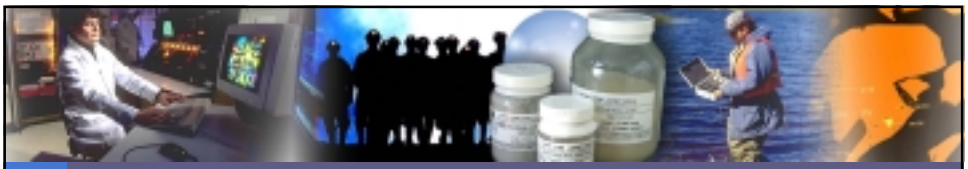


Natural Resources Canada | Ressources naturelles Canada

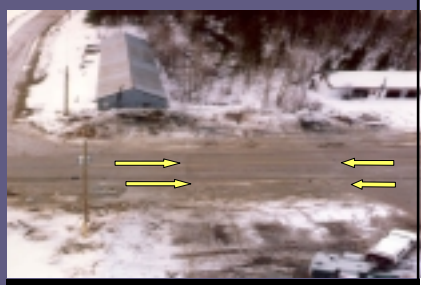
Underground Mining and Its Surface Effects

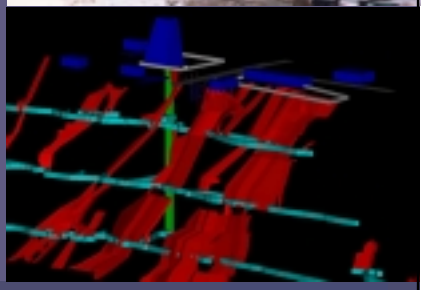
Presentation to the U.S. Interstate Technical Group
on Abandoned Mines
May 1-3, 2002
Dr. Marc C. Bétournay

Philosophy

Murphy's Law

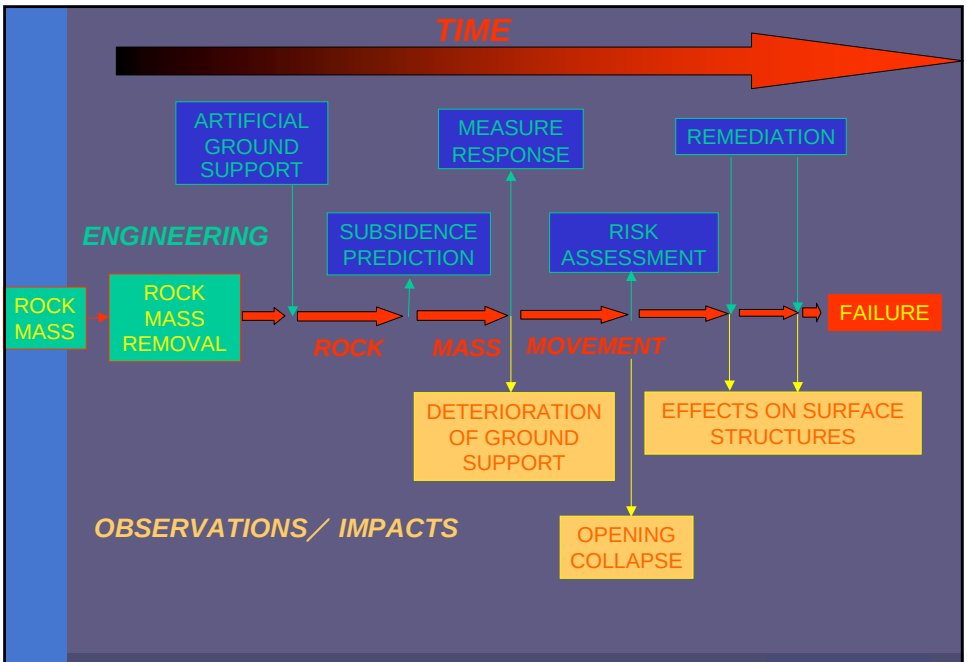
- **Little minesite information is preserved after closure**
- **The presence of underground mines is unknown**
- **The failure potential/condition is unknown**
- **Roads are built over underground minesites**
- **Roads fail without expectation**





