EGU21-5185, updated on 25 May 2022
https://doi.org/10.5194/egusphere-egu21-5185
EGU General Assembly 2021

Ground motions induced by pore pressure changes at the Szentes geothermal area, SE Hungary

Eszter Békési[1], Peter Fokker[1,2], Thibault Candela[2], János Szanyi[3], and Jan-Diederik van Wees[1,2]
[1]Utrecht University, Earth Sciences, Utrecht, Netherlands (e.bekesi@uu.nl)
[2]TNO Utrecht, Netherlands
[3]University of Szeged, Department of Mineralogy, Geochemistry and Petrography, Szeged, Hungary

The long-term sustainable exploitation of geothermal resources requires cautious planning and regulation. Exploitation in excess of natural recharge can result in reservoir pressure decline, causing a decrease in production rates. Furthermore, such "overexploitation" of geothermal reservoirs may lead to compaction and land subsidence. Understanding of such phenomena is critical for the assessment of societal-environmental risks, but can also be used for optimization by constraining reservoir processes and properties.

Excessive thermal water volumes have been extracted from porous sedimentary rocks in the Hungarian part of the Pannonian Basin. Thermal water production in Hungary increased significantly from the early 70's. Regional-scale overexploitation of geothermal reservoirs resulted in basin-scale pressure drop in the Upper Pannonian sediments, leading to compaction and ground subsidence.

We investigated surface deformation at the Szentes geothermal filed, SE Hungary, where the largest pressure decline occurred. We obtained data from the European Space Agency's ERS and Envisat satellites to estimate the ground motions for the periods of 1992-2000 and 2002-2010. We applied inverse geomechanical modelling to understand the compaction behaviour of the reservoir system and to estimate the subsurface properties. We constrained the model parameters using the Ensemble Smoother with Multiple Data Assimilation, which allowed us to incorporate large amounts of surface movement observations in a computationally efficient way. The model requires pressure time series as input parameters, therefore, the lack of regular pressure measurements in geothermal wells of Szentes resulted in significant uncertainties. Still, we managed to identify a potential delay in pressure drop and subsidence, implying a time-decay compaction behaviour of the reservoir system, and we arrived at realistic estimates for the compaction coefficient of the reservoir. The improved parametrization enables better forecasting of the reservoir behaviour and facilitates the assessment of future subsidence scenarios. This study thus demonstrates the effectiveness of InSAR-based ground motion data and inverse geomechanical modelling for the monitoring of geothermal reservoirs and the establishment of a sustainable production scheme.