Improving Ground Control Risk Management Practices

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2006 Queensland Mining Industry Health and Safety Conference

Overview

- MIRMgate sponsors
- MIRMgate background
- Bow Tie Analysis approach
- Hypothetical rockburst scenario
- Application of Bow tie Analysis approach on MIRMgate
- Challenges & strategies
- Shaping MIRMgate for Users' Needs of the Future
  - New MIRMgate services
  - Future Directions

MIRMgate Sponsors

- MCA
  - Oversees MIRMgate progress
  - Provides input for further system
    - development, and
    - implementation
  - Contributes towards database population

- ICMM
  - Oversees MIRMgate progress

Mining - Hazardous

Mining by its nature is a hazardous occupation in terms of safety and health and individuals are not immune from the likelihood of an accident or injury.

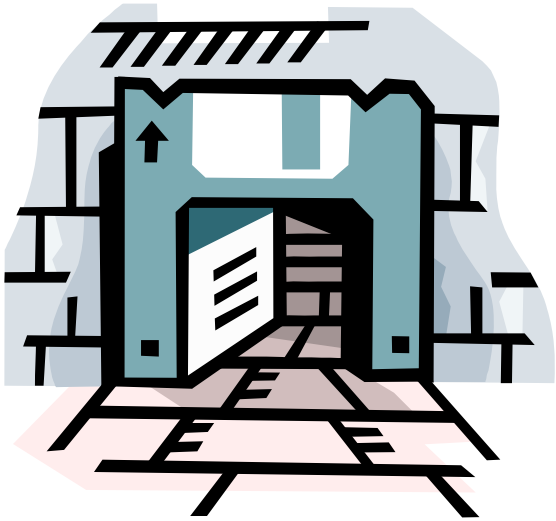
Mining Risks

- Traditional mining risks would include but not limited to
  - Ground control
  - Equipment operation / maintenance
  - Changes in production methods, and
  - Others….

How could MIRMgate assist?

- What are the best practices in managing ground control in Australia and overseas?
- What are the latest, most effective ground control management techniques?

MIRMgate Background



- Established in June 02
- Launched in March 04
- Developed, managed and hosted at MISHC
- System and website upgrade completed in June

MIRMgate
Minerals Industry Risk Management Gateway

Your Gateway to
Minerals Industry Risk Management

About MIRMgate
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MIRMgate Survey
MIRMgate News
Alert Service

