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Coupled THM Processes in PFLOTRAN for Modeling Enhanced Geothermal Systems

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Numerical modeling of coupled thermal, hydraulic, and mechanical (THM) processes is crucial for understanding and capturing the complex interactions in enhanced geothermal systems (EGS). We describe the development of the numerical approach for coupling those processes to improving the predictive capabilities for the EGS testbed site, part of the Center for Understanding Subsurface Signals and Permeability (CUSSP). In PFLOTRAN, fluid flow and heat transport are modeled using TH mode which is sequentially coupled with a linear elasticity model for capturing the geomechanical stress response by deformation of the subsurface. Biot's model and and the coefficient of thermal expansion are integrated to capture fluid flow and thermal effects, respectively, in geomechanics. The geomechanical solution contribute to changing the rock properties such as porosity and permeability. The pressure and temperature constitute the primary unknowns when solving the fully coupled system of the mass and the energy conservation equations in TH mode employing the finite volume approach. The displacement is the primary unknown in the quasi-static goemechanical problem and solved with the finite element approach. We aim to present how the geomechanics process model is integrated into PFLOTRAN frameworks and describe the sequential solution strategy for solving the thermo-poro-elasticity problems. We demonstrate the advancement of PFLOTRAN process model coupling for THM processes with numerical experiments for enhanced geothermal systems.

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References

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