Canadian Geotechnical Society

Southern Ontario Section

Graduate Student Competition

Given on January 21st 2004

Mining Induced Seismicity – Friend or Foe!
Damage Limits for Risk Analysis

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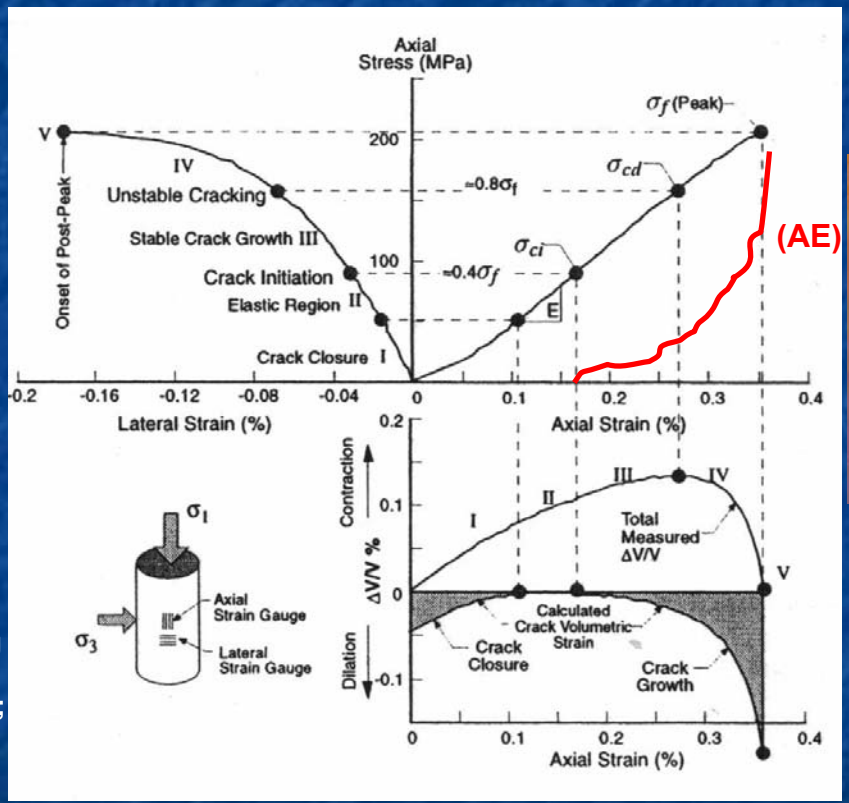
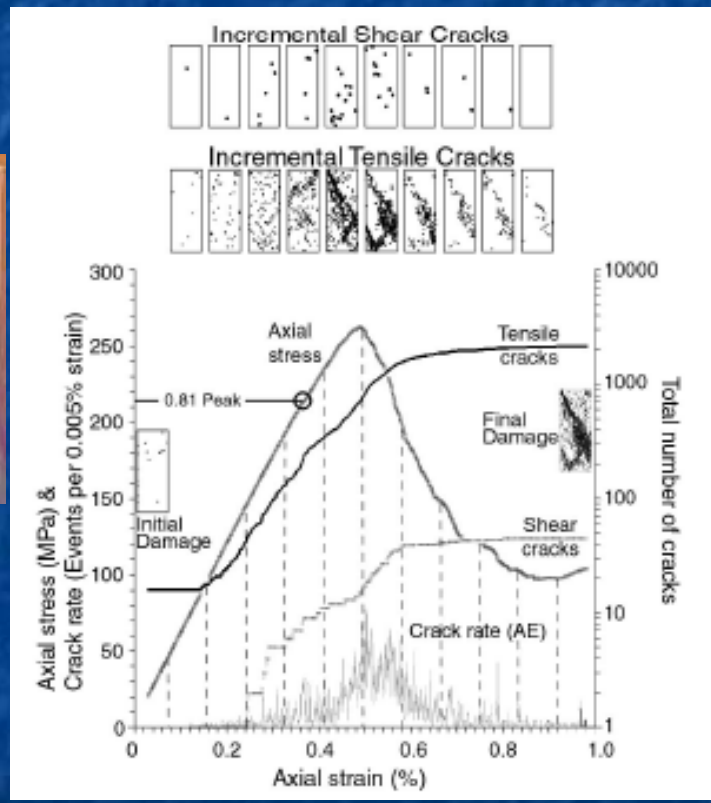
What happens at the Laboratory Scale ? Acoustic Emissions (AE)

AE Monitoring (Scholz, 1968; Lockner, 1993; Young, 2002)





Laboratory (after Martin, 1997)

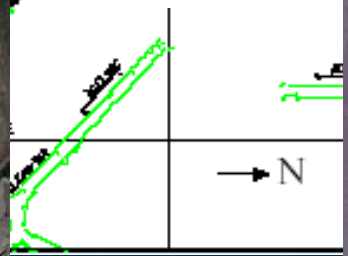
PFC Modelling (Deiderichs, 1999)

What happens at the Rock Mass Scale ? Microseismicity (MS)

328-9 Abutment Stress Crushing/Stress Fracturing

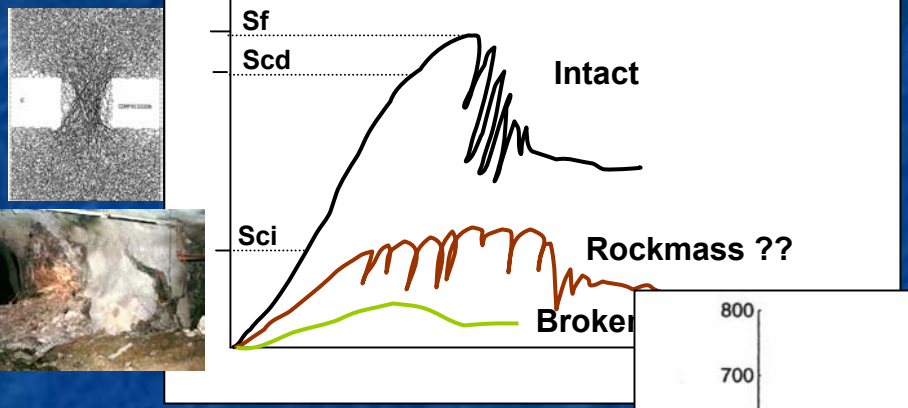
Oct 2000, 32

March 2000, 270-3 Burst

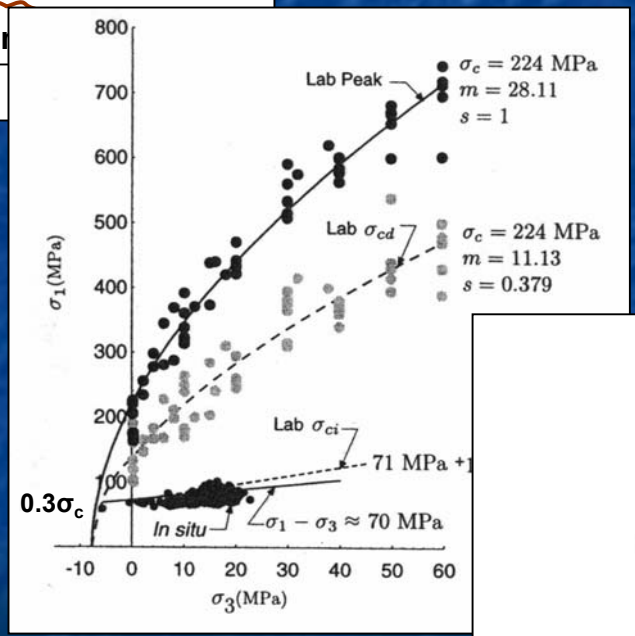


Oct 2000, 327-x/c 2.8 Mn Burst

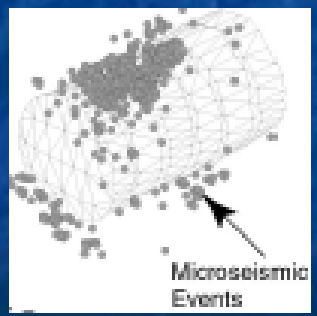
What happens at the Rock Mass Scale ?
Microseismicity (MS)