MISHC
Minerals Industry Safety & Health Centre

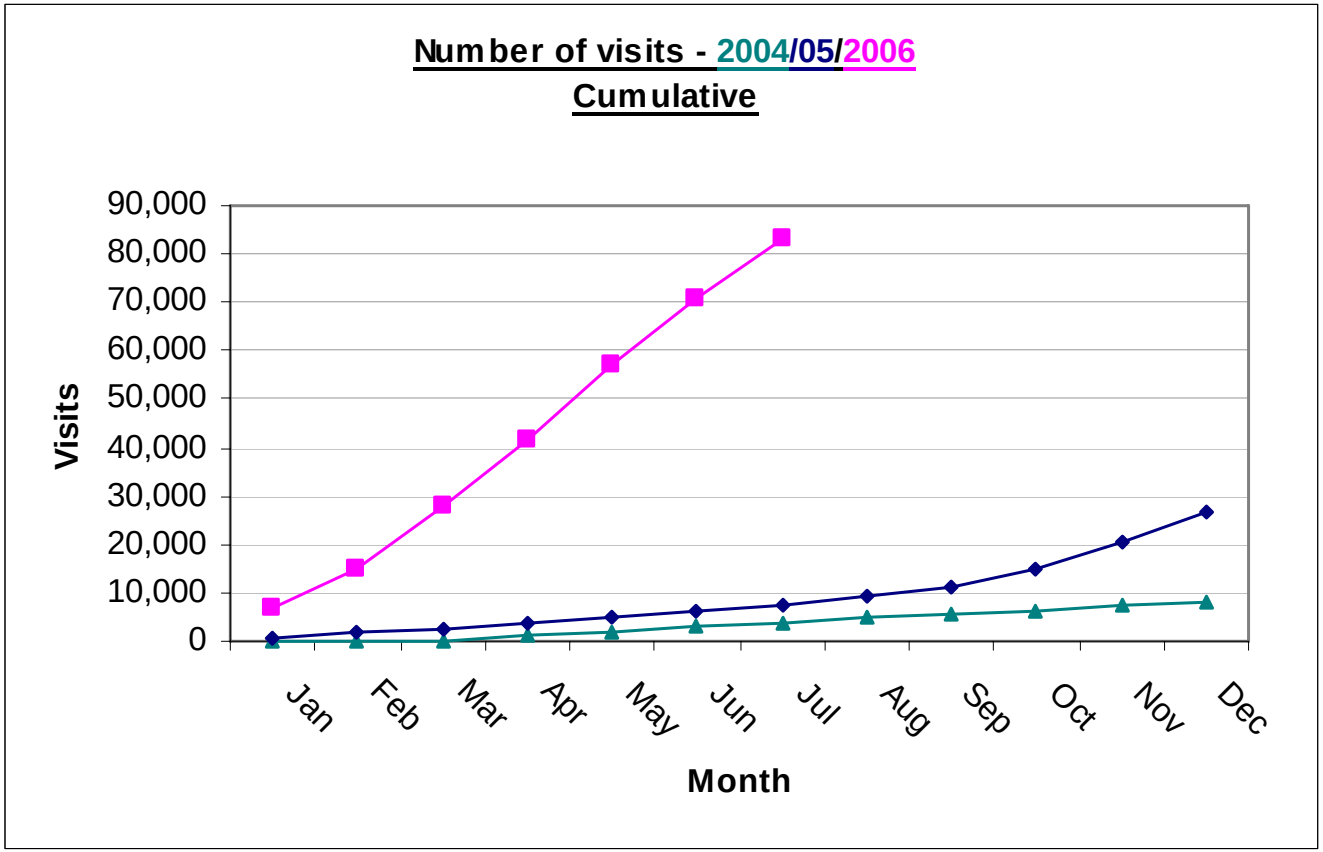
ICMM
International Council on Mining & Metals

Minerals Council of Australia

Welcome to MIRMgate..... your one-stop shop for good practice information about managing safety and health risks in the minerals industry.

Site Usage

Site usage continues to grow.

