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Improved Definition of Faults in the Groningen Field Using Seismic Attributes

Marloes Kortekaas[1], Bastiaan Jaarsma[1], and Barthold Schroot[1]

[1]EBN B.V., Utrecht, Netherlands.

ABSTRACT

The Groningen Field is the largest onshore gas field in Europe. The gas-bearing section comprises aeolian sandstones of Permian age and fluvial sandstones of Carboniferous age. Continuous production since 1963 has led to induced seismicity starting in the early 90’s. From 2003 to 2013, the number and magnitudes of earthquakes increased. The largest earthquake (ML 3.6) was recorded in 2012 causing the most damage to date. Production measures aimed at lowering the level of seismicity have been implemented since 2014. Faults at reservoir level play a major role in the seismicity in the Groningen field. Fault slip is expected when shear traction is sufficient to overcome frictional resistance on the fault surface (e.g. Dost et al., 2012 and Bourne et al., 2014). Clear insights into which faults and which fault segments are most susceptible to seismicity could be used to optimise production and minimise the seismic risk. To gain these insights, a detailed and realistic fault model is required as input to statistical analyses on seismicity and geomechanical modelling of seismogenic behaviour fault planes. Geometrical seismic attributes were extracted from a re-processed and depth-imaged 3D seismic cube. This resulted in a detailed visualization of the faults at reservoir level, with extension into the underburden in some cases. Geobodies were extracted from these attributes subsequently. They represent fault planes with realistic dimensions and shapes. The resulting improved fault model is used to correlate faults with earthquake hypocentres. The extracted fault shapes and dimensions are used in geomechanical modelling of seismogenic behaviour. We conclude that a detailed fault model of the Groningen field can be created using 3D seismic attributes and that detailed 3D fault planes can be extracted from these attributes. The results are input to statistical and geomechanical analyses on seismicity. Figure 1. Top reservoir structural map of the Groningen field. Inset shows NW-SE filtered geobody faults. Solid lines indicate original fault model. Red dots indicate seismic events. References Bourne, S. J., Oates, S. J. , van Elk, J. and Doornhof, D. (2014). A seismological model for earthquakes induced by fluid extraction from a subsurface reservoir, J. Geophys. Res. Solid Earth, 119, 8991–9015. Dost, B., Goutbeek, F., van Eck, T., Kraaijpoel, D., (2012). Monitoring induced seismicity in the North of the Netherlands: status report 2010. KNMI report.