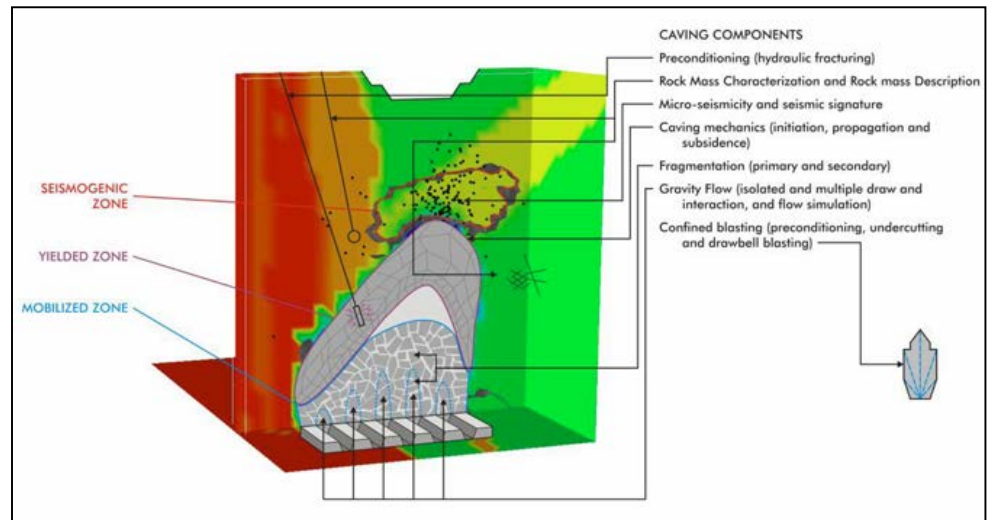


# Mining Innovation

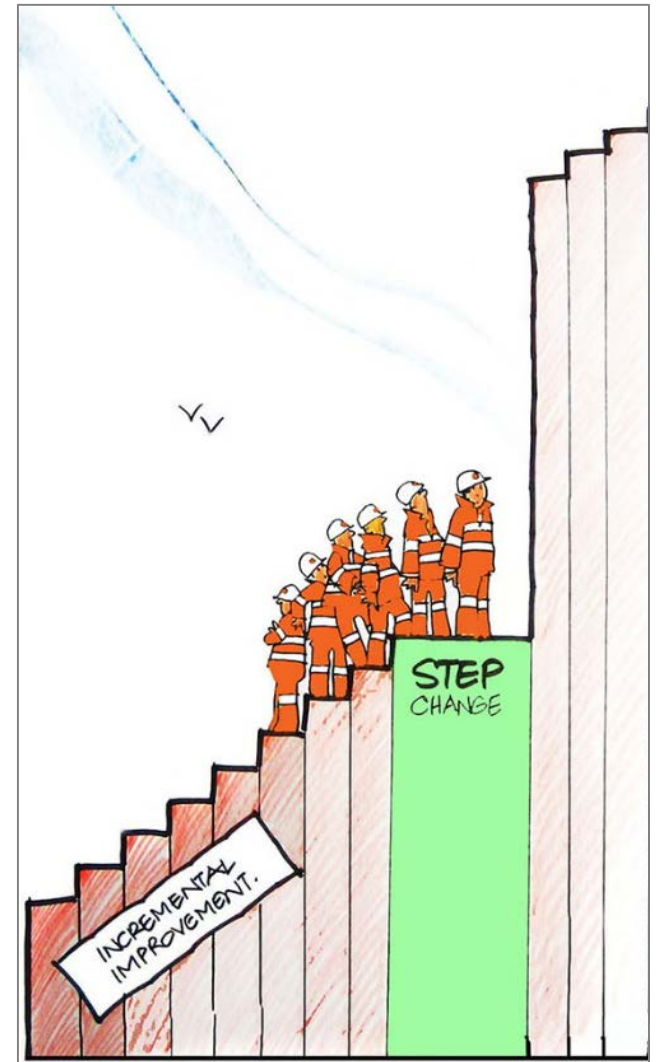
Andrew Logan



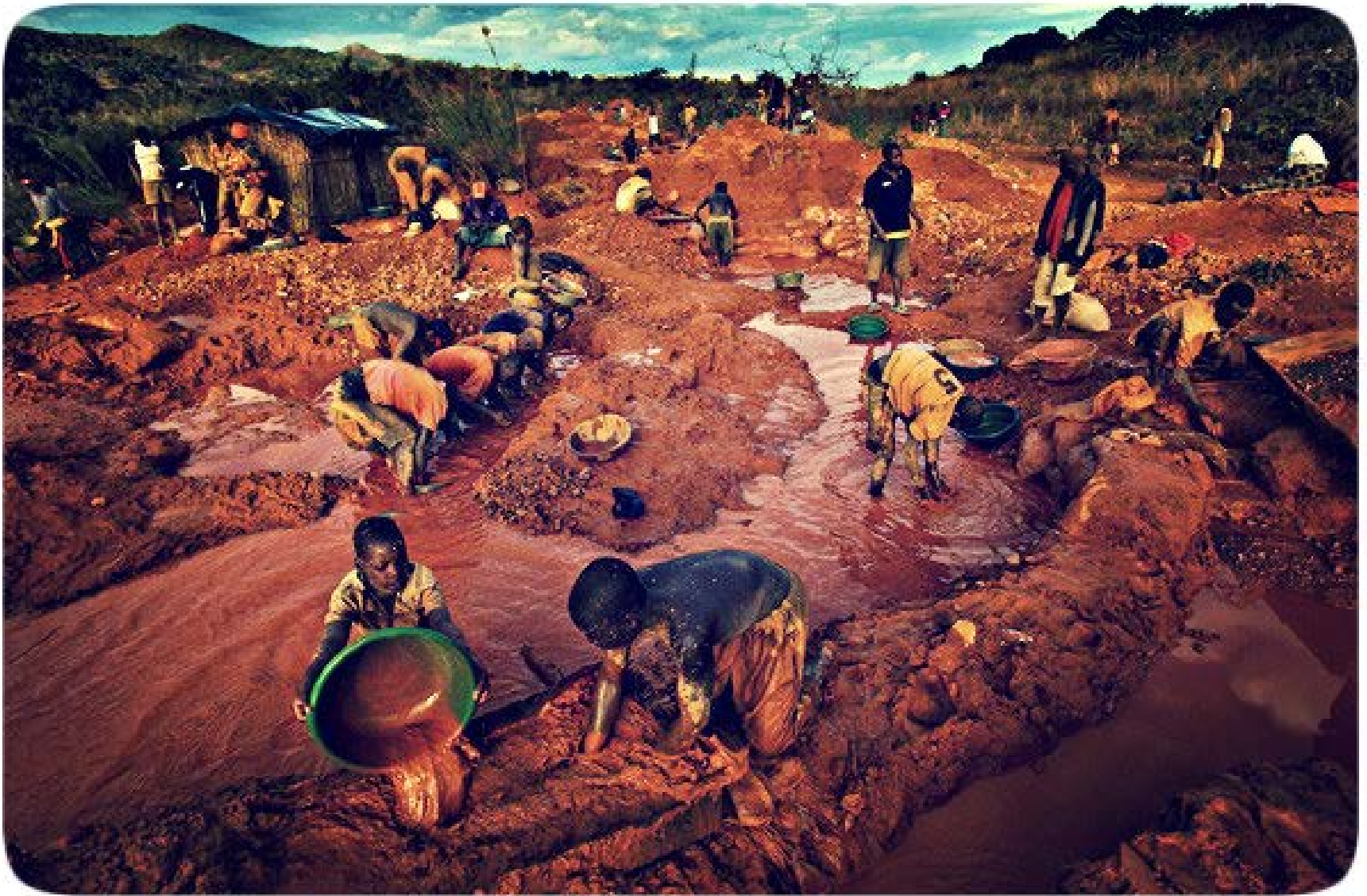
Disclaimer: Views expressed are those of author not of other parties

# Mining Innovation

- We've come a long way ....
- Reflect on step changes over time
  - Mineral processing
  - Open pit mining
  - Underground mining
- Consider challenges to overcome
- Learn from history ....



