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# Rock mass response to strong ground motion generated by mining induced seismic events and blasting observed at the surface of the excavations in deep level gold mines in South Africa

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The strong ground motion generated by mining induced seismic events was studied to characterize the rock mass response and to estimate the site effect on the surface of the underground excavations. A stand-alone instruments, especially designed for recording strong ground motions, were installed underground at a number of deep level gold mines in South Africa. The instruments were recording data at the surface of the stope hangingwalls. A maximum value of 3 m/s was measured. Therefore data were compared to the data recorded in the solid rock by the mine seismic networks to determine the site response. The site response was defined as the ratio of the peak ground velocity measured at the surface of the excavations to the peak ground velocity inferred from the mine seismic data measured in the solid rocks. The site response measured at all mines studied was found to be $9 \pm 3$ times larger on average.

A number of simulated rockbursts were conducted underground in order to estimate the rock mass response when subjected to extreme ground motion and derive the attenuation factors in near field. The rockbursts were simulated by means of large blasts detonated in solid rock close to the sidewall of a tunnel. The numerical models used in the design of the simulated rockbursts were calibrated by small blasts taking place at each experimental site. A dense array of shock type accelerometers was installed along the blasting wall to monitor the attenuation of the strong ground motion as a function of the distance from the source. The attenuation of the ground motion was found to be proportional to the distance from the source following $R^{-1.1}$ & $R^{-1.7}$ for compact rock and $R^{-3.1}$ & $R^{-3.4}$ for more fractured rock close to the surface of the tunnel.

In addition the ground motion was compared to the quasi-static deformations taking place around the underground excavations. The quasi-static deformations were measured by means of strain, tilt and closure. A good correspondence between the quasi-static deformations and seismic ground motion was found.

During the blasting time and the subsequent seismic events the strain, tilt and closure show a rapid increase. Similar increase was observed during the strong seismic event. The deformations associated with a strong seismic event were described as ‘fast’ seismic events. Much of quasi-static deformations, however, occurred independently of the seismic events and was described as ‘slow’ or aseismic events.