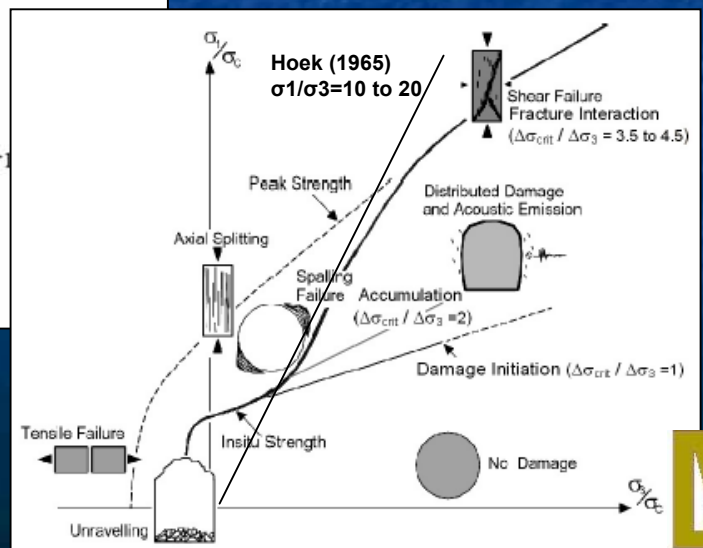
- Non Linear Stress – Strain Modelling ?



(After Deiderichs, 1999)

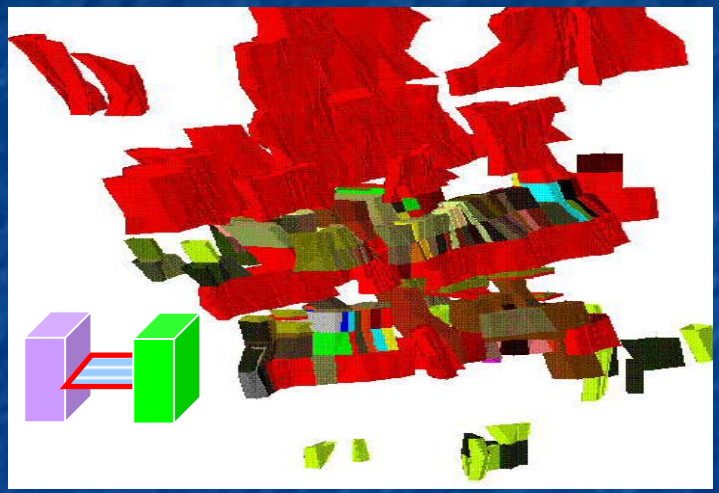


(after Martin, 1997)



The Field Scale Laboratory!

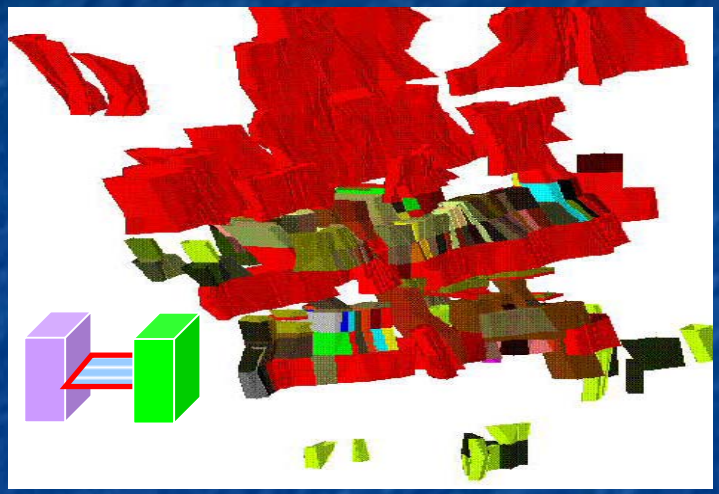
Brunswick #12 Mine (BMS) - Strong Brittle Rock Mass

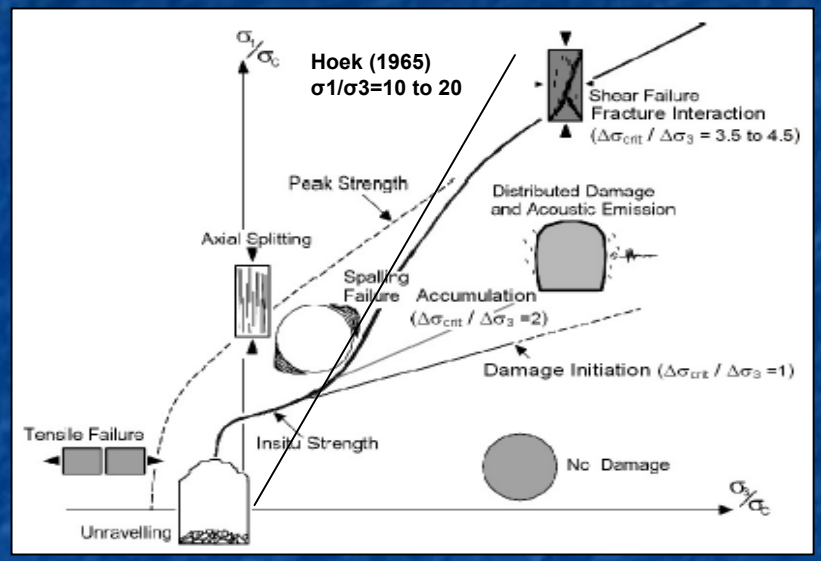


- **BMS Mature Mine – Major Seismicity/ Rock bursts**
- **Required a calibrated tool aid Future Production decisions**
- **Linear Elastic Stress Modelling (Map3D – BEM)**

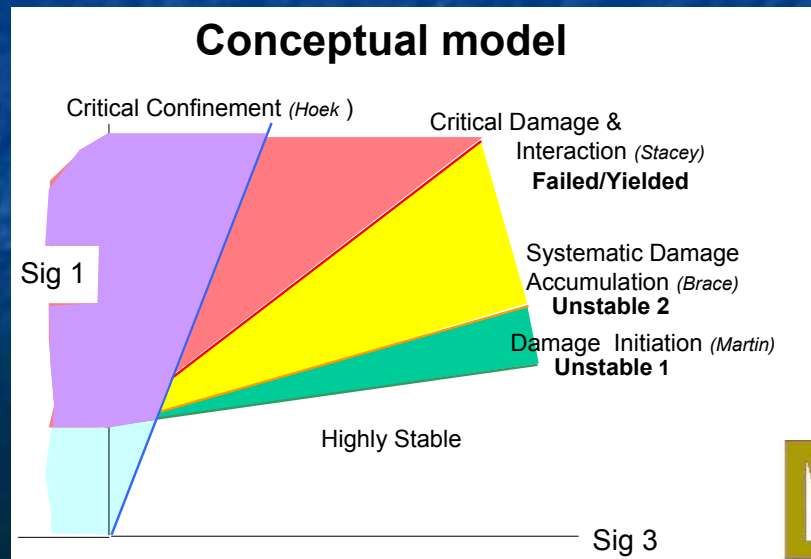
The Field Scale Laboratory!

