

EGU21-13040

<https://doi.org/10.5194/egusphere-egu21-13040>

EGU General Assembly 2021

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Induced micro seismicity due to raising mine water level in former coal mines in the eastern Ruhr area (Germany)

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FloodRisk is an interdisciplinary project focusing on the effects of mine water level rise in abandoned coal mine regions in Germany. Such effects are heterogeneous ground uplift, stress changes due to the change in pore pressure and the reactivation of potential faults. One of the most directly measurable effects is certainly the induced micro seismicity. It is known from previous studies that the flooding of old mines can lead to a renewed increase level in induced micro seismicity in these regions.

In this study the relationship between mine water rise, fluid-induced stress changes and induced seismicity in the Haus Aden dewatering area in the eastern Ruhr area (Germany) will be investigated in more detail.

For this purpose, we operate a network of currently 21 short period seismic stations in the region of the former "Bergwerk Ost" colliery, which had the highest seismicity rate in the Ruhr area during active underground coal mining. This network is still to be expanded to cover the entire water drainage area, about 30 Raspberry Shake sensors are waiting for the possibility of installation.

Nevertheless, the existing network registered almost 1000 induced micro seismic events in a magnitude range from -0.7 up to 2.6 M_{LV} . Many of these events are spatially clustered and some show quite high waveform similarity. This allows relative localisation and can increase the accuracy of the location. The depth location of the earthquakes, within the limits of localisation accuracy, agrees very well with the distribution of seismicity at the time of active mining. The spatial distribution so far seems to be limited by a large inactive transverse fault in the west. It needs to be clarified what influence this fault has on the propagation of mine water in the underground.

The measured temporal trend of the mine water level, after pumps were shut down in mid-2019, shows a strong correlation with the temporal evolution of the observed micro seismicity. In the first months after the pumps are switched off, the water levels at the observation points rise only slowly and isolated microseismic events occur again. In November 2019, the rise in water levels doubled and at the same time, the strongest induced event in the measurement period was recorded with a magnitude of 2.6 M_{LV} . In the following months, the seismicity rate ranged from 8 to 34 events above 0.5 M_{LV} per month, some of which were felt. A structural geological 3D subsurface model is developed to help to understand the distribution of induced seismicity and the role of the raising mine water level.

