

# Mine Engineering Issues when Dealing with the Problem of Fault-Slip in Underground Mines

Apr 2009



## The Request

*A mine management perspective on the importance of modeling/data integration and mine design/planning aspects when dealing with the problem of fault slip*

- > *The need for new research and tool development!*



## MTS – Vision Statement

**To Design Safe, Sustainable Ore Extraction at Optimum Value Through Technical Excellence.**

### Strategic Imperatives

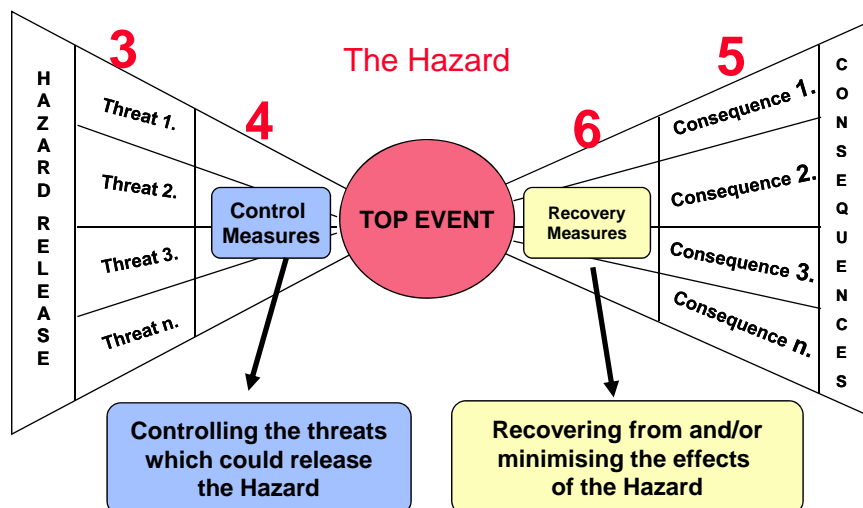
- > Our development programs and MTS Systems will assure that the work experience is such that we attract, retain and develop the best people.
- > Our use of Risk management tools at the design phase will manage hazards to a level of excellence that eliminates the possibility of catastrophic events.
- > Our exploration success delivers the resource required to support sustainable production.
- > Our use of innovative technology will maximize productivity and efficiency.
- > Our designs and models will maximize margins for Vale Inco.
- > Our role in the MTS group as the stewards of the mine plan/resource is appreciated and we are expected to raise concerns while monitoring compliance.

We will continuously improve the MTS Systems to achieve the Strategic Imperatives

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## Bowtie Analysis Model



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## Control Rating Code

<b>Design Change</b>	<b>Engineering type controls that potentially eliminate the hazard.</b>
<b>Passive Control</b>	<b>Controls that are in place that do not require human intervention.</b>
<b>Active Control</b>	<b>Controls that are in place that require humans to activate them.</b>
<b>Warning Device</b>	<b>Alarms or monitoring that indicate a hazardous situation.</b>
<b>Procedure</b>	<b>Documented SOPs that control the hazardous situation.</b>

 Represents Hard Controls

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## Presentation to Senior Management on Seismic Activity

October 2008



## Outline

- > Introduction
- > Mining Evolution
- > Review of magnitude event in the Ontario Operation in the last 5 years
- > Bow Tie Risk Analysis Results
- > Conclusion