Brunswick #12 Mine (BMS) - Strong Brittle Rock Mass

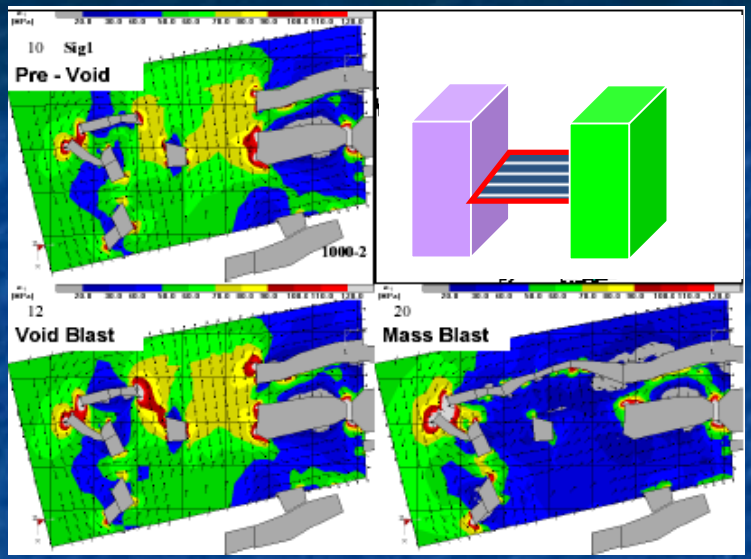


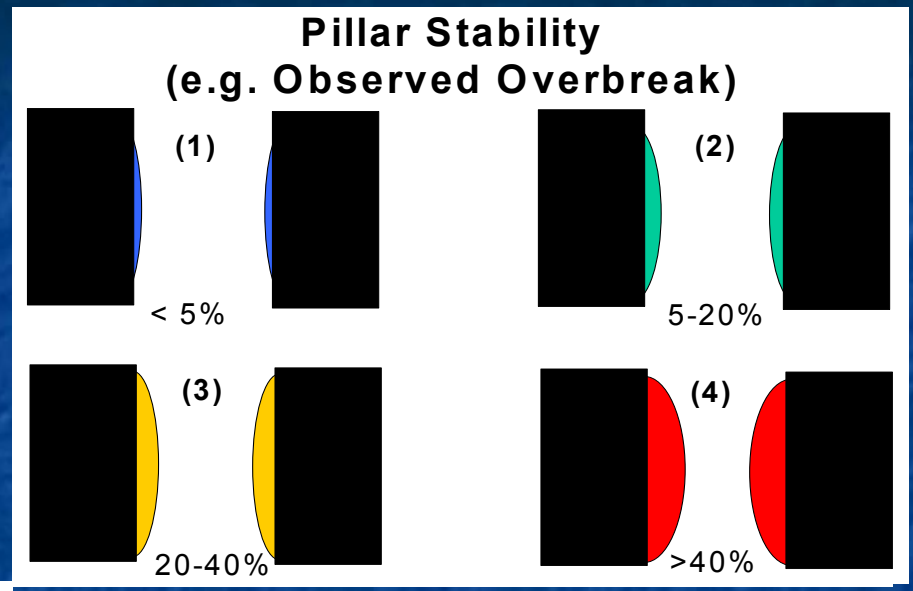


- **Back Analysis of 57 Secondary Stope Pillars Tracked:**
  - **Stress Path (avg. core stress)**
  - **Overbreak**
  - **Seismicity**
  - **FOG's and Operation issues**
- **Damage Criteria :**
  - **4 level Scale (Stable – Failed)**

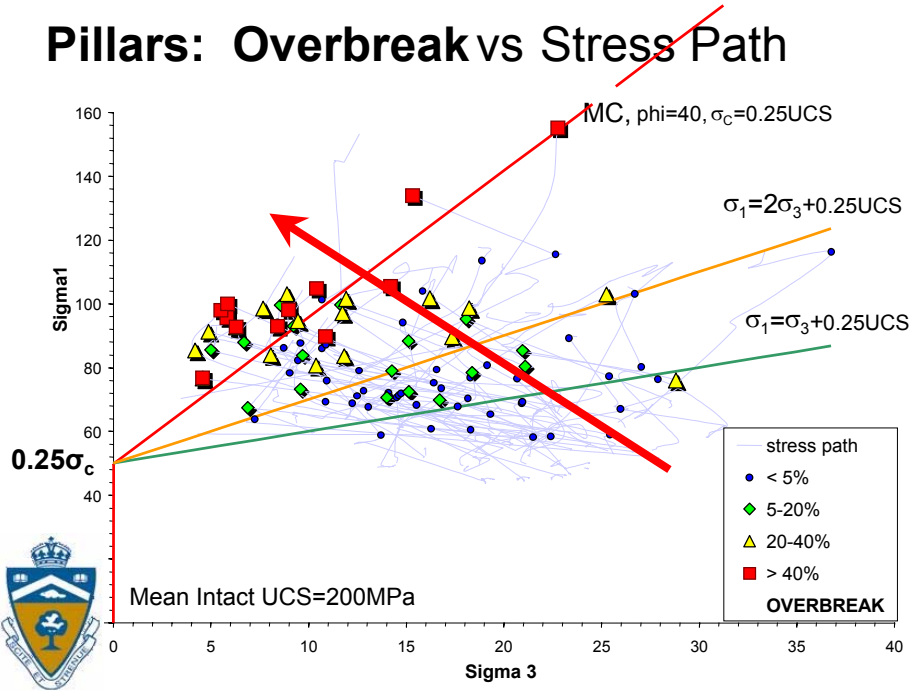


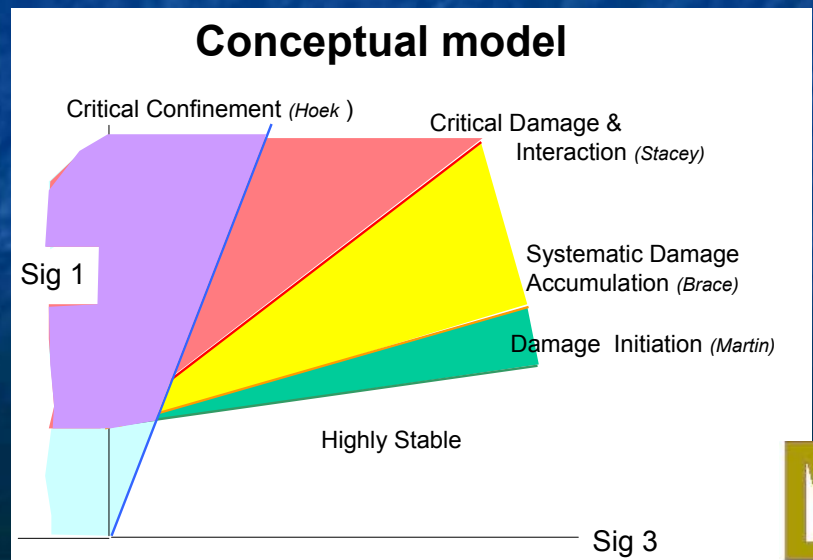
The Field Scale Laboratory!



