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# Influence of stress changes and geological heterogeneities on mining-induced seismicity

Francesca De Santis (1,2), Isabelle Contrucci (1), Pascal Bernard (3), Jannes Kinscher (1), Vincent Renaud (1), and Yann Gunzburger (2)

(1) INERIS, France (francesca.de-santis-etudiant@ineris.fr), (2) GeoRessources, Université de Lorraine, France (francesca.de-santis@univ-lorraine.fr), (3) IPGP, Paris, France

Microseismic events (MSE) in underground mines are the result of stress perturbations and rock fractures due to mining excavations. In the last decades, the problem of mining-induced seismicity has become more and more important due to the increasing depth of underground mines. Indeed, in situ stresses on average increase with depth, resulting in seismic activity intensification, both in terms of events rate and radiated seismic energy. Understanding how and why MSE occur is, then, a fundamental purpose in order to control the rate of seismicity and guarantee mine infrastructures and mine workers safety.

With the aim of better understanding interactions between stress modifications induced by mining and the generation of seismic activity, different factors need to be taken into account: geological structures and rock properties, initial state of stress and stress modifications, but also mining method, excavation geometry and blasting practice, are some of the principal aspects affecting seismic activity in mines. This interaction between natural and anthropogenic parameters makes the understanding of mining-induced seismicity more complex, not only because the seismic response to mining will be unique at each mine, but also because it requires multi-parameter approaches.

In this work we present data collected in the metal mine of Garpenberg (Sweden) exploited by the mining company Boliden, where a monitoring network was installed by INERIS between 1108 and 1257 meters below ground surface. The network consists in both one-component and three-component geophones for MSE recording, together with two geotechnical cells for local stress field changes monitoring.

A comparative analysis of seismic and geotechnical data, together with information about mine production will be presented, in order to determine correlations between blasting procedures, MSE occurrences and local stress field modifications. It will be shown how mine blasts play an important role in seismic activity triggering, even if the rock mass response to mining appears to be very variable across space and time. Differences in rock mass behavior will be explained by considering local geology characteristics and stress redistribution in the monitored area. Indeed, increases in seismicity rate will be justified by the fact that some mine blasts have an effect on remote overstressed areas. This effect is intensified by the presence of weak geological zones which produce a heterogeneous distribution of the initial stress field. Seismic source parameters analysis will allow understanding differences in ruptures dynamics and source region characteristics between areas of the mine dominated by distinct geological properties. Finally, first results of numerical modeling will be presented and compared with the integrated analysis of geotechnical and geophysical data, with the aim of giving first insights on seismic risk prevention at Garpenberg mine and, more generally, in deep underground mines prone to rockbursts.