Abandoned Mine Impacts

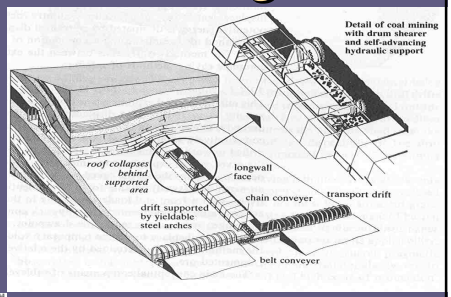
- Safety
- Infrastructure costs
- Liability
- Delays
- Community trust
- Services



Underground Mining

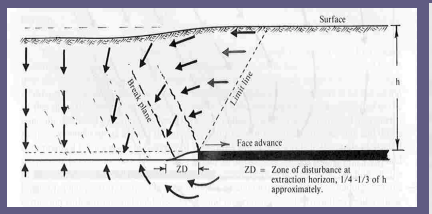
Coal - longwall

- Full extraction, roof caves

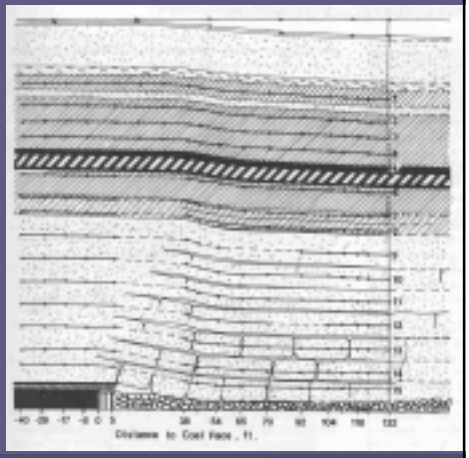


Underground Mining - Failure Mechanisms

Coal - longwall

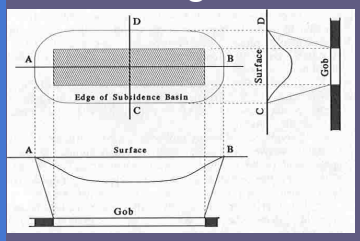


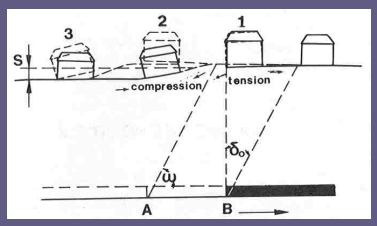
Mining depth	Advance per day	Total Duration
65 m	5-9 m	1 month
100 m	4-10 m	1.5 months
225 m	10-30 m	2 months

