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Surface Deformation Study for a Geothermal Operation Field

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Surface subsidence from conventional geothermal operations have been observed and studied for many decades. Surface subsidence can induce a devastating effect in the construction of facilities, such as building, pipeline, and other infrastructure. It can also interrupt the balance in the ecosystems nearby. Good monitoring of the surface level and according management of the geothermal operations will reduce the risk of subsidence and the other effects related to it.

In this study, we investigated the surface deformation due to a geothermal field operation located in New Zealand. The associated thermal area for this field has extensive surface features. Operations have started in 1997 and surface subsidence has been observed in the beginning in 2004, and is likely to continue into the future. This is the primary motivation to review and analyze the impact of development plans on ground level changes. Since partial produced water from geothermal operation was re-injected into the reservoir with cold temperature, both pressure and temperature impacts were studied to evaluate the surface subsidence effect. An integrated 3D geological model, geomechanical model, and fluid and heat flow model were developed in the study. The geological model was constructed based on available seismic, log and drilling data. This 3D grid structure forms the basis of the fluid and heat flow and the geomechanical model. Production and injection scenarios were modeled by first applying the fluid and heat flow model. The pressure and temperature output from fluid and heat flow simulation were then transferred to the 3D geomechanical model to estimate the surface deformation. A history match of geomechanical model was first performed against the historical subsidence survey data based on the fluid and heat flow simulation of historical injection and production data. The geomechanical model was calibrated with the observed historical survey data. The calibrated geomechanical model was then applied to simulate future scenarios to predict surface subsidence and provide a guideline to optimize field development plans.