INTEGRATED APPROACH FOR GEOTHERMAL RESERVOIR STUDIES: GEOLOGY, FLUID FLOW AND GEOMECHANICS

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Geothermal reservoirs are characterized by complex geological structures associated with faulted and fractured formations. Highly conductive fractures are the main flow channels and therefore, are the primary targets in well placement design. During the reservoir development, reinjection of cold water at high rates will not only change the stress field but could lead to undesired events like, fault reactivation and potential seismic activity. Coupling fluid flow and geomechanical simulators allows the assessment of potential impact of reservoir operation on the subsurface system, notably the change of flow direction and the closure and opening of fracture networks, affecting the performance of the system as a heat exchanger, and the occurrence of microseismic events due to the reactivation of faults, impacting public acceptance.

This project demonstrates the construction of a 3D reservoir geomechanical model of the Rittershoffen (France) geothermal reservoir, based on structural model built by ES Geothermie. At first, petrophysical and mechanical reservoir properties are obtained from well logs information, then image logs are analyzed to define the fractures geometries and properties. These results are subsequently upscaled to the reservoir grid to build a 3D static property model, including a discrete fracture network (DFN).

Secondly, the dynamic model is build. The first step is to define initial fluid and stress conditions. Most of geothermal reservoirs are not in hydrothermal equilibrium therefore one of key task is correct definition of initial flow and stress boundary conditions. This is done by model tuning to reproduce the temperature and pressure measurements and initial fluid flow. Similarly, stress boundary conditions are calibrated with well and offset data, and mechanical simulations are conducted to define the initial state of stress throughout the field.

Finally, mechanical simulations are coupled with reservoir flow simulations to evaluate the change of stress and strain as a function of fluid and heat flow. Then the model is further calibrated by using historical production/injection rates, well tests, tracer tests, fluid samples: this concludes the history matching, after which reservoir is simulated with different scenarios in order to improve the development strategy and evaluate the performance and risks of the system. Sensitivity analyses are run to assess the impact of poorly constrained parameters, on the behaviour of the geothermal system, together with different production/injection rates that impact cold water breakthrough time, fault reactivation and microseismicity.

The ability to model complex phenomena caused by the hydro-thermo-mechanical behavior of the geothermal system, such as fault reactivation and microseismicity will ultimately allow management of uncertainty and mitigation of the geothermal project risks.

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НАФТОГАЗОНОСНІСТЬ ПАЛЕОЗОСЬКИХ ВІДКЛАДІВ ВОЛИНО-ПОДІЛЬСЬКОЇ НАФТОГАЗОНОСНОЇ ОБЛАСТІ

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Одним із перспективних і маловивченим регіоном України є територія Волино-Подільської нафтогазоносної області. Перспективним напрямком пошуків вуглеводнів на досліджуваній території є пошук родовищ нафти і газу, пов’язаних з пастками неантиклінального типу (поховані