracture evolution and connectivity. In addition, the application of pore network modelling and discrete element modelling enables the simulation and prediction of fracture behaviours under geothermal conditions. These integrated methodologies offer critical insights into the interaction between thermal degradation and fluid-driven fracture dynamics, advancing the understanding of geomechanical responses in geothermal reservoirs.

Biography

Dr Pabasara Kumari is a lecturer in geotechnical engineering at the School of Civil Mining Environmental and Architecture Engineering of the University of Wollongong, Australia. She received her PhD from Monash University, Australia with a focus on geomechanics applications for deep geothermal extraction and hot dry rock reservoir stimulation. She is a recipient of the 2024 Discovery Early Career Research Award from the Australian Research Council (ARC) which supports her current research focus on investigating heat recovery and energy storage from underground mines.