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A modeling approach for analysis of coupled multiphase fluid flow, heat transfer, and deformation in fractured porous rock

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Abstract

This paper presents the methodology in which two computer codes—TOUGH2 and FLAC3D—are linked and jointly executed for coupled thermal–hydrologic–mechanical (THM) analysis of multiphase fluid flow, heat transfer, and deformation in fractured and porous rock. TOUGH2 is a well-established code for geohydrological analysis with multiphase, multicomponent fluid flow and heat transport, while FLAC3D is a widely used commercial code that is designed for rock and soil mechanics with thermomechanical and hydromechanical interactions. In this study, the codes are sequentially executed and linked through external coupling modules: one that dictates changes in effective stress as a function of multi-phase pore pressure and thermal expansion, and one that corrects porosity, permeability, and capillary pressure for changes in stress. The capability of a linked TOUGH-FLAC simulator is demonstrated on two complex coupled problems related to injection and storage of carbon dioxide in aquifers and to disposal of nuclear waste in unsaturated fractured porous media.

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