Geomechanical modelling of spent fluid reinjection in the Hengill geothermal field

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Monitoring micro-seismicity during operations of a geothermal field is critical to the understanding of seismic hazard and changes in the reservoir. In the context of a geothermal project, induced earthquakes are an important tool to enhance the permeability and thus productivity of reservoirs and to image structure and processes. However, felt and/or damaging earthquakes are a major threat to societal acceptance and regulatory license to operate. With the adaptive data-driven tool ATLS (Adaptive Traffic Light System), we aim at managing and mitigating the risk posed by induced earthquakes during stimulation and operations, while at the same time ensuring and optimising the productivity.

The demonstration site for the application of ATLS lies in the Hengill volcanic region located in the South-West of Iceland, host to two power plants (Hellisheiði and Nesjavellir) with a total production capacity of 423 MWₜₐₜ and 433 MWₜₐₜ. The production of energy and heat is accompanied by reinjection of the spent geothermal water in dedicated areas, both to maintain production and to comply with legal requirements. These reinjection areas have been showing different seismic responses to drilling and injection operations. We investigate these different behaviours by performing numerical modelling for two of the reinjection regions.

Two models are compared: TOUGH2-Seed, a full 3-dimensional stochastic simulator and an analytical model based on a cumulative density function linking maximum pressure in the reservoir and reactivation. Those two models fulfil two different aspects of the development of an ATLS, with the full 3D allowing an in-depth dive in the driving mechanisms of induced seismicity; and the analytical solution providing a robust and fast approximation of the forecast for real-time application. We show that both models can reproduce observed seismicity patterns in the Hengill geothermal field.