ESC2016-206, 2016
35th General Assembly of the European Seismological Commission

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4–10 September 2016 Trieste

Seismic monitoring performance for hydraulic fracturing

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Hydraulic fracturing is considered among the human operations which could induce or trigger seismicity or microseismic activity. The influence of hydraulic fracturing operations is typically expected in terms of weak magnitude events, although moderate magnitude events associated to fracturing operations have been recently observed in Canada. The sensitivity of the rock mass to trigger seismicity varies significantly for different sites and cannot be easily predicted prior to operations. However, the detection and location performances of a planned monitoring network can be assessed and this information later used to judge the amount of background and induced microseismicity. We perform a seismic monitoring at a shale gas exploration/exploitation site in the central-western part of the Peribalticsynclise at Pomerania (Poland). The monitoring setup includes a distributed network of broadband stations covering a region of 60 km2, and three small-scale arrays of short-period stations with aperture between 450 and 950 m. The fracking operations are planned in May 2016 at a depth 4000 m in two horizontal wells. The monitoring of background seismicity started in July 2015 and will be continued during and after the termination of hydraulic fracturing operations. Seismic data from the pre-operational phase can be used to assess the seismic noise and the detection performance of our monitoring setup, making use of a synthetic microseismic catalogue and synthetic waveform dataset. We adopt a recently developed tool to generate a synthetic catalogue, considering a realistic distribution of hypocenters, magnitudes, moment tensors and source durations. Synthetic waveforms are generated for a local crustal model and superposed to real noise traces reproducing true monitoring conditions. Detection rates are used to estimate the detection probability for different magnitudes, source-receiver distances and noise conditions, finally mapping the magnitude of completeness in a target volume around the hydraulic fracturing horizontal wells. Our technique is useful to evaluate the efficiency of the seismic network and validate detection and location algorithms, taking into account the signal to noise ratio. The application of a detection tool to synthetic and real seismic data during different phases is then discussed in the framework of our concept to assess the monitoring performance.

This work is funded by the EU H2020 SHEER project.