Seismicity in the Northern German basin - from simple model to complex regime

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The Northern German basin was considered aseismic in most of the seismic hazard maps of last century. Then seismic events occurred in the last decades, and were located in the vicinity of gas production. Until now more than 70 earthquakes are documented with magnitudes ranging from ML 1.0 to 4.5. Especially the 2004 Rotenburg ML 4.5 event caused much concern, and first locations of different authors disagreed in depth. Dahm et al (2007) argued for 5 km depth close to the horizons of gas production, and suggested a depletion-induced event. Macroseismic studies and other authors, however, determined focal depths of 8-12 km, clearly below gas production. Within the last 15 years new stations from BGR (Bundesanstalt für Geologie und Rohstoffe) and the BVEG (Bundesverband Erdöl, Erdgas und Geoenergie e.V.) were established in the region between Cloppenburg and Soltau. Our own work is based on a small-scaled, but dense network with arrays and single stations that were installed from 2014 to 2018 in the eastern central part of the gas fields near Rotenburg. Results resolve that seismic activity can occur in a great range of depths down to 30 km, and it is not exclusively focussed on the reservoir horizons. We found strong dependence of depth determinations from parameter settings – notably vP/vS – and station selection. Besides obvious mis-locations of weak, low SNR events based on few phase readings we also traced this dependency back to the 2004 Rotenburg event which at that time was recorded only by a sparse network of remote stations.

In summary, the Northern German basin offers a complex regime of weak seismicity, ranging from single low-crust earthquakes to frequent, induced events of gas production. The 2004 Rotenburg event does not fit either category, and geomechanical modelling will be needed to decide on its relation to gas production.