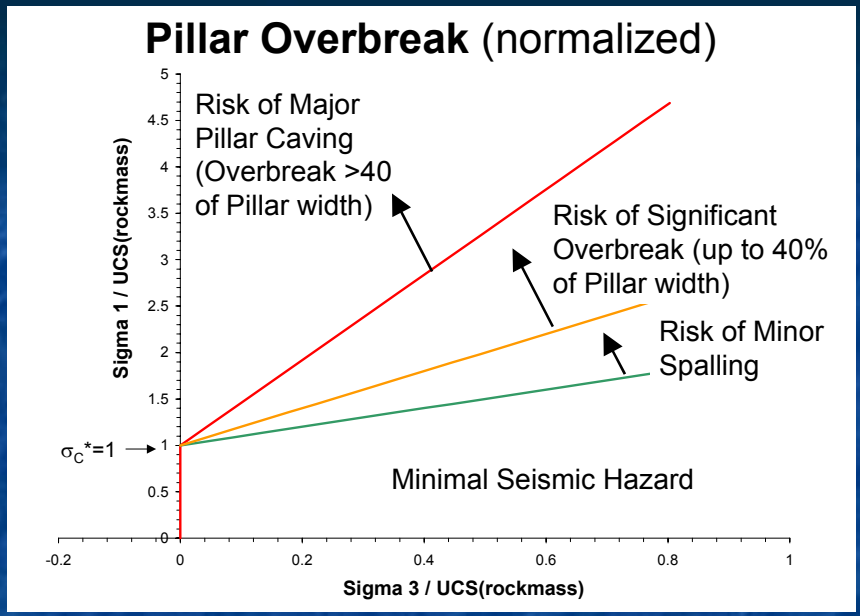


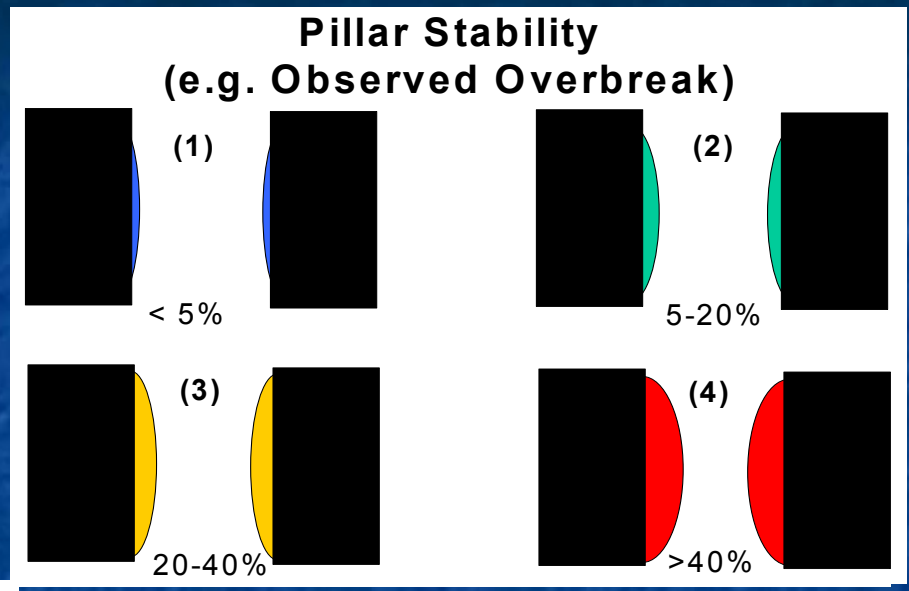
Pillars: Overbreak vs Stress Path

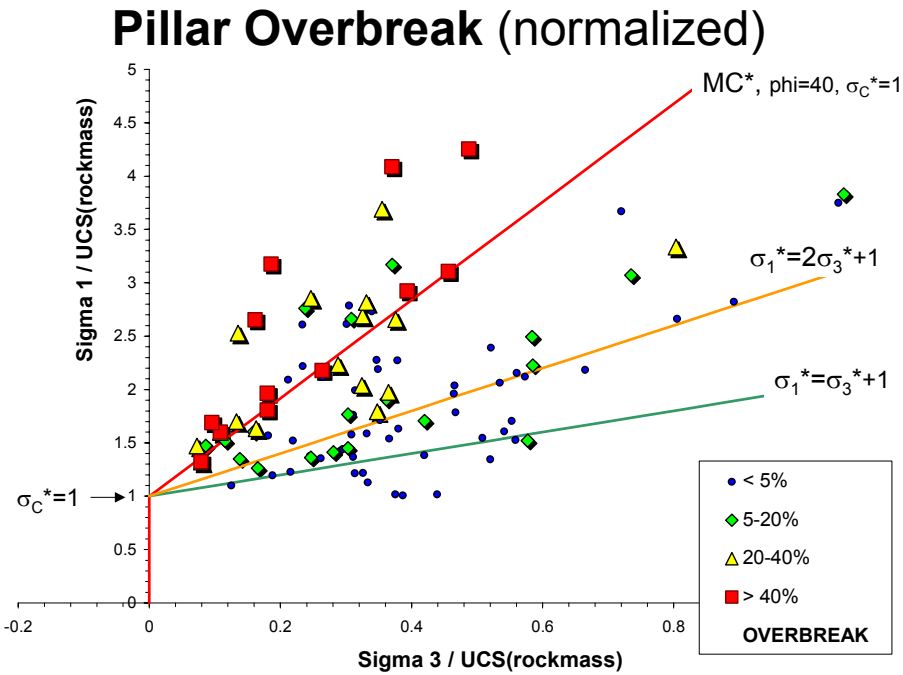


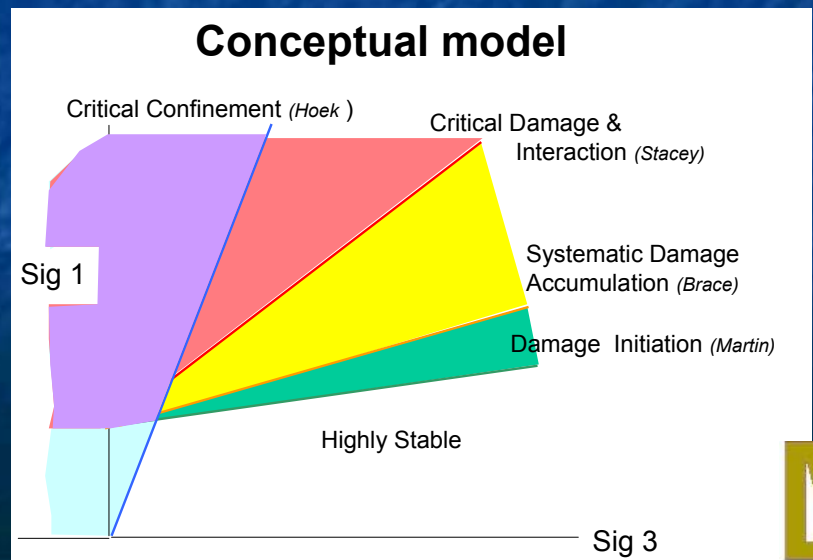


Pillar Overbreak



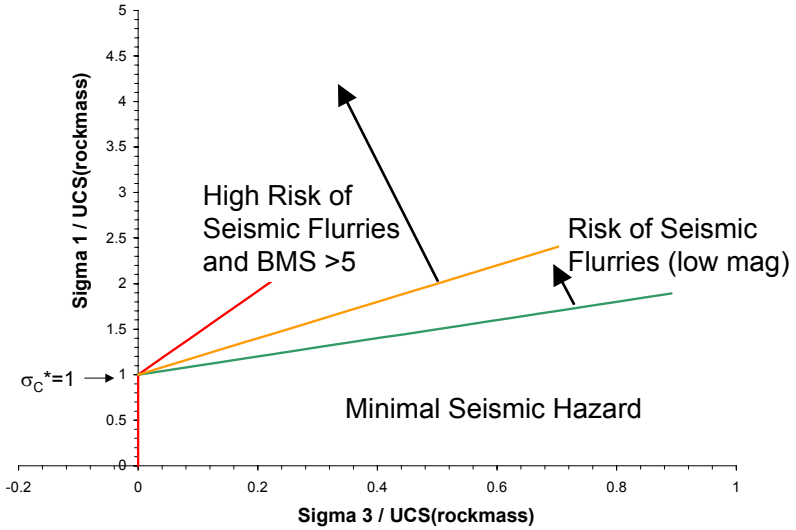




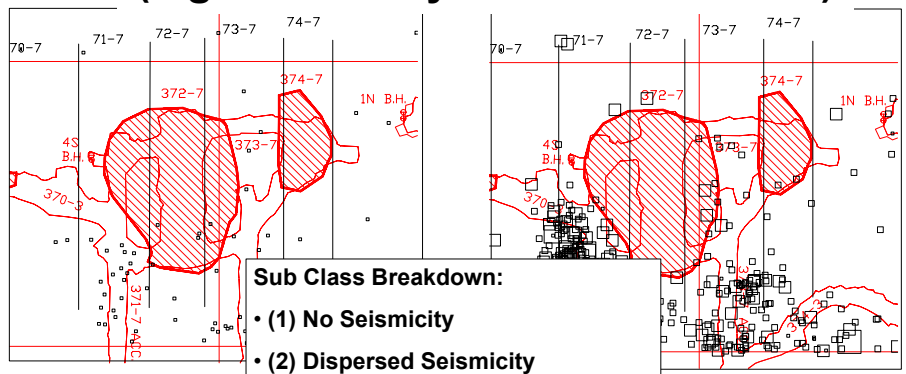


Pillar Seismicity

Pillar Seismicity (normalized)