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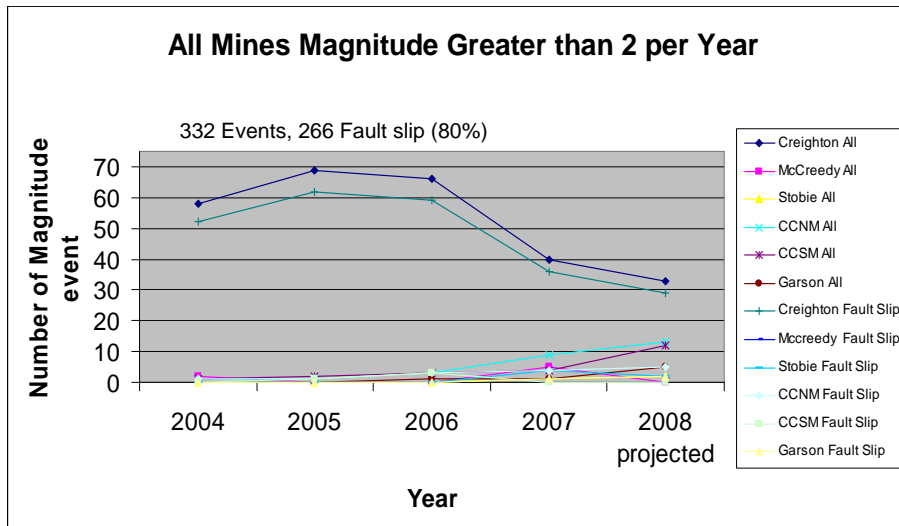
## Introduction

- > **Context**
  - > A number of seismic events have occurred at Creighton, Stobie, Garson and North Mine. The largest being event recorded 3.8 and was felt by the community
- > **Purpose**
  - > To outline the controls that are in place to mitigate the risk associated with mining induced stress change.

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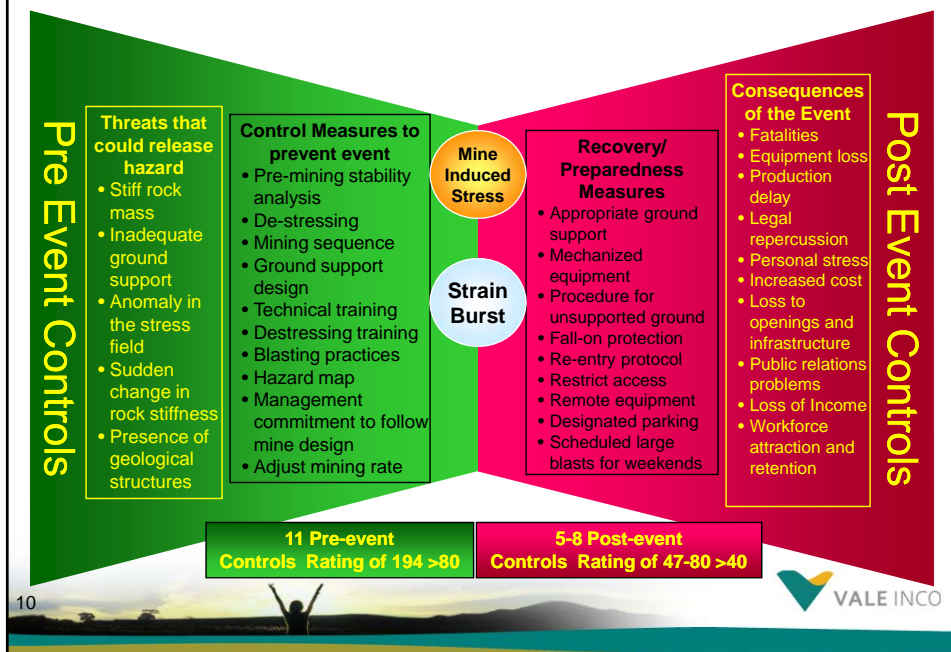
## Analysis of the Events to Date (Magnitude Event)