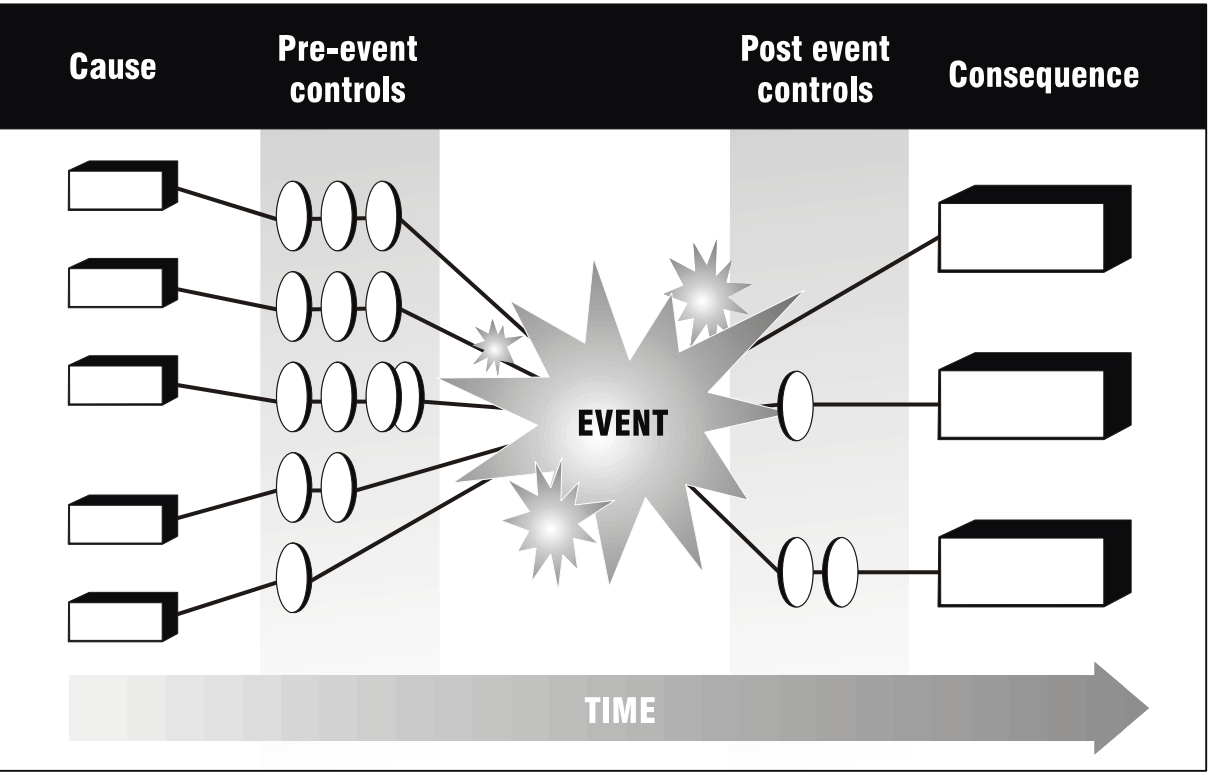


Number of visits between Q1 06 – Q2 06.

MIRMgate CONTROL ANALYSIS

MINING INDUSTRY HAZARDS		
Blasting		Ground Control
Conveyors		Health and Well Being
Drilling		Mobile Plant
Exploration		Natural and Physical
Fixed Plant		Ventilation

Bow Tie Diagram



Bow Tie diagram has 3 distinct pieces: 1.Potential major event, 2.Causal pathways, and 3. Controls.

Centre: Unwanted event is given in the centre of the Bow Tie.

Left Side: Describes the causes that have potential to lead to an initiating event. The controls or barriers to the event occurring are also shown. Proactive controls.

Right Side: Describes various consequences that can occur. The controls or barriers that are in place for after an event occurs are also shown. Reactive controls.

Ref. Stephen Lawson, Formal safety assessment methodology utilizing control effectiveness evaluation, Newmount Australia

Hypothetical rockburst scenario

Background information

- In 1990's: UG nickel mine operated, utilising narrow vein mining method
- In 1996: Due to falling commodity prices & increasing input costs was placed under care and maintenance
- In 2000: Metal prices increase. Reassessed as economic.
- Miners were sent back into this area to
  - extend old development, and
  - recommence mining.

Hypothetical rockburst scenario

Re-entry

Prior entering, re-entry procedure was followed which included:

- Visual inspections,
- Re-ventilating,
- Checking for gas accumulations, and
- Pumping out of excess water.

Prior re-entry:

- No new specialised geotechnical assessment. Area appeared stable during inspection.
- No ground support monitoring. No visible fretting or slabbing of the roof or sides.
- Secondary support not considered as primary support appeared stable.
- Exploratory drilling did not recommence. Initial drilling did not show any large geological structures possibly due to the large spacing between boreholes.

Hypothetical rockburst scenario

Historical data:

- Old workings survey plans. Assisted with determination of possible flooded and gaseous areas
- No information on the overall stability of the area to be mined. Data relating to ‘as mined’ layouts & previous geotechnical investigations were not available.