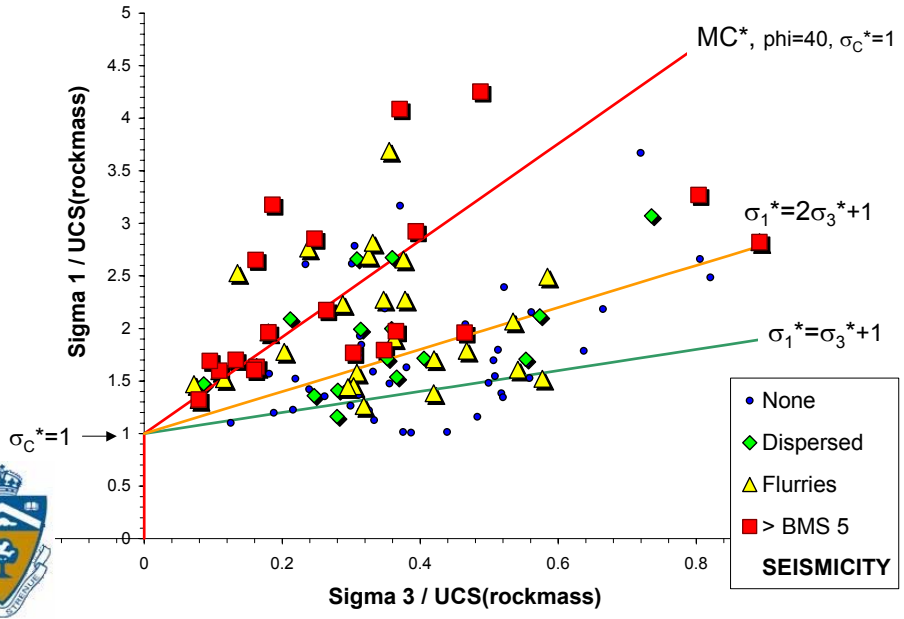
Pillar Stability (e.g. Seismicity 71-7& 73-7 Pillars)



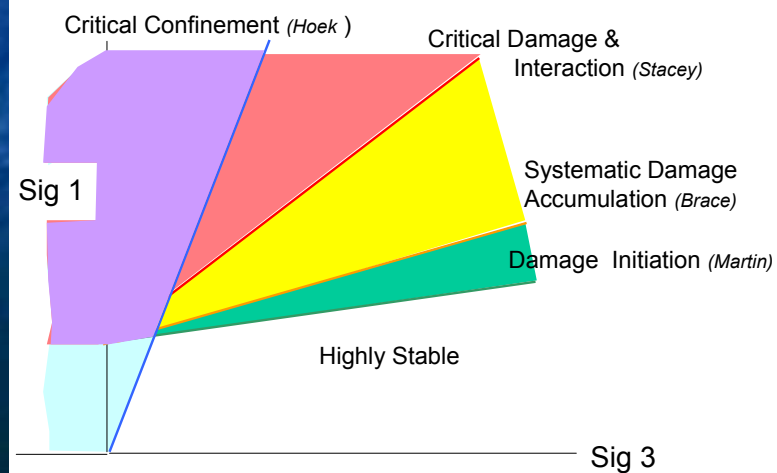
Sub Class Breakdown:

- **(1) No Seismicity**
- **(2) Dispersed Seismicity**
- **(3) Significant Seismicity Flurries**
- **(4) Intense seismic flurries + Events > BMS Mag 5 (Nuttli 1.0)**

Pillar Seismicity (normalized)



