Contents

• Overview

• History of rock bursts

• Investigation, findings and recommendations

• Completed actions/changes – Future + Legacy

• Update on progress

• Way Forward

• Questions
Plan of Siphumelele 1 Shaft

Location of the events in relation to the shaft Magnitude = 1.7 & 2.7
Plan of Siphumelele 1 Shaft

Mining depth ~1330 m below surface
Deepest stoping section at the shaft
Virgin stress = 37.18 MPa
Reef dip ~9 degrees
Declines positioned 60 m below reef
Area being mined by 2 different MO sections
System Sensitivity
Rock Burst History

- $M_L 2.0$
  - 18/08/2013
- $M_L 2.6$
  - 31/12/2012
- $M_L 1.7$ & $M_L 2.7$
  - 10/12/2013
- $M_L 2.1$
  - 18/02/2013
Events 10 December 2013

ML 1.7 & 2.7
10/12/2013
Conditions Prior to the Events

Condition of west mining face before the event
4E Gully closed from ~ 10m from face
Elongate damage above 4E gully in back area
Rock Burst Damage

5E gully closed ~ 10m from face

2013/12/18
Complete stope closure just above 5E gully
Rock Burst Damage
Events Post December 2013

- M 2.8 on 2014/09/30 At 33E-01
- M 3.1 on 2014/09/23 At 33W-01
- M 2.2 on 2014/07/28 At 33W-01
- M 2.7 on 2014/10/07 At 34W-01
- M 1.7 on 2013/12/10 At 34E-01
- M 2.7 on 2013/12/10 At 34-01
Damage – Footwall Infrastructure

33 Main Tip: Tensile separation in the hanging wall

33e-08 x-cut: Damage observed

33 Haulage

33W-01 x-cut: Large FOG

34 Main Tip: Small FOGs from shotcrete

Footwall Infrastructure

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Hazard Assessment Footwall

Peak Ground Velocity
Hazard Assessment Footwall - RCF
Numerical Modelling Results - APS

Average Pillar Stress Results – Criteria 500 MPa
External Stakeholders

- All platinum RE HODs
- Simrac researchers
- IMS – Dr. Gerrie van Aswegen
- Gold mine RE HODs
- Dr. Matthew Handley
- DMR
Findings

- Seismic events are associated with ad hoc and regional pillars
- Pillars punch into the footwall with extensive footwall heave in surrounding area
- Little to no damage to hanging wall
- Pillars that experienced seismic events had APS > 300 MPa
- Irregular shaped pillars
- Poor mining sequence in certain cases
**Actions**

- Used numerical modelling to establish new design criteria (IMS patronage research)
- Stopped all mining in the central bottom area
- Changed all new designs to comply to new design criteria and confirmed with modelling
- Reviewed current active working places and adjusted designs where required (left additional pillars)
- Reviewed by external consultant
- Conducted risk assessment of infrastructure where legacy pillars exist
- Started program of secondary support based on risk assessment
- Various sessions with Siphumelele team on changing mind set
- Monthly monitoring in-stope pillar compliance
- Briefed other operations
Regional Pillar Design Changes

Broken dip pillars –
To overstope haulages

Solid dip pillars –
31 level downwards
Haulages 35 to 40 m
In footwall
Modelled Regional Pillar Design Changes
Seismic History - Before and After Design Changes

Seismic event of Mag ≥ 0.5

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Final Changes Below 31 Level

- Regional pillar spacing 210 m and continuous (No holings)
- Regional pillar w:h ratio 20:1 and APS < 2.5 x UCS of footwall
- Ad hoc pillar w:h ratio 20:1 and APS < 300 MPa
- Strict adherence to overall mining sequence. No mining in opposite directions or from one side only.
- Leads and lags between panels = 15m
- Regular shaped pillars
- Strict adherence to in-stope pillar dimensions
- Install rock burst resistant support in haulages below pillars
- Mesh and lace x/cuts next to pillars and Rocprops and anchors beyond footwall marker