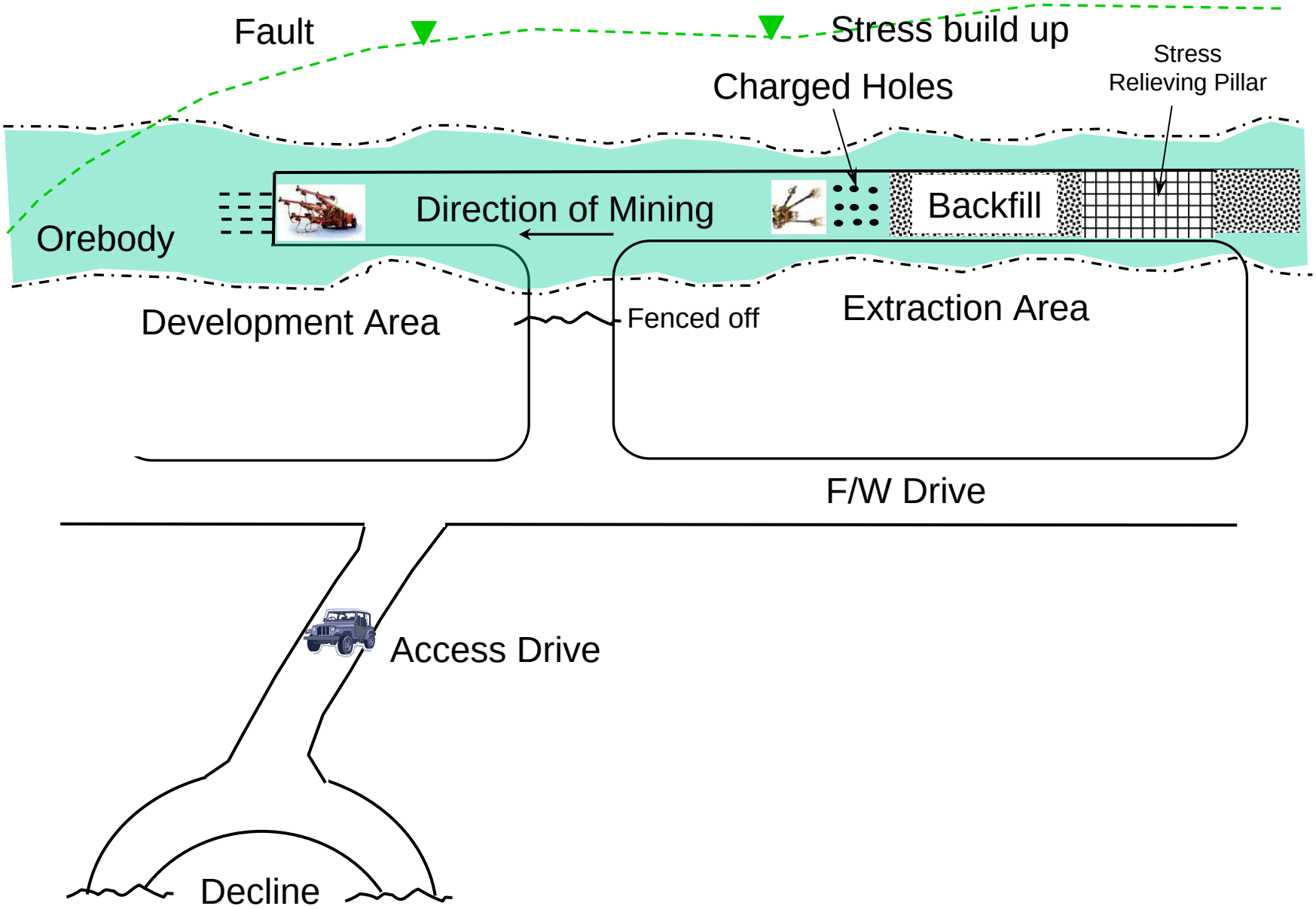
Hypothetical rockburst scenario

Rockmec charging truck, Nitro Nobel. Ref. Mining and Construction methods. Guide to underground mining. Methods and applications. Atlas Copco.

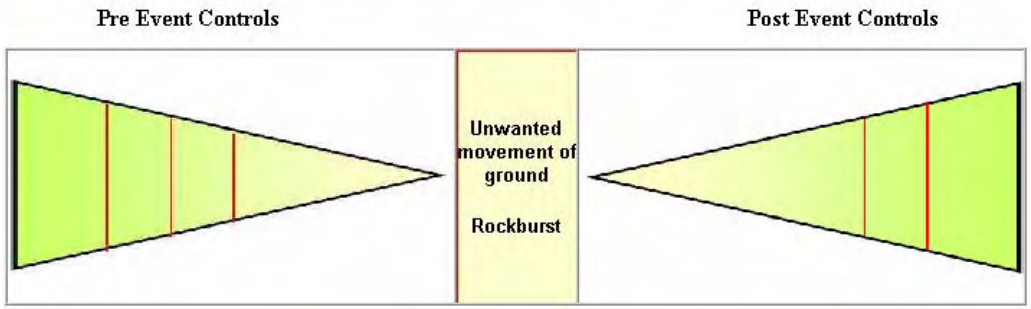
What happened?