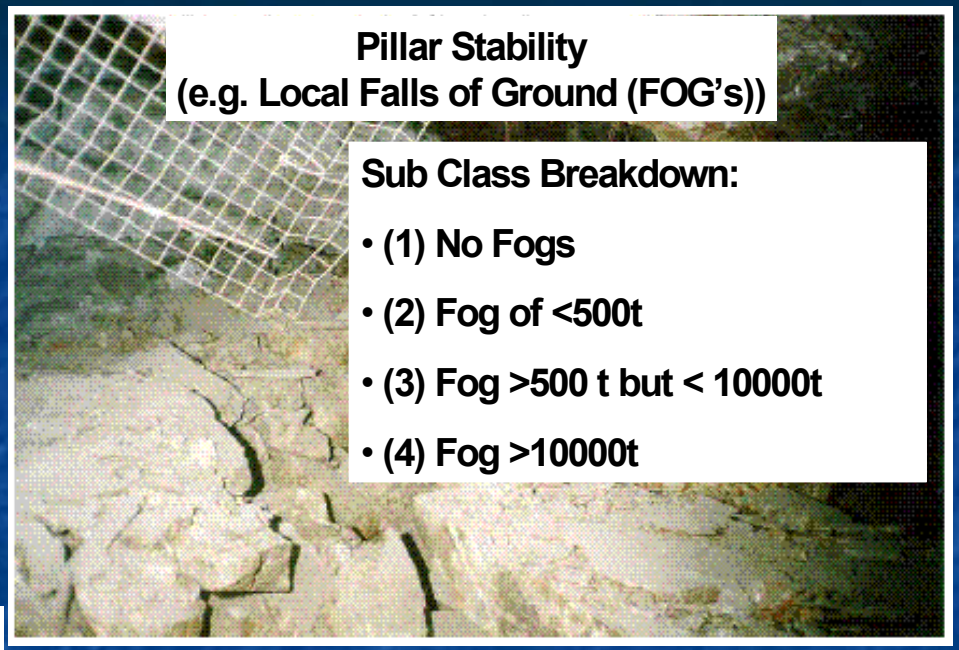
Conceptual model



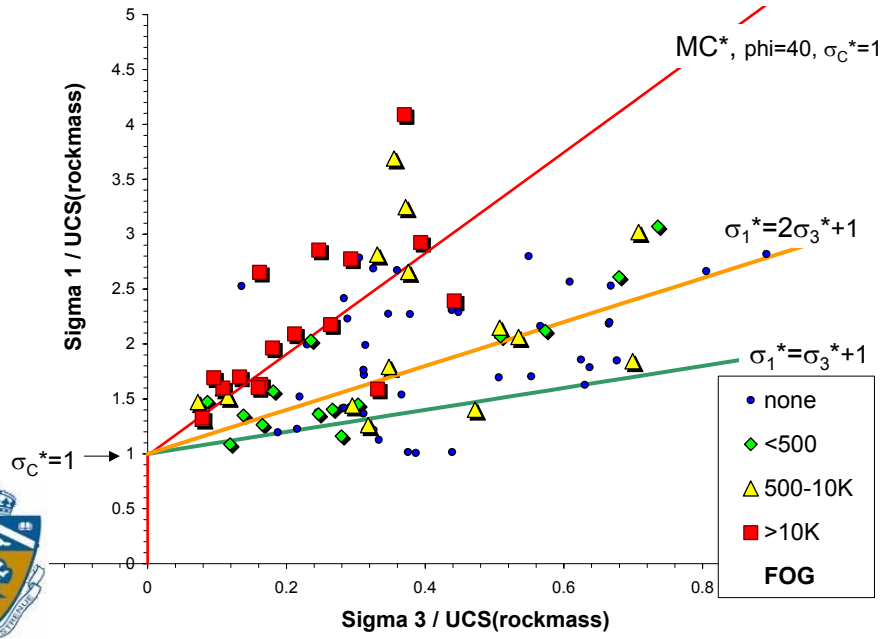
Local Falls of Ground

Factors:

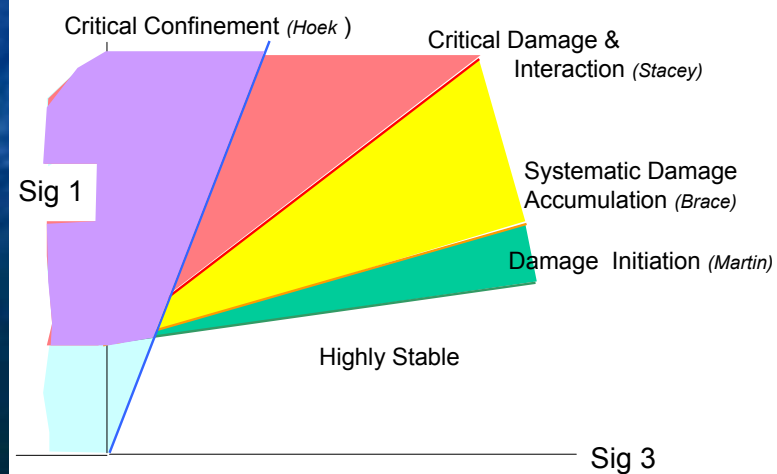
- Opening Size
- Opening Age
- Support quality
- Support quantity
- Support Age
- Installed FOS



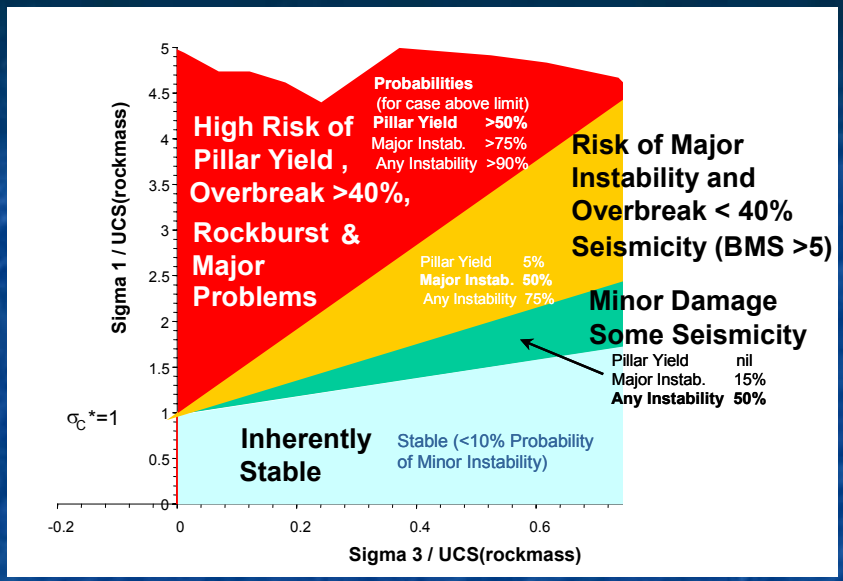
Pillar FOG's (normalized)



