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Analysis of coupled thermal-hydrologic-mechanical model for Springerville CO2 reservoir

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Abstract

The St. Johns - Springerville area lies in the high plateau country of east-central Arizona. A 3-D Geologic framework model is being developed for NRAP-APRA project. Thermal-hydrologic-mechanical (THM) models often need equations that relate the rock permeabilities to stress changes. Existing models relied on tensile failure models or hydraulic fracturing formulas. These methods are useful in understanding near wellbore rock failure under pumping conditions or temperature changes. Faults and to a lesser extent fractures, especially those that are sub vertical, are often thought to fail due the shear slip along the fault or fracture faces. This failure or movement is also responsible for seismic events. Previously we had developed and tested permeability-stress relationships for induced tensile and shear stresses. A plastic failure model, for use with softer caprocks was also developed. These models required that only one type be applied to each gridblock. This precludes a gridblock being affected by both shear and tensile stresses. A combined model was developed (and tested) that combines the all the perm stress models accounts for all stresses and changes the anisotropic permeability tensor appropriately. Coupled thermal-hydrologic-mechanical simulator implemented in FEHM is being used for understanding the coupled modeling component of temperature-stress-permeability interdependence. To perform realistic simulations at the Springerville area we need field information such as geological structure, the hydrological and mechanical properties of the different formations, the subsurface distributions of pressure and temperature, the locations of faults, etc. These parameters are essential for designing numerical models, and model results may be sensitive to small variations in the values assumed. Model sensitivity analysis is used to determine the relative importance of the model parameters. Model driven data collection strategies are developed to prioritize additional modeling and data collection efforts at Springerville area.