- Charging crew to load blast holes at the brow of an uphole bench
- Seismic event:
  - Likely to be associated with the recommencement of mining, and
  - Increase in stresses stored in the fault zone
- Resulted in a fall of ground in the roadway in which the crew was operating

Hypothetical rockburst scenario - Impacts of the event



Underground Ground Control: Controls



HIERARCHY OF CONTROLS			
Elimination	Substitution	Isolation / Engineering	Administrative / PPE

CAUSE	PRE EVENT CONTROLS						POST EVENT CONTROLS		CONSEQUENCE
Inadequate ground support	DESIGN	PASSIVE	ACTIVE	WARNING	PROCEDURAL	Unwanted Event	First Response	Second Response	Fatality
Inadequate geotechnical assessment									Severe injury to a mineworker
Inadequate support type									Damage to machinery
Inadequate mine design									Production loss
Effects of water									Community concern
Inadequate stress modelling									Reputation damage
Geological structures (faults)									Increased costs
Seismic event									
Limited historical data									
Inadequate monitoring									
No exploratory drilling									
No Secondary Support									

INADEQUATE GROUND SUPPORT

CONTROLS

CONTROL TYPE	CONTROL DESCRIPTION
Passive	Primary support & reinforcement
Passive	Restriction of access
Active	Support performance monitoring
Active	Seismic monitoring
Active	Stress monitoring
Active	Roof deformation monitoring
Active	Primary support & reinforcement installation
Active	Reinforcement rehabilitation
Warning Device	Monitoring and alarms
Procedural	Inspections
Procedural	Exploration drilling plans
Procedural	Standard Working Procedures (SWPs)
Procedural	Geotechnical model
Procedural	Training
Procedural	Mine design & roadway layout guidance
Procedural	Ground support design guidance

INADEQUATE GROUND SUPPORT

SAMPLE INFORMATION

View Accident Reports Back View Safety Bulletins

Good Practice Resources:

Title	**Geotechnical Considerations in Underground Mines**
Description	A guideline for general compliance of Mines Safety and Inspection Regulations. Using Regulation 10.28 as reference the guideline details important information related to Geotechnical concepts and considerations. Including ground control, rock strength, openings, and ground support and reinforcement. The development of a detailed Ground Control Management Plan is specified as an important step when designing mine ground control. Also explained is the need for a summary of recognised associated geotechnical hazards, considered essential to maintaining a safe working environment.
Identifier	http://www.docep.wa.gov.au/ResourcesSafety/Sections/Mining_Safety/pdf_/MS%20GMP/Guidelines/MS_GMP_Guide_geoconsguideug.pdf
Title	**Management of Rockfall Risks in Underground Metalliferous Mines : a Reference Manual**
Description	This is a national guideline on rockfall management intended to eliminate rockfalls as one of the major causes of fatalities in underground metalliferous mines. The manual describes "good ground control practices". There are six major steps in managing rockfall risks, namely geomechanical data collection, definition of geomechanical domains, preliminary design, identification of rockfall hazards and assessment of rockfall risks, control of rockfall risks and monitoring rockfall risks. Quality control for ground support and pro-active inspection to detect potential rockfall hazards are part of ongoing risk monitoring. Appendix 1 covers the Geotechnical Risk Assessment Guideline for Underground Mining Operations. Appendix 2 is SAF-1371 Ground Support Standards. These standards refer to the Mining and Quarrying Safety and Health Act 1999 and Australian Standards AS 1012.9-1986 and AS 1012.14-1991
Availability	Contact Minerals Council of Australia to purchase a copy. The order from is available at: http://www.minerals.org.au/safety/s_and_h_publications/guidelines