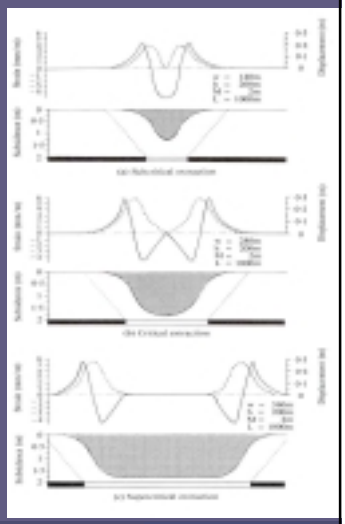


Underground Mining - Surface Effects

Coal - longwall







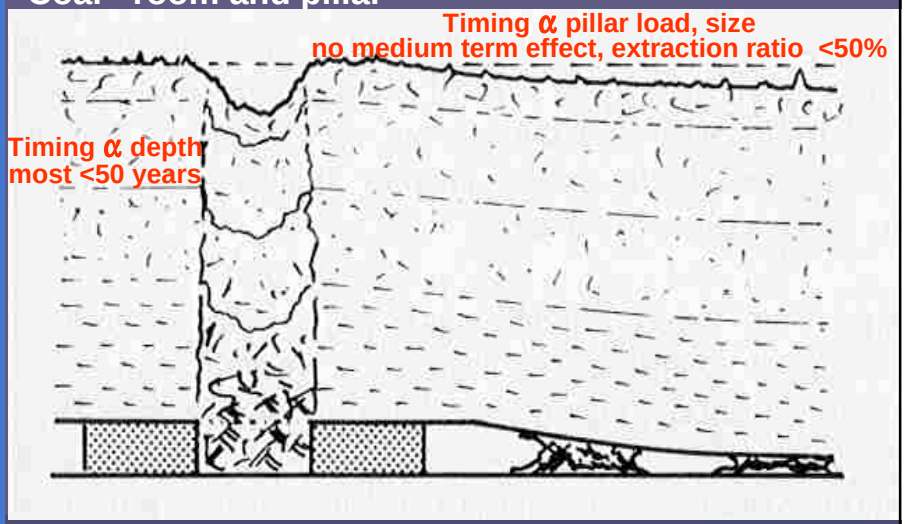
Underground Mining

Coal - room and pillar

- **Partial extraction, roof controlled, pillars may be recovered**

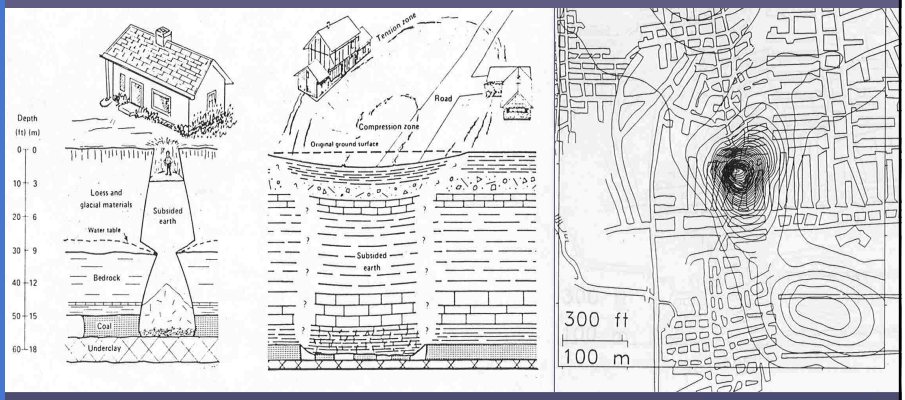
Underground Mining - Failure Mechanisms

Coal - room and pillar



Underground Mining - Surface Effects

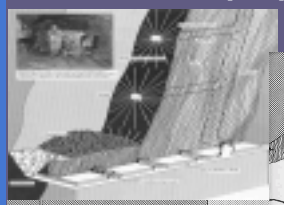
Coal - room and pillar

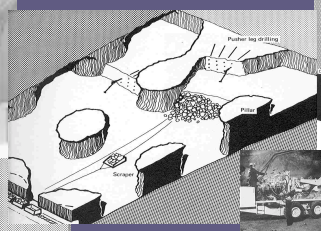


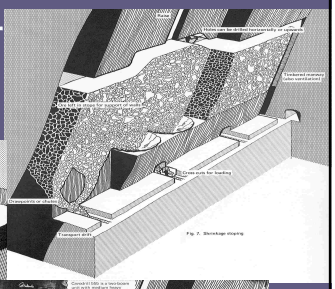
Underground Mining

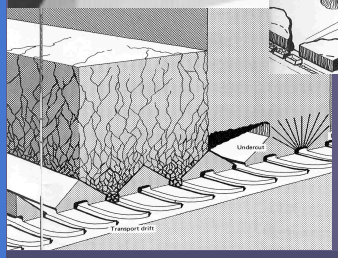
Metal

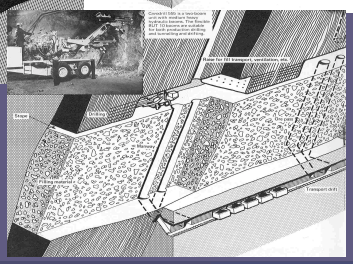
- Extraction leaves stopes, filled or not, some purposefully caved.