# Old Mining ....



After [www.mining-recruitment-jobs.com/mining/blog/the-ddi-development-diamond-initiative/](http://www.mining-recruitment-jobs.com/mining/blog/the-ddi-development-diamond-initiative/)

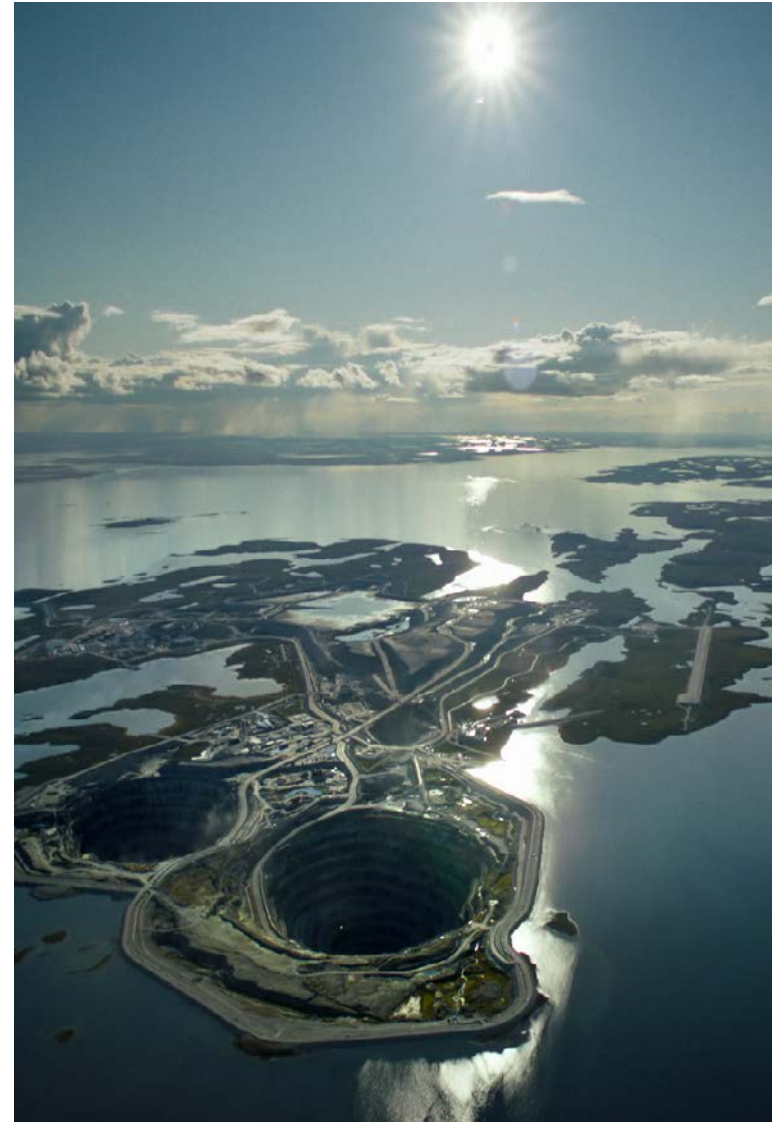
# Modern Mining ...

At Mega Scale – Escondida, Chile



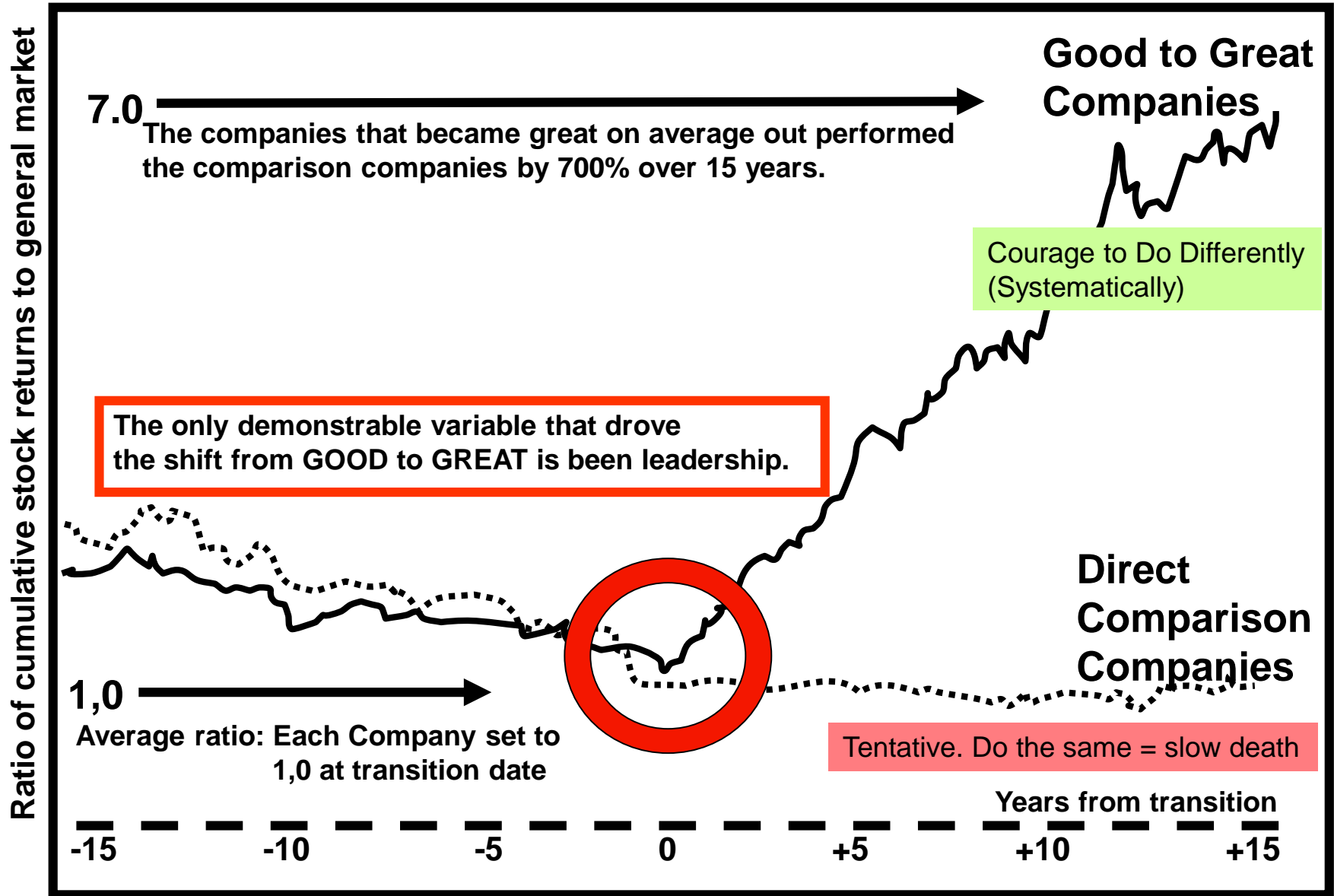
After [mining-technology.com](http://mining-technology.com)

In Adverse Conditions – Diavik, Canada

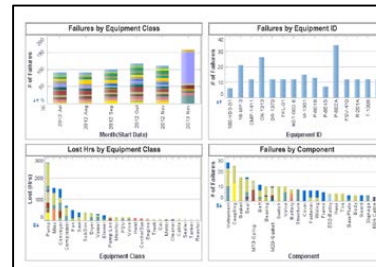
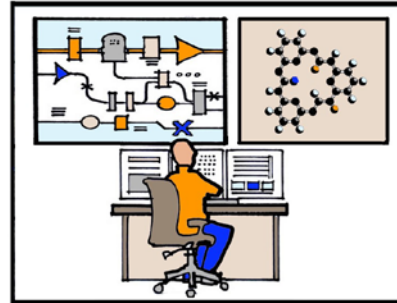
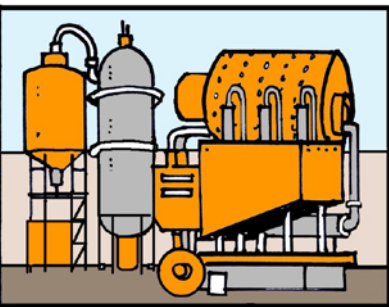
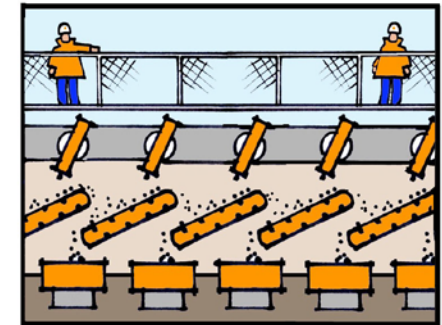
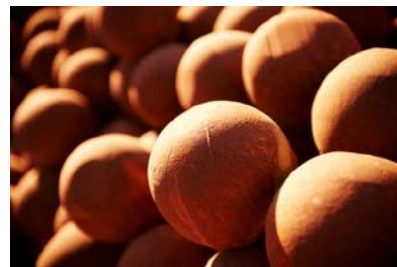
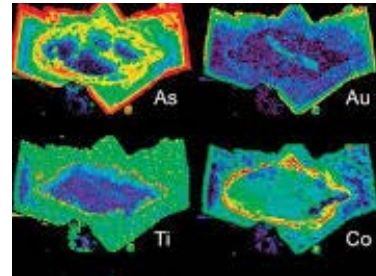
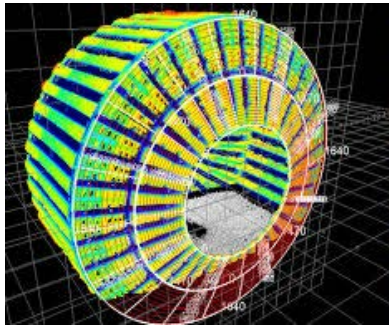


After [mining.com](http://mining.com)

# Innovation leadership outcomes



# Mineral processing



## 2000+

- Automated Liberation Analysis
- Laser Ablation Probes
- Core mineral scanners
- Chalcopyrite Leaching
- Processing Residue Cleaning
- Diagnosis Centres
- Outsourced Design

## 2020+

- Early Waste Rejection
- Online Conveyor Analysis
- Customised Blasting
- Fine Crushing
- Electro Fragmentation
- Dry Milling
- Coarse Flotation and Gravity
- Complex As Ore Processing
- HydroMet Next Gen
- Rock MRI style holography
- Remote Nuclear Power Plants
- Collaborative Design

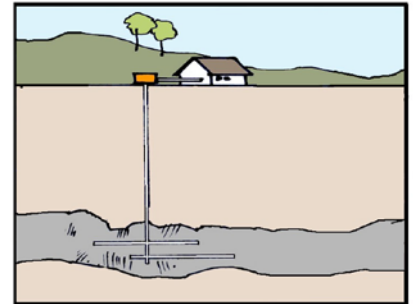
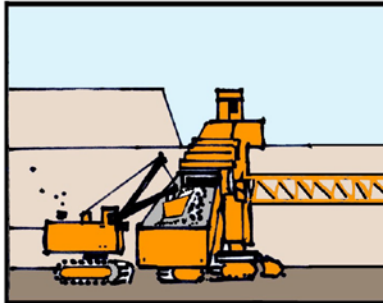
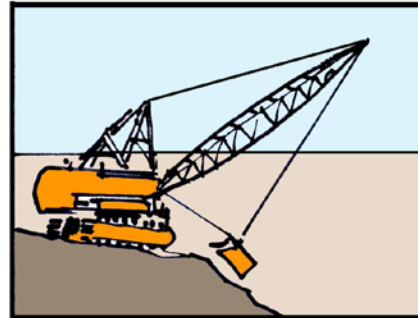
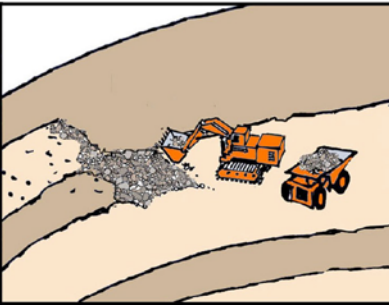
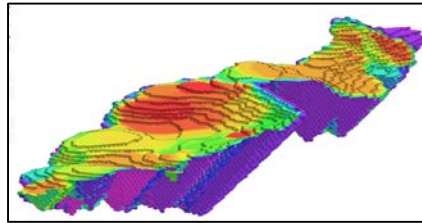
## 1950+

- Early SAG & AG Mills
- Flotation Chemistry
- Gold Leaching
- Electronic Sorting
- Electron Probe Micro Analysis
- In House Design

## 1980+

- Plant Process Control (inc. PLCs)
- On Line Analysers (OSAs, SCADA)
- Process Modelling
- Mine to Mill
- HPGRs & Fine Grinding
- Flotation Scale Up
- Acid Pressure & Bio Oxidation
- Pressure Filtration
- Lance Smelting

# Open pit



**1950+**

Truck and Shovel  
ANFO & Emulsion Explosives

**1980+**

Drag Lines  
Ultra Truck & Shovels  
Measure While You Drill  
Electronic Detonators  
Schedule Value Optimisation  
Geotechnical Engineering

**2000+**

In-Pit Crusher/Conveyors  
Operations Centres  
Surface Miners  
Autonomous Trucks  
Drone Surveys

**2020+**

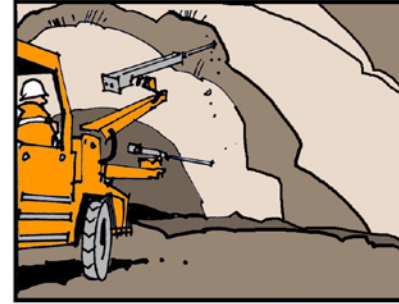
Land Farming  
Insitu Extraction  
More Selective Pits  
Mine to Mill Scheduling Next Gen  
Hybrid Underground - Plts

# Underground metals



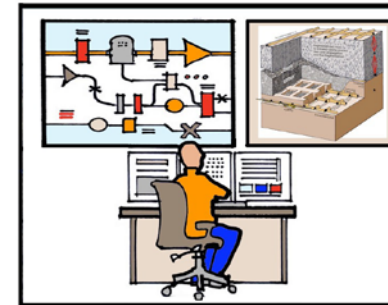
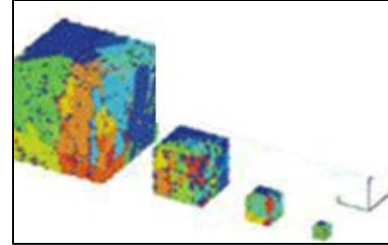
**1950+**

Hand-Held Stoping  
Cemented Fill  
Small Mines (<1Mtpa)



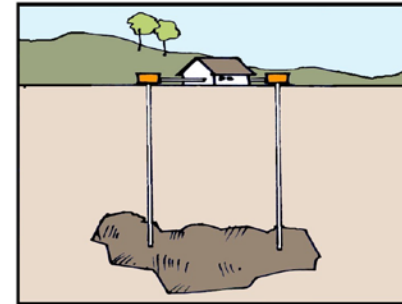
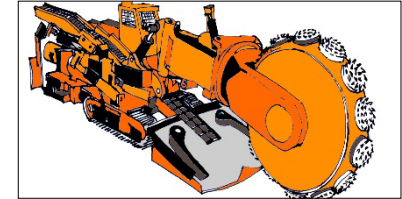
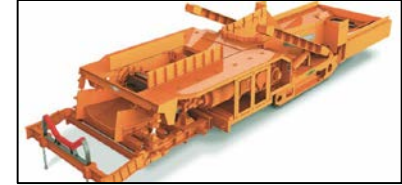
**1980+**

Mechanised Mining  
10t Loaders  
Bolts & Mesh Support  
Large Scale Stoping (>5Mtpa)  
Leaking Feeder Comms



**2000+**

Mine Process Control  
20t Loaders  
Shotcrete Support  
Bulk Undergrounds (+25Mtpa)  
Rock Fracturing Modelling  
WiFi Data Comms



**2020+**

In-Place Processing  
Rock Cutting Tunnelling  
Continuous Transfer Systems  
Small, Mobile Feeder Breakers



# Innovation lessons...

