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Understanding driving mechanisms of induced seismicity at the Balmatt geothermal site

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Ambitions to accelerate development of geothermal energy production require development of new geothermal targets. One such target for production of geothermal energy in the Netherlands, Germany and Belgium is the Dinantian fractured carbonates play. The Balmatt geothermal project in Mol (Belgium) is the first deep geothermal project realized in northern Belgium. The project targets the fractured carbonate sequence of the Carboniferous Limestone Group. The site comprises a geothermal plant with three wells drilled to a maximum depth of 4200 m. The production well targets the permeable damage zone of the regional Beringen Fault, whereas the injection well targets a reservoir section at significant distance from the mapped regional fault structures. Equipped with a dedicated monitoring network and having been operated as a research facility, with varying injection rates and volumes, the Balmatt geothermal project provides a unique dataset to analyze the relationship between doublet operations and induced seismicity. In this study, we used seismicity data in combination with operational data on flow rates, injection and production temperatures and well head pressures, to analyze the relationship between operations and seismic activity. Using a coupled thermo-hydro-mechanical model, we quantify the contribution of the physical processes of pressure diffusion, thermoelasticity, poroelasticity and (a)seismic stress transfer to fault loading and induced seismicity. This way we aim to further our understanding of the potential mechanisms driving seismicity in the fractured carbonates at the Balmatt site and in fractured carbonates in general. A better mechanistic understanding of the relationships between operations and seismicity can help managing seismic risks of geothermal operations in these fractured reservoirs. These insights are crucial for designing operations in a way that minimizes risks of induced seismicity in the Dinantian carbonates and to define the operational window at the site.