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▶ **To cite this version:**

Dalija Namjesnik, Peter Niemz, Jannes Lennart Kinscher, Simone Cesca, Isabelle Contrucci, et al.. Clustering and event similarity based fault characterization of post mining induced seismicity of Gardanne mine, France. EGU General Assembly 2022, European Geosciences Union (EGU), May 2022, Vienne, Austria. pp.EGU22-7757, 10.5194/egusphere-egu22-7757 . ineris-03895193

HAL Id: ineris-03895193
https://ineris.hal.science/ineris-03895193

Submitted on 17 Apr 2023

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EGU22-7757, updated on 17 Apr 2023
https://doi.org/10.5194/egusphere-egu22-7757
EGU General Assembly 2022
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Clustering and event similarity based fault characterization of post mining induced seismicity of Gardanne mine, France

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In post-mining environments, seismic hazard is still not very well understood, as number of research studies remains limited. Seismicity is often considered in post-mining risk mitigation procedures as a precursory of failure initiation in rocks within the mining works leading to ground instabilities. However, flooding of the mines can also lead to perturbations of stress states and pore pressures within the rock mass leading to failure of pre-existing faults, which may have more important impact on public safety due to a potentially longer period of activity and possibly higher magnitudes of the induced seismic events depending on the fault size.

In a former coal mine in Gardanne, France, which was abandoned in 2003 and flooded afterwards, seismicity started appearing and raising concerns since 2010, when flooding reached the center of the mining basin. The seismic activity has been occurring approximately every two years in the form of crises. Events were also felt by the local population. A sparse temporary monitoring network has been installed in 2013 in this seismically active area. Based on research results so far, seismicity originates from the reactivation of faults underlying the mining excavations and is influenced by flooding, pumping of the water, and seasonal meteorological conditions.

We investigate the clustering behavior and multiplet occurrences within the seismic events recorded by the sparse temporary microseismic network between 2014 and 2017. Detailed cluster analyses, the spatio-temporal distribution, recurrence time patterns, and source parameters help to characterize seismically active structure(s) below the mining works. The triggering of the seismic activity in each cluster appears to be differently influenced by the hydro-meteorological conditions, with some clusters being more affected by rainfall, while other by dry period. The variations of the pumping rate strongly affect the rate of seismicity in this area as well. The analysis is complemented by incorporating a new dataset recorded by an enhanced monitoring network during 2019, which allows to follow the evolution of the cluster activity.