4.3.5 Rock support and reinforcement

10.28 (2) (e) appropriate measures are taken to ensure the proper design, installation and quality control of rock support and reinforcement

Design:

It is recommended that the design of ground support and reinforcement should be based on a thorough understanding of the following points, particularly item 1:

1. Geological structure of the rock mass in and around the workplace;
2. Rock stress levels and the **changes** in rock stress around excavations during the life of the excavation;
3. Rock strength;
4. Behaviour of the rock support or reinforcement system under load;
5. Groundwater regime (particularly corrosion); and
6. The potential for mining induced seismicity.

The essential geotechnical issue is that the rock support and reinforcement should be matched to the ground conditions; anything less could not be said to be sound geotechnical engineering practice.

The rock support and reinforcement design methods that may be applicable have been listed in section 3.13.

Procedural – ground support design guidance

INADEQUATE GROUND SUPPORT

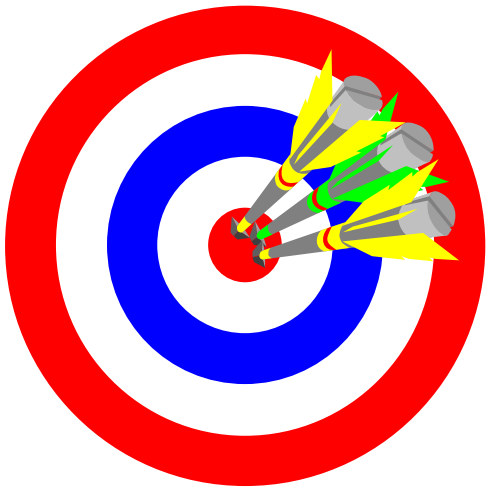
SAMPLE INFORMATION

View Accident Reports Back View Safety Bulletins

Good Practice Resources:

Title	**Monitoring The Rockmass Response to Mining In Witwatersrand Gold Mines**
Description	Rockburst and rockfalls remain important hazards in the S.A. mining industry. Such incidents form an important, albeit small subset of the general rockmass response to mining. By monitoring the general rockmass behaviour, important insight may be gained about the variation of rock-related hazards in time and space. This paper describes some principles and applications of the routine monitoring of the rockmass response to mining. Superficial reference is made to some methods and more detail descriptions are given of a few based on seismic monitoring. This is not a comprehensive review. It rather highlights aspects that appear important to us
Identifier	http://www.bullion.org.za/Departments/Safety&SusDevl/ohs/conference/papers/day2/051-62%20van%20Aswegen.pdf
Title	**Guideline For The Compilation of a Mandatory Code of Practice to Combat Rock Fall And Rock Burst Accidents In Tabular Metalliferous Mines**
Description	Mine Rock Fall and Rock Burst Incident Analysis; Terms and Definitions; Risk management; Strategies: Overall Mine Stability; Shallow Hard Rock Operation; Deep Hard Rock Operations; Protection of Mine Accesses/Exits; Stability of Tunnel and Service Excavations; Mineral Excavation Process (Stoping); Rock-Breaking; The Impact of Mining Activities on Neighbouring Mines; Monitoring of Rock-Related Hazards/Risks; Seismic monitoring and analysis strategy; Monitoring the stability of workings; Integrated Mine Process Design and Planning; Support Design Methodology; Rock Engineering Support Service
Identifier	http://www.dme.gov.za/publications/pdf/guidelines/Rock_Bursts.pdf
Title	**Management of Rockfall Risks in Underground Metalliferous Mines : a Reference Manual**
Description	This is a national guideline on rockfall management intended to eliminate rockfalls as one of the major causes of fatalities in underground metalliferous mines. The manual describes "good ground control practices". There are six major steps in managing rockfall risks, namely geomechanical data collection, definition of geomechanical domains, preliminary design, identification of rockfall hazards and assessment of rockfall risks, control of rockfall risks and monitoring rockfall risks. Quality control for ground support and pro-active inspection to detect potential rockfall hazards are part of ongoing risk monitoring. Appendix 1 covers the Geotechnical Risk Assessment Guideline for Underground Mining Operations. Appendix 2 is SAF-1371 Ground Support Standards. These standards refer to the Mining and Quarrying Safety and Health Act 1999 and Australian Standards AS 1012.9-1986 and AS 1012.14-1991
Availability	Contact Minerals Council of Australia to purchase a copy. The order from is available at: http://www.minerals.org.au/safety/s_and_h_publications/guidelines
Title	**Rock Bursting and Seismicity During Ramp Development, Lucky Friday Mine, Mullan, Idaho**
Description	A comprehensive survey of mine seismicity and rock bursting during development of two sublevels at the Lucky Friday Mine, Mullan, ID, U.S.A., was conducted to better define rock failure mechanisms and sources of ground control hazards. Survey data included rock burst damage reports, seismic event locations and magnitudes and, for the most energetic events, first-motion information.
Identifier	http://www.cdc.gov/niosh/mining/pubs/pdfs/rbsdr.pdf

