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Analysis of subsalt induced seismicity in the Netherlands

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A number of natural gas fields in the North of the Netherlands show moderate seismicity induced by gas extraction. The gas reservoirs are located underneath a thick layer of Zechstein evaporites (salt). The presence of the salt has two important effects on the wave motions of induced events as observed at the surface close to the epicenter. The first effect is the defocusing of seismic energy with its consequences for observed amplitudes and radiation patterns. The second effect is the relatively strong conversion from P- to S-energy at the bottom of the salt leading to the presence of S-wave precursors. Failure to recognize these effects may lead to misinterpretation of source location and mechanism. Moreover, the S-wave precursors provide a handle to reduce uncertainty in depth estimation.
We investigate the effects using a number of strong motion records measured at short epicentral distances for some of the stronger recents events (M2.0-3.5) in the Groningen field.