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Draganov, Deyan; Naranjo, Deyan; Polychronopoulou, Katerina; Weemstra, Cornelis

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The potential of probabilistic moment-tensor inversions for the characterization of geothermal reservoirs in urban environments

Deyan Draganov[1], **David Naranjo**[1], Katerina Polychronopoulou[2], and Cornelis Weemstra[1]
[1]Geoscience and Engineering, Delft University of Technology, Delft, Netherlands
[2]Seismotech S.A., Marousi, Greece

Geothermal energy is a cleaner and more sustainable source of power, which plays a key role in the transition to a low-carbon economy. Sustainable and safe exploitation of geothermal resources, however, depends on our ability to understand and manage the associated seismic risks. In 2018, Nature's Heat geothermal project began operations in Kwintsheul, Netherlands, aiming to supply heat to 64 hectares of greenhouses. Between July and October 2019, a temporary seismic array was installed to monitor for possible seismic activity at the site. Microseismic moment-tensor inversion is a valuable tool for understanding the mechanics and structure of geothermal reservoirs, and for optimizing their exploitation. It can be challenging, though, to apply this technique when there are high levels of ambient seismic noise, as is often the case in geothermal operations in densely populated areas. In this study, we evaluate the feasibility of inverting the centroid moment tensor of microseismic events in Kwintsheul, using probabilistic moment-tensor inversions. We first test the probabilistic inversion using synthetic recordings of ambient seismic noise, after which we apply the technique to the low-magnitude (Md=0.16) event recorded on July 14, 2019. Our results give insight into the challenges and limitations of applying moment-tensor inversion to low-magnitude events in the context of geothermal operations in the Netherlands.