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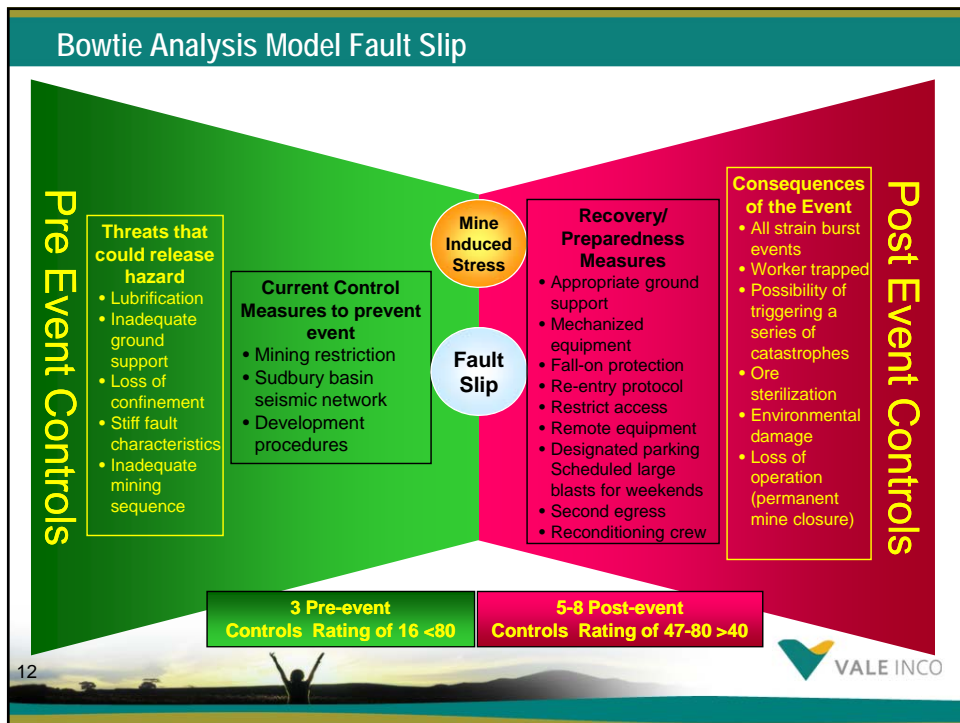
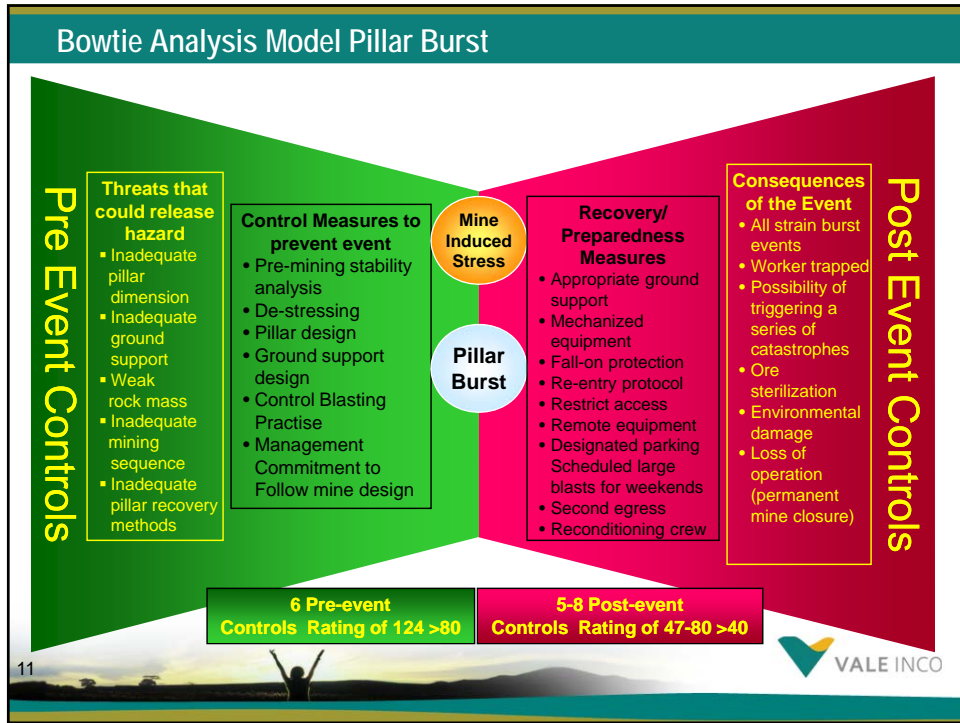