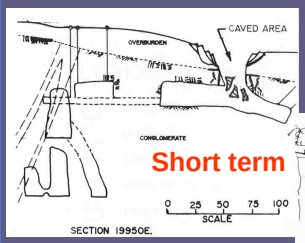




Canada

Underground Mining - Failure Mechanisms

Metal

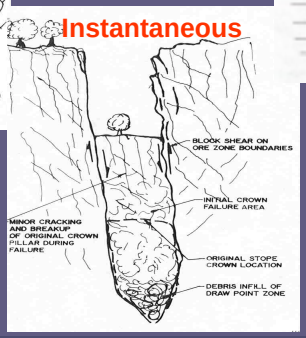


Short term

Rock Mass Fracturing

Plug Failure

Instantaneous



> 2 m/day

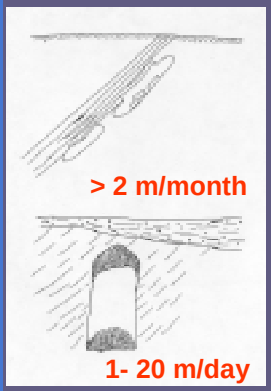
Ravelling

Canada

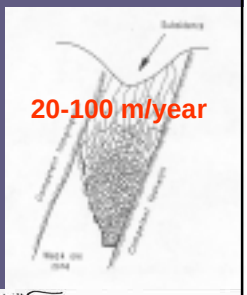
Underground Mining - Failure Mechanisms

Metal

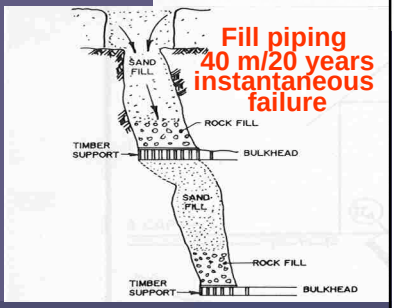
Destratification



Block Caving



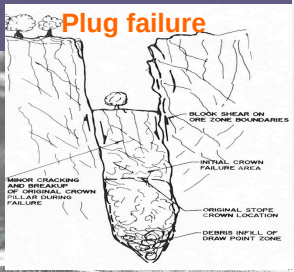
Fill Failure

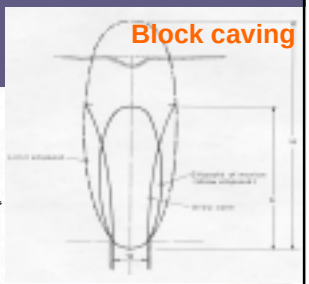


Chimneying Disintegration

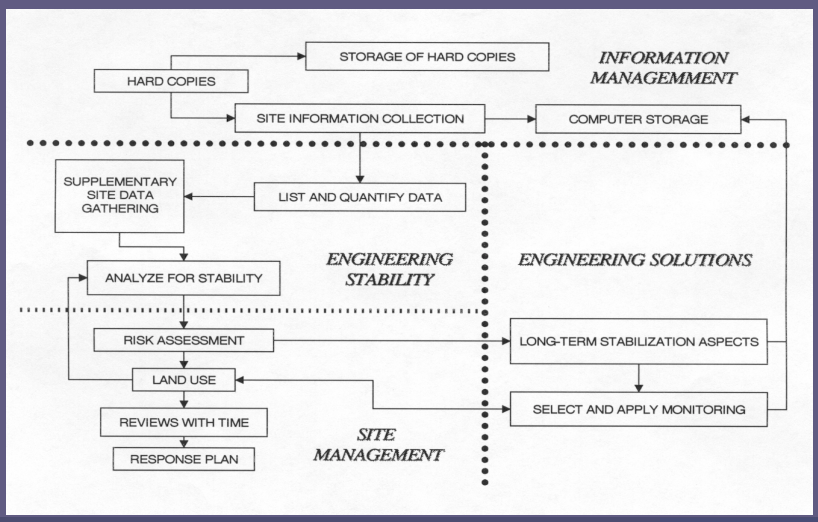
Underground Mining - Surface Effects

Metal



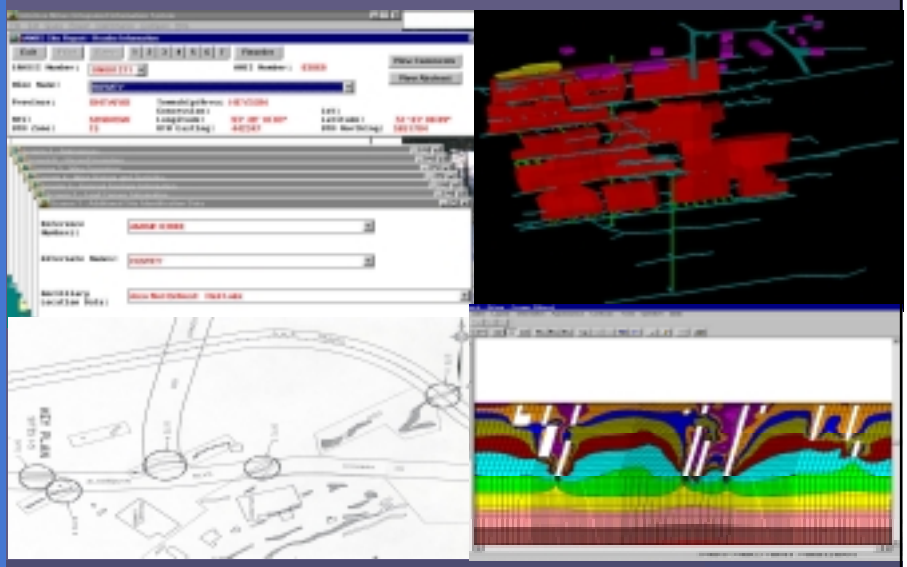


Approach to Site Problem



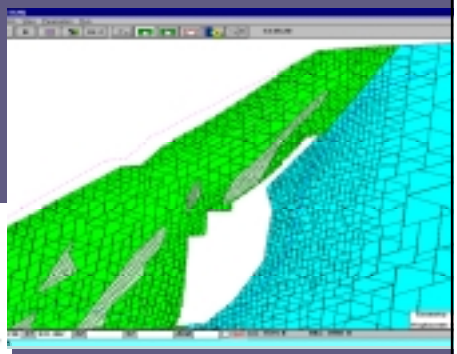
15 CANMET MINING AND MINERAL SCIENCES LABORATORIES Canada

Information Management



16 CANMET MINING AND MINERAL SCIENCES LABORATORIES Canada

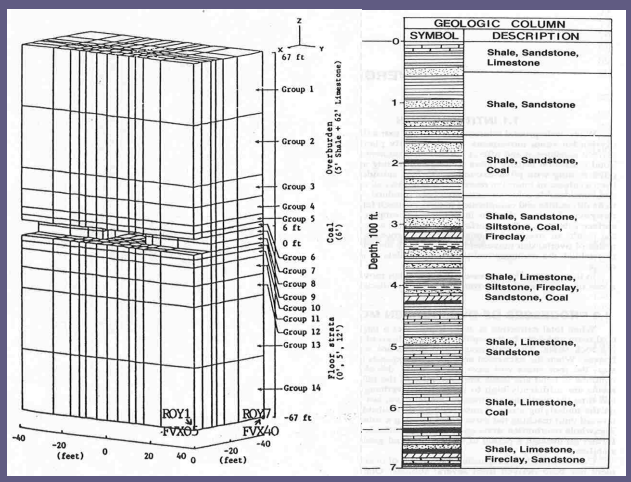
Engineering Stability



CANMET MINING AND MINERAL SCIENCES LABORATORIES

Canada

Engineering Stability (ctd)



CANMET MINING AND MINERAL SCIENCES LABORATORIES

Canada

Site Management

$$R = Px \cdot Cx$$

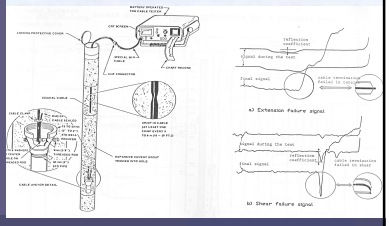
PUBLIC						ECONOMIC			ENVIRONMENTAL	
Safety	Water source	Social	Cultural	Trust	Services	Land-owner	Public	Industry	Species	Habitat
loss of life	unusable	different residence, lifestyle	loss of object, structure	recreation-ality disruption	complete, long-term	high (>20% of property value)	high (>$250K)	high (>$250K)	major (entire population)	major (total loss)
serious injury	partial use with treatment	change in residence, lifestyle	significant damage to object, structure	recreation-ality activities	partial, long-term	moderate (5-20%) of property value	moderate ($50-250K)	moderate ($50-250K)	moderate (partial loss)	moderate (replace-able)
minor injury	acceptable quality	disruption in residence, lifestyle	repairable damage to object, structure	disappro-val	short-term	low (<5%) of property value	low (<$50K)	low (<$50K)	minor (localized loss)	minor (replace-able)
negligible or no impact										

Decision cost= risk-reduction cost + probability-based risk reduction consequence cost

CANMET MINING AND MINERAL SCIENCES LABORATORIES

Canada

Engineering Solutions



CANMET MINING AND MINERAL SCIENCES LABORATORIES

Canada

Summary

Failure is anticipated with time

Longwall coal mining

- *predictable: surface effect, timing; filling effective and final*

Room and pillar coal mining

- *unpredictable: location, timing*
- *predictable: surface effect; filling can have temporary effect*

Metal mining

- *unpredictable: timing*
- *predictable: approximate location, sudden surface effect; filling and capping stop failure process and allow land use*

Preventative Action

- *Identify priorities ahead of problems*
- *Quantify risk*
- *Entrench engineering requirements in highway/building codes*
- *Have authorities perform full site decommissioning*