The coupling mode analysis of injecting fluid into the deep formation

Chih-Hao Yang[1], Shih-Cheng Lei[1], Wen-Han Tsai[1], Chi-Wen Yu[1]
[1] Sinotech Engineering Consultants, Inc.
No.280, Xinhu 2nd Rd., Neihu Dist., Taipei City 114, Taiwan
+886-2-8791-9198
yangch@sinotech.org.tw

Abstract

Energy development, such as geothermal power generation, gas and oil production, wastewater disposal, and carbon geological storage, all are human activities which have the general potentials to induce micro-seismicity or even trigger unwanted earthquakes. Characterized by conducting fluid injection in deep reservoir, these development schemes are similar in common and the safety of injection activities had long been an issue of public concern. People worried about the security threaten from unstable high pressure during fluid injection operation and potential explosion dangers under incidentally events. For example, the CO_2, a two phase flow fluid in the carbon geological storage activity, may migrate through the pore space of deep formation of sedimentary origin. The pore spaces and rock permeability will control the fluid migration rate and the spatial distribution of injected flowing carbon plume, and result in the variation of the thermo-physical properties of the injected fluid. These interactions will significantly change the hydraulic transfer property inside rock pore space and vice versa.

It had been noted that the CO_2 fluid injection change the mechanical behavior of the surrounding rock, which in turn also reform the pore spaces and effective rock permeability. The interactions in between thermos-dynamic, hydrogeology and rock mechanics (T-H-M) should be considered by using the numerical coupling model to simulate the interaction process of carbon storage effectiveness. In this study, we use the TOUGH2-CSM code and related processing modules to investigate the change of the formation mechanical property during the CO_2 injection in a deep saline aquifer. The simulation results can be helpful to investigate the coupling behaviors of porosity, permeability and effective stress in a scenario analysis where a porous storage reservoir was underlain by a homogeneous cap rock. All the rocks are assumed to be in linear elastic stress-strain relationships, which means the formation rock will not be failure at ultimate stress. Finally, we integrate FLAC3D's mechanical solving capability with TOUGH2's calculation to evaluate the safety of formation during injection and assess the potential of induced seismicity in a preferred storage injection site.