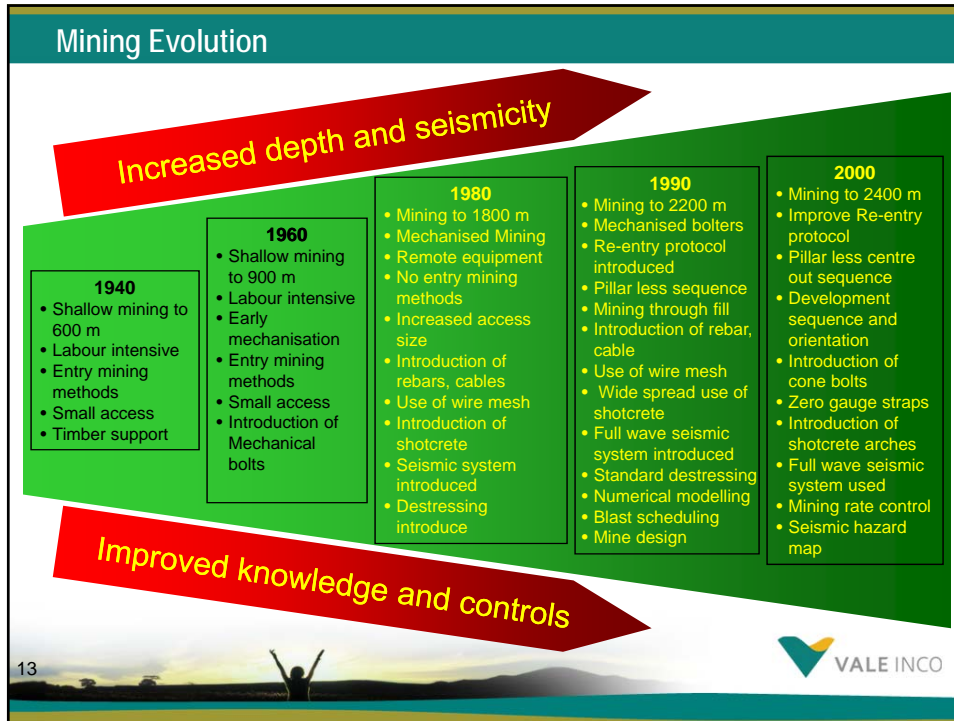
## Bowtie Analysis Model Strain Burst



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## Conclusion

- > Sufficient pre-event controls for strain burst and pillar bursts
- > More research to develop and implement pre-event controls for fault slip
  - > Defining fault properties
  - > Understanding response
  - > Controlling or inducing Fault movement
  - > Learn from other operations
  - > Fault monitoring
  - > Daily analysis of seismic data
  - > Internal network for seismic monitoring
- > Post event controls are sufficient to mitigate consequences to personnel and operation.
- > Sudbury operation have the tools to continue operation safely with respect to mining induced stress and associated seismic activity.

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### Mine Design Model

<b>To Design Safe, Sustainable Ore Extraction at Optimum Value Through Technical Excellence.</b>	MODELS	RISK ASSESSMENT <i>(Technical, commercial &amp; social)</i>	STATIC TOOLS	DYNAMIC TOOLS
	Geological/ Structural	<b>MUST DRIVE NEED FOR STATIC VS DYNAMIC ANALYSIS</b>	Data Mine	Simulations Probabilistic analysis
	Geotechnical		2D or 3D modeling tools	Probabilistic Stability Analysis Non linear tools
	Ventilation		Modeling tools	VOD
	Mining Methods & Equipment			Simulations
	Infrastructure		Excel Models	Simulation Cristal Ball
	Mine Planning		2-4D	Automod Simulation Stochastic Mine Planning
	Financial		DCF	Real Options

**Increasing Data & Cost**

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### Mine Design Model

**Mine Planning Model**

Dynamic Simulation  
Probabilistic Modelling

**Risk Management**

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