Shaping MIRMgate for Users' Needs of the Future



Challenges & three main strategies:

- Collaboration,
- Service design, and
- User engagement.

Shaping MIRMgate for Users' Needs of the Future

- Site evaluation,
- Tailored email alerts of new Internet resources,
- 2006 MIRMgate Usability Survey
- Bow Tie Analysis approach development

- Possible addition of site specific information
- Continue to introduce MIRMgate

Add/Remove Alerts

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Add A New Alert

Tasks Reset

Ground control and strata control

Ground control

- Ground control
- Haulroad maintenance
- Highwall and low wall
- Highwall stabilization
- Longwall roof support installation
- Mesh installation
- Portal development
- Rib support
- Rock bolt
- Roof bolt
- Roof support

Stored Alerts

Delete	Change		
Delete	Change		trata control | Rock | Rock
Delete	Change		trata control | Roof | Scaling
Delete	Change	☑	Hazard | Hazardous substances | Gases | Air contaminants
Delete	Change	☑	Hazard | Hazardous substances | Gases | Gas explosions
Delete	Change	☑	Hazard | Plant, machinery and equipment | Underground plant and equipment
Delete	Change	☑	Subject | Ergonomics and human factors | Plant, machinery and equipment design
Delete	Change	☑	Subject | Ground control / strata control | Ground stability
Delete	Change	☑	Subject | Water | Water drainage
Delete	Change	☑	Subject | Workplace exposure monitoring | Atmospheric
Delete	Change	☑	Task | Plant, machinery and equipment | Operation | Surface mobile equipment

Note: You may enable or disable email notifications by ticking the checkbox(s) above.

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Alert Service

Welcome to the 2006 the MIRMgate User Survey

MIRMgate site has been improved to make it as useful to you as possible. We would like to know a bit about our users, and your suggestions on how we can expand or improve our site. Please take a few moments to answer these questions about MIRMgate. Thank you.

The data collected from this survey will remain anonymous and will only be used to determine the overall opinion of MIRMgate users. Individual details will not be released. The survey data will not be used for other purposes.

If you would like to receive the latest MIRMgate News, please provide your email address:

1. Your Occupation?

Other (please specify)

- Please select
- Production Worker
- Management
- Maintenance worker
- Health and safety professionals
- Educator / Researcher
- Other (please specify)

2. Wh

3. Yo

4. Your Age?

Please select

5. Which country do you live in?

Please select

6. How often do you visit MIRMgate?

Please select

7. Where did you find about MIRMgate?

Other (please specify)

8. What were you looking for on MIRMgate?

Acknowledgements

- Minerals Council of Australia (MCA),
- International Council on Mining and Metals (ICMM)
- Australian States' and Territory's Mining Departments,
- Sustainable Minerals Institute (SMI),
- MIRMgate team
- MISHC staff members
- All involved in MIRMgate development, and
- Minerals Industry

Questions???

Thank you!

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Share your organisations' good practice / lessons learned / innovation information resources with us

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