Rockbursts at Great Depth

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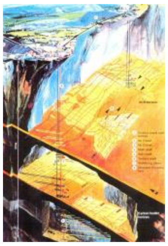
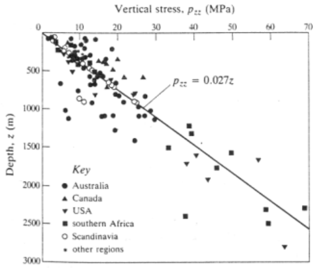
1. Introduction

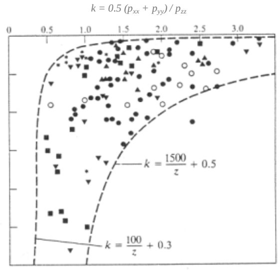
The general term „rockbursts" relates to seismic events generated in mining environments, especially in connotation with violent rock failure. Several types (mechanisms) of events could be distinguished , which also show a typical damage pattern underground. Some of these seismic events are strong enough to cause damage on surface.



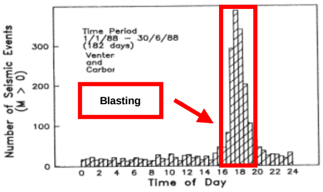
Deep mining is conducted in South Africa west of Johannesburg along the so-called Golden Arc. The mining depth has reached 4000 m. Rock stresses approach the bearing capacity of undisturbed rock, hence rockbursts occur frequently and different mechanisms of rockbursts could be distinguished.

Seismicity is experienced as a major obstacle in mining at great depth as vertical stresses increase and horizontal stresses decrease in respect to vertical stesses (Hoek & Brown, 1980).

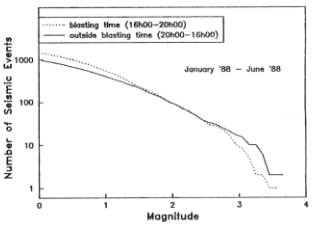




2. Statistics



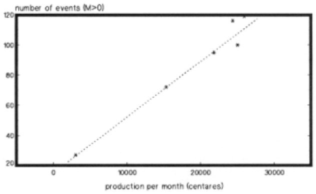
Approximately 700 seismic events (M > 0) were recorded over 6 month. 80 % occurred in ultimate vicinity of the mine workings.
The remaining 20 % are spead between the neighbouring mines.
No seismic tendency could be observed during the week or year.



The b-value is different during the two time spans. During blasting time (in red in the diurnal diagram above) more small events are generated, whereas outside blasting time larger seismic events tended to happen, indicating long-lasting stress adjustments.

(June '87 until November '87)

Lower Carbon Leader Reef



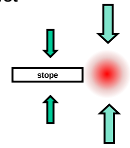
During a labour strikein 1987, mining production came to a standstill. After the strike, production recovered on a linear rate, which also corresponded with a linear increase in seismicity (M>0, centares = m² ~ m³)).
The mining induced seismicity increases with depth.

3. Types of Rockbursts

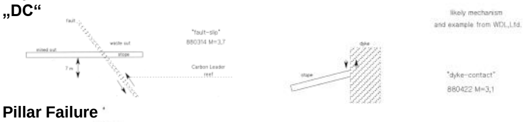
Several rockbursts could be distinguished in deep level mining:

1. Face bursts (the classic rockburst; exceedance of the yielding capacity of the rock face)
2. Fault slips and dike events (comparable with tectonic earthquakes)
3. Pillar foundation failures (pillare are over-loaded and punched into the ground)
4. Abutment failures (remaining abutments are approached by mining)

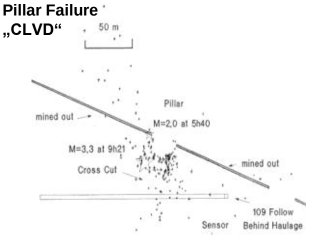
Face Burst „ISO"



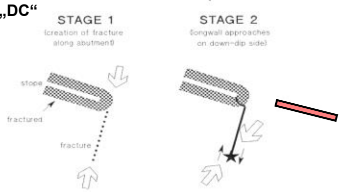
Slip Event „DC"



Pillar Failure „CLVD"



Abutment Failure „DC"

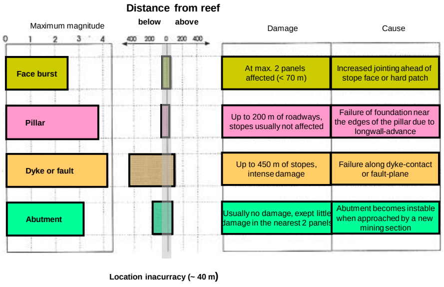


Damage after and tensile crack in footwall after pillar foundation failure. The crack had a length of 80 m.

Legend of observed mechanisms: ISO – Isotropic; DC – Double Couple; CLVD – Compensated Linear Vector Dipol

4. Summary

As rockbursts have different causes, their effects also differ very strongly. Whereas face bursts and faults/dyke slips are considered most dangerous as they occur more frequently, other seismic events in mining are more counter-productive, such as pillar foundation failures at great depth.



Selected References

Hoek, E. & Brown, E.T. 1980. Underground excavations of rock. The Institution of Mining an Metallurgy, London.
Lenhardt, W.A. 1992. Seismicity associated with deep level mining at Western Deep Levels Limited. J.S.Afr.Inst.Min.Metall., Vol.92, No.5, 113-120.

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