Conceptual model



Overall Pillar Stability

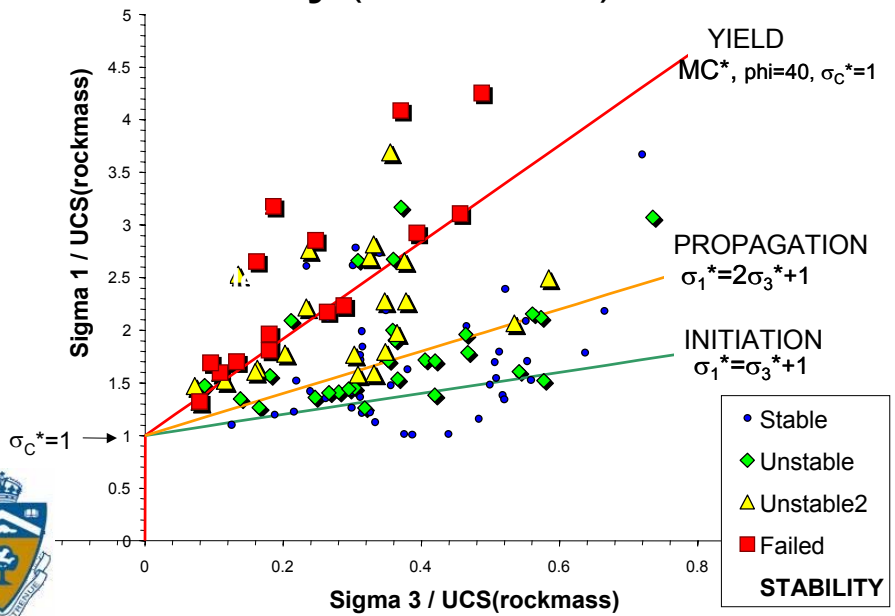


Pillar Damage/Failure - Class 1-4

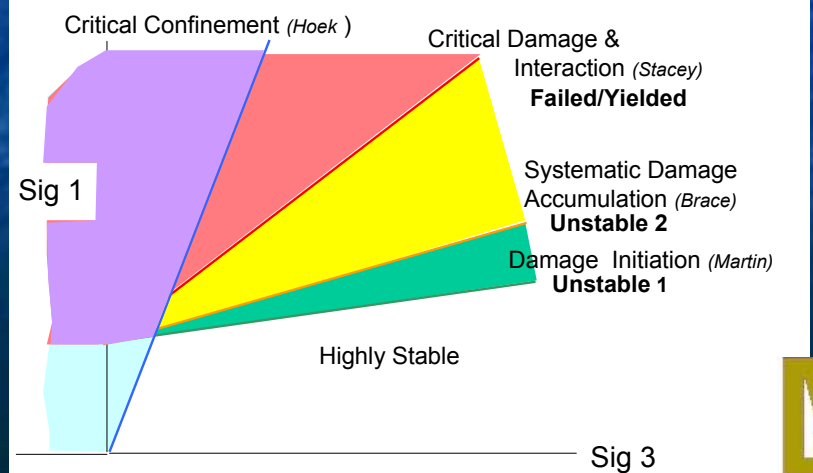
COMBINE OBSERVATIONS INTO A SINGLE PERFORMANCE CLASSIFICATION

1) - **STABLE - Nothing happening**
2) - **UNSTABLE - Onset of events**
3) - **UNSTABLE 2 - Deterioration**
   increase in seismicity, overbreak etc.
4) - **FAILED - Post peak region**
   (i.e major operational problems)
   A real Mullahva Headache

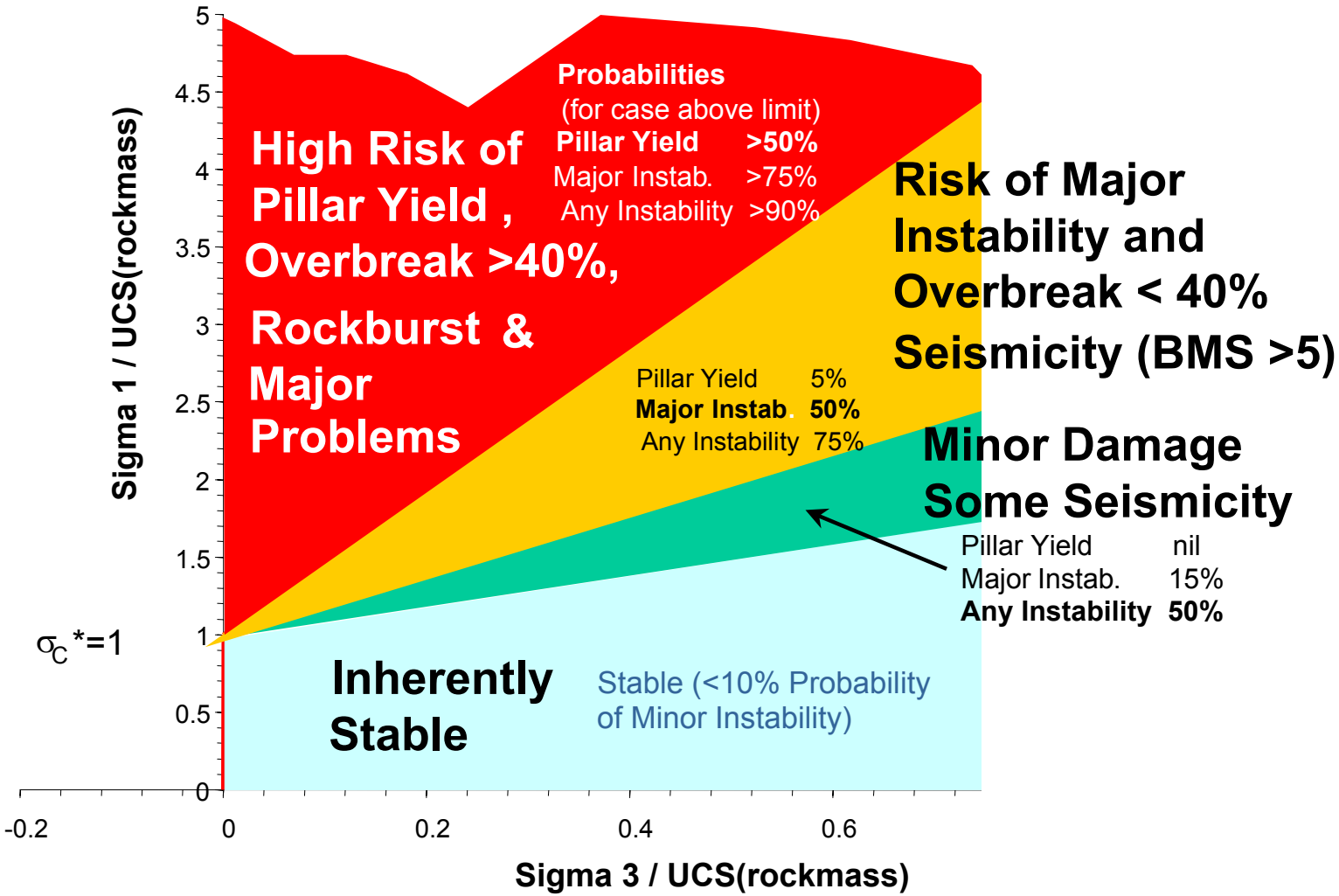
Pillar Stability (normalized)



