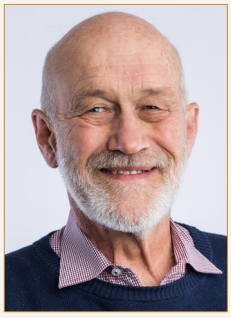
Seismic activity related to mining



This issue focuses on mine seismology, a discipline that has its roots in the South African mining industry. Gold was discovered near present-day Johannesburg in 1886. Mining related seismicity was first encountered in the early 1900s, when extensive stopes, supported solely by small reef pillars, reached depths of several hundred metres. In 1908, -the Government Mining Engineer appointed a committee to "inquire into and report on the origin and effect of the earth tremors experienced in the village of Ophirton" (Report of the 1908 Ophirton Earth Tremors Committee, Witwatersrand Earth Tremors Committee, 1915). The committee concluded that "… under the great weight of the superincumbent mass of rock [...] the pillars are severely strained; that ultimately they partly give way suddenly, and that this relief of strain produces a vibration in the rock which is transmitted to the surface in the form of a more or less severe tremor or shock." Since then, strenuous efforts have been made to understand the phenomenon of mining induced seismicity, and to mitigate the harm that it causes through damage to mine workings and surface infrastructure, loss of production, and injury to mine workers and the public.

In recent decades, the South African mining industry has made great strides in improving safety. Every death is a tragedy. Nevertheless, we are encouraged that 2022 is the safest year on record, with 49 deaths, compared to a toll of 484 in 1994, with a similar workforce of about 500,000. Provisional figures published by the Ministry of Mineral and Petroleum Resources suggest that 2024 might be even safer. Up until 9 December 2024, 41 lives had been lost and 1746 reportable injuries had occurred, of which 12 of the deaths (29%) and 253 of the injuries (15%) were 'rock-related' (i.e. attributed to falls of ground and rockbursts). The rockburst risk has been reduced but not eliminated, requiring further research and better implementation of knowledge and technology. As shallow ore bodies are depleted, the depth of mining is likely to increase and it will become even more important to reduce the risk of rockbursting by managing mining-induced stresses, reinforcing excavations with robust energy-absorbing support elements and systems, and reducing the exposure of mineworkers to hazardous conditions through mechanization and automation.

Not all seismicity related to mining is bad. For example, there are techniques to destress the rock mass and reduce the likelihood of damaging events by releasing stored seismic energy at times and in places where it does not pose a risk. Furthermore, there are mining methods that depend on stress-induced fracturing to break the rock. Here it is important to monitor the progression of the cave front. Seismic energy can also be used to image the rock mass and detect new ore bodies, map extensions to existing ore bodies, and detect structures that might be seismogenic and pose risks, such as faults and dykes. Lastly, deep South African gold mines have provided the stage for pioneering scientific investigations of the physics of earthquakes, the nature of neutrinos, the characteristics of 'extremophile' organisms (which could be prototypes of extraterrestrial life), and even the origin of the magnetic field of the Earth and Sun.

The development of knowledge and skill in the field of mine seismology is vital for the wellbeing of the South African mining industry. The papers in this special issue record current efforts by industry practitioners and researchers to ensure that our mines remain efficient while we strive for zero harm.

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