

Integration of underground mapping, petrology, and high-resolution microseismicity analysis to characterise weak geotechnical zones in deep South African gold mines

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Abstract:

A highly-stressed shaft pillar is prone to large seismic events, falls of ground and rockbursts, which may cause injuries and loss of production, especially in weak geotechnical zones. It is thus important to identify weak geotechnical zones in order to mitigate risks. In this study, we present integrated studies (underground mapping, petrology, rock mechanics and high-resolution microseismicity analysis) to understand the different geotechnical zones in the shaft pillar of Cooke 4 mine in South Africa. The footwall of the remnant shaft pillar comprises the Upper Elsburg reef of the Mondeor Formation, while the Ventersdorp Contact Reef (VCR) of the Venterspost Formation and soft/weak lavas of the Westonia Formation form the hangingwall. Results from underground mapping and microscopic analysis show that the shaft pillar is composed of quartzites, pebbly quartzites, argillaceous quartzites and conglomerates. Underground mapping further shows that the shaft pillar is characterized by several discontinuities, which vary from minor to macro scale fractures. Laboratory uniaxial compressive strength (UCS) tests indicate that quartzite has the strongest strength, followed by pebbly quartzite, argillaceous quartzite and lastly, conglomerate. Analysis of high-resolution acoustic emissions (AEs) clusters indicates that the majority of AEs are associated with the mining stope faces. The clusters show the formation of Ortlepp shears ahead of the stope, which is caused by the excavation-induced stress field. Microseismic data further reveal that the fracture turning-point occurs in the soft strata (weak hangingwall lavas). The integration of these datasets has allowed us to develop the fracture model for different geotechnical zones, which concurs with previous models developed for the similar underground environment (i.e., weak/soft lava hangingwall and quartzite/conglomerate footwall). This has major implications for future mining, support, production and safety.