Conceptual model



Hazard Assessment

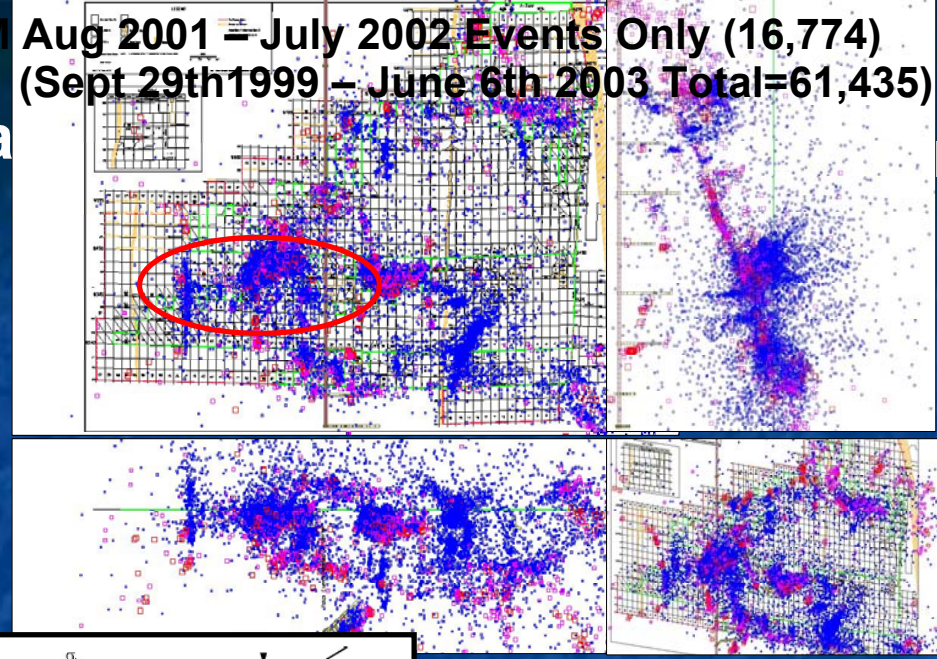


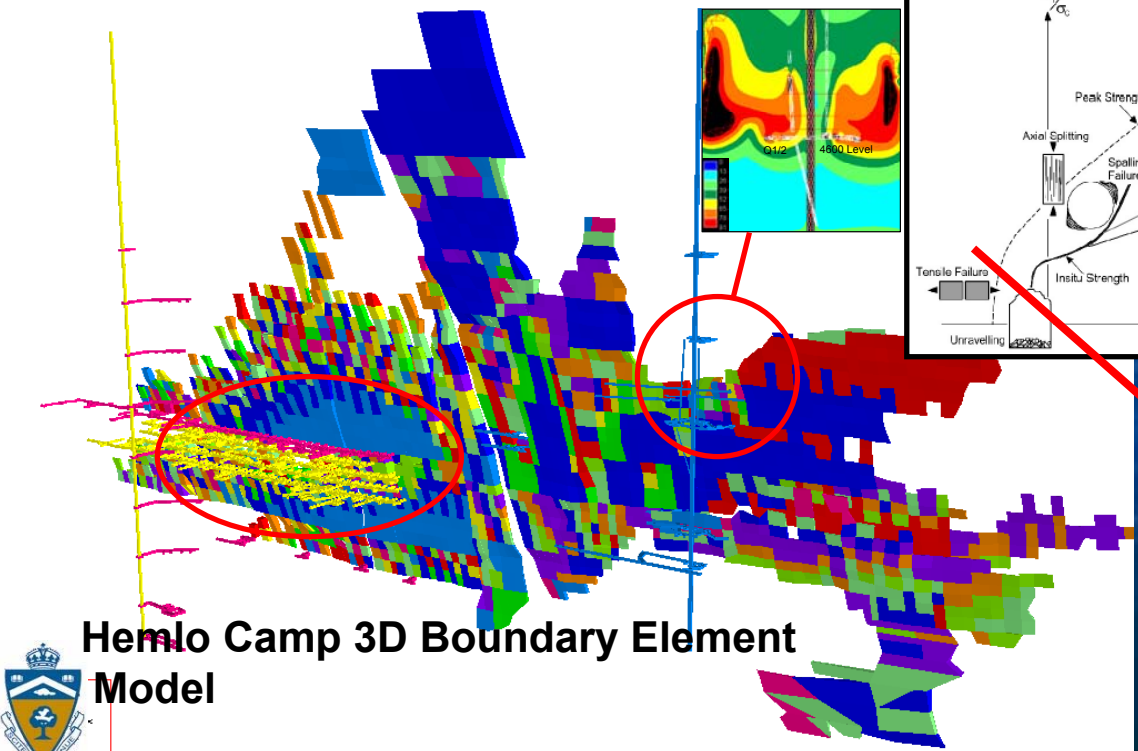
Concluding Remarks

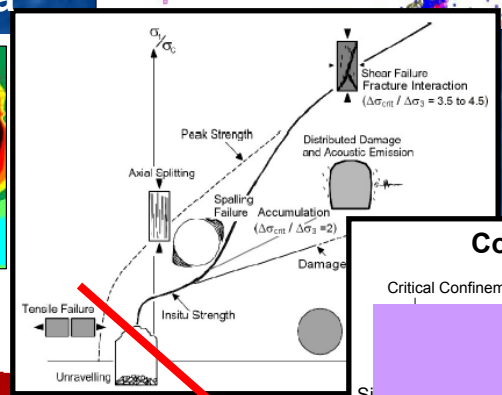
- Benefits of Combining Theoretical Damage Mechanics with the Case Histories Calibration:
  - Valuable tool for interpreting elastic stress modeling in complex multi-component rock systems.
  - Produces a practical stress index facilitating hazard prediction and risk analysis
  - Improves contingency planning for design in seismically active high stress mines
- Monitoring and analysis of mine induced seismicity is essential for locating yielding in the rock mass – safety of personnel

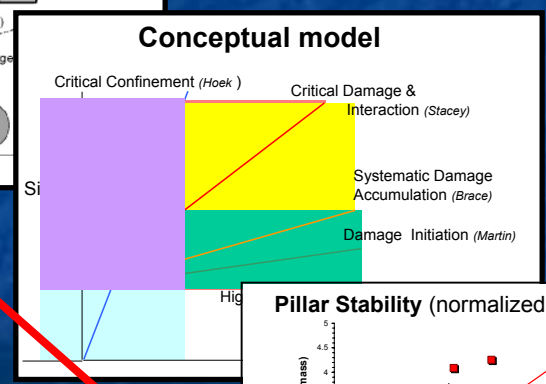
Future Direction :

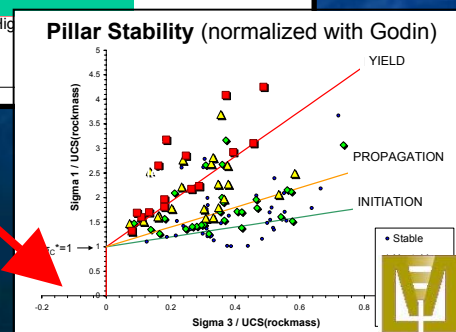
- Back Analysis of observationa Data at other mines with different strength rock masses
- Spatial and Temporal analysis of seismicity – coalesc. b-values
- Source Mechanisms+ V_a, σ_a











Questions !

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