



Seismicity and stress field in the vicinity of natural gas fields in Northern Germany

Nicolai Gestermann (1), Thomas Plenefisch (1), and Monika Bischoff (2)

(1) Federal Institute for Geosciences and Natural Resources, Germany (nicolai.gestermann@bgr.de), (2) State Authority for Mining, Energy and Geology, Hannover, Germany

The Northern German basin is a tectonic region of relatively low seismic activity with only singular and weak tectonic events. However, during the last decades seismicity raised in the vicinity of the natural gas fields. Due to the spatial vicinity of the earthquakes to the operated gas fields and their appearance starting after the beginning of extraction they are ranked as induced events. The epicenters of these events extend 50 km NS and 400 km EW from the border to the Netherlands in the West to Altmark region in the East.

Altogether, 47 events with ML 0.5 to 4.5 were detected between 1977 and 2014. Many of them were felt by parts of the inhabitants up to 15 km from the epicenter whereas the strongest one, the magnitude 4.5 event close to the village of Rotenburg on 20th October 2004, was even felt in Hamburg as far as 65 km from the epicenter. Whereas epicenters can be determined with high accuracy, other source parameters, such as focal depths and focal mechanisms, are of lower accuracy. This is mainly caused by the sparse station coverage in the area at least until 2012 and relatively bad signal-to-noise conditions as a result of thick sedimentary layers. Overall, focal depths are found to be rather shallow in the range of 2 to 10 km, correlating with the reservoir horizons.

The process of earthquake generation is still not well understood. Trigger mechanisms have not systematically been investigated. We generally assume, that anthropogenic stress changes within the reservoir lead to the reactivation of prominent tectonic faults. The predominant cause for stress variations might be the large pore pressure reduction in the reservoir as a consequence of the gas extraction. Additionally, heterogeneous compaction within the reservoir may influence the variation of the local stress field.

We present focal mechanisms for 10 events with ML > 2.8 under the assumption of a pure double-couple and invert the solutions for the regional stress field. The majority of the focal mechanisms represents normal faulting and exhibits NW-SE oriented nodal planes being in quite good agreement with the strike direction of nearby tectonic faults. For example, the Aller Lineament which marks the southwestern boundary of the natural gas field Völkersen, might be activated.

In our presentation we compare the focal mechanisms of the induced events of Northern Germany with mechanisms of the natural gas fields in the Netherlands and with the few mechanisms for the rare tectonic events in Northern Germany and adjacent areas. The stress field calculated on the base of the induced events is compared with stress measurements in boreholes published in the European Stress Map for Northern Germany.