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Reliability of geometrical interpretation of induced seismicity in geothermal fields

Emmanuel Gaucher and Thomas Kohl

Karlsruhe Institute of Technology (KIT), Institute of Applied Geosciences, Division of Geothermal Research, Karlsruhe, Germany (emmanuel.gaucher@kit.edu)

Induced seismicity is a concern associated with the development and the exploitation of deep geothermal fields. To be mitigated, the physical and chemical processes at the origin of these events must be understood and seismic monitoring in the field is required. Such a monitoring is intended to record and process seismicity to feed real-time mitigation procedures and to provide matter for further investigations. All of them rely on the earthquake hypocentres whose location errors need to be properly understood and quantified to enable reliable interpretation of the induced seismicity.

We illustrate the effect of velocity model errors on the determination of earthquake locations at the Rittershoffen geothermal field (France). In this synthetic study, we generate a cloud of earthquakes representative of the seismicity induced in the field during stimulation. The events are distributed between 1 and 4 km in depth within a radius of 1.5 km around the well. Then, we assume that the real velocity model is a 3D fault model, however, we relocate the events in a 1D velocity model, as often done for initial data processing. Thereby, we introduce velocity model errors between the synthetic and the relocation steps, which leads to discrepancies between the positioning of the relocated earthquake hypocentres and the original one.

This study is performed on hypocentres computed using an absolute location method but also relative-location methods, some of which following a non-linear Bayesian framework. The benefit of a calibration shot is also presented. We analyse the consequences of the wrong velocity model assumption in terms of location uncertainty and inaccuracy. Finally, we discuss how reliable could be the geometrical interpretation of the structural features highlighted by the seismicity distribution.