



## **Local seismic effects in Swedish underground mines (Zinkgruvan, Garpenberg, Kiruna)**

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Three local seismic systems from Institute of Mine Seismology (IMS) were installed by August 2015 in deep underground mines in Sweden – Zinkgruvan Mine (Lundin Mining AB), Garpenberg Mine (Boliden Mines), and Kiirunavaara Mine (LKAB). The areas of installation are chosen within the volumes where large rockbursts are expected. One of the systems is deployed at depth around 700 m and the other two around 1100 m. The horizontal extent of the instrumented volumes is between 65 and 115 m. Each system consists of 16 to 18 sensors. A combination of uni-axial and three-axial 4.5 Hz geophones is installed on the wall and roof surfaces of the drifts, in shallow (~0.5 m) and deeper (6-9 m) boreholes. Extensometers and instrumented bolts are installed in close proximity to the profiles with seismic sensors. Data acquisition systems run mostly in triggered mode, with remote access to the data. Very small to larger seismic events (local magnitudes from ~ -4.5 to 2.0) are recorded during the time of operation.

The aim of the seismic systems is to provide data about the seismic waveforms recorded as they approach the underground openings. Data is used to evaluate: 1) the site effect on the amplitudes, frequency content, and duration of the seismic signals, 2) the attenuation/amplification of the seismic waves. The seismic data is correlated with the records from the extensometers and instrumented bolts in case of larger seismic events, rockbursts, and blasting in the surrounding area. The final goal is to obtain new information for improvement of the requirements for the rock support in rockburst prone areas.

The results show large variations of the amplitudes and frequencies of the recorded seismic waves within small distances, as well as between the walls and the roof. Data recorded by the local systems in the near-field are used for estimation of the attenuation and for comparison with the far-field attenuation derived from mine-wide data. Results are obtained also on the amplitude and frequency modification of the seismic waves as they approach the surface of the walls/roof of the underground openings.