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Overpressure Caused by the Smectite Dehydration Influences on the triggering of fault slip

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Overpressure, which is pore fluid pressure higher than hydrostatic pressure, is observed in numerous mechanical processes along major faults. Many investigations currently show that the pore fluid pressure has been observed to influence the thrust fault strength and slip behavior and updip limit of the seismogenic zone. Clay dehydration is one key control on overpressure generation under undrained condition in thermal pressurization processes. Increasing pressure and temperature with depth depending on the local geological setting and conditions can cause clay dehydration which has been proposed as an explanation for the generation of overpressure. However, study about the effect of excess pore pressure caused by clay dehydration on the triggering of earthquake is seldom addressed in Taiwan. In fault zones like the Chelungpu Fault, clay minerals are abundant in the fault gouge. Therefore, to quantify the effect of overpressure caused by clay dehydration on the triggering of earthquake under undrained condition, we adopt the chemical thermodynamic model and chemical kinetic model to calculate the amount of water expelled from clay dehydration; derive the three-dimensional governing equation of groundwater flow with clay dehydration varied with pressure and temperature; follow the Coulomb-Mohr frictional failure model of earthquake occurrence to evaluate the influence of the pore pressure on the change of effective Coulomb stress. Finally, development of numerical model to simulate the effect of excess pore pressure caused by clay dehydration on the coulomb failure stress coupled thermal-hydraulic-mechanical-chemical has been performed. Moreover, field application with numerical model to quantify analysis of the effect of overpressure caused by clay dehydration on the triggering of earthquake has been progressed. Coulomb stress increases of $\geq$0.01 MPa have been shown to be associated with seismicity rate increase and in many cases triggering earthquakes. The results have shown the safety analysis of earthquake slip in the clay-rich gouge of fault zones. In addition, the study has been proven to be a feasible examining tool for evaluation of overpressure influence on triggering of earthquake, especially when considering faults with abundant clay minerals of smectite.