USC CENTER FOR GEOTHERMAL STUDIES (CGS)

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Presents

Modeling Reactive Transport And Fracture Stimulation in Geothermal Systems and Hydrocarbon Reservoirs

By

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ABSTRACT:

Most natural and engineered systems in the subsurface involve strong coupling of thermal, hydrological, mechanical, and chemical (THMC) processes. The types of processes are varied and include conductive/advective heat transport, porous and fracture flow of multiphase fluids, chemical transport, mineral dissolution/precipitation, as well as changes in rock stresses leading to porosity changes and fracture shearing/failure. The development of models and computer codes to analyze and predict such processes in heterogeneous geological formations has been a focus of research for about the past 30 years, with limited success. Part of this is due to the complexities in developing the computer codes, the lack of thermodynamic/kinetic data, and also the training of scientists and engineers that require us go outside our expertise into hydrology, rock mechanics, geochemistry, and numerical modeling. The focus of this presentation will be an overview of the approaches and challenges in modeling coupled THMC processes and their application to enhanced geothermal systems (EGS) and hydraulic fracturing in unconventional reservoirs. EGS is the engineered creation of a geothermal reservoir in hot rock that has very low permeability and often a paucity of water. EGS development requires stimulating many fractures within a large volume of low permeability rock. Hydraulic fracturing in unconventional hydrocarbon reservoirs usually requires stimulating (or creating) a single fracture to access a volume of hydrocarbon-bearing rock. Evaluation of the stimulation effectiveness for both is done primarily by separate analyses of injectivity, temperatures, tracer returns, microseismicity, geochemical data, and reservoir modeling. Typical reservoir modeling is effective at analyzing pressures and temperatures during injection and production, but is not well-suited to capturing dynamic changes in hydrological properties due to mineral dissolution/precipitation, fracture shearing or tensile failure, and geochemical effects owing to gas (e.g., CO_2) injection or exsolution. Prediction of coupled THMC processes will not only be the basis for successful development of resources, but also their sustainability and environmental impacts.

BIO:

After a B.S in Geosciences (Penn State University, 1982), I went to the University of Oregon, where I developed an interest in reactive fluid flow, volatile transport, and deformation to explain complex geochemical patterns in the Skaergaard Intrusion, Greenland (Ph.D. 1990). This led to postdoctoral work at Indiana University and The French Institute of Petroleum developing numerical models for sedimentation, chemical compaction, and hydrofracturing during basin diagenesis. Since joining the Earth Sciences Division at LBNL in 1996, my main interest has been in simulating thermal, hydrological, mechanical, and chemical processes for evaluating the geologic storage of high-level nuclear waste, geologic CO_2 sequestration, Enhanced Geothermal Systems, and more recently hydraulic fracturing in unconventional hydrocarbon reservoirs. I have been one of the primary developers of the reactive transport code TOUGHREACT and recently led the development of new parallel versions, coupling of rock mechanics with reactive transport, and using geochemical/isotopic systems to constrain THM processes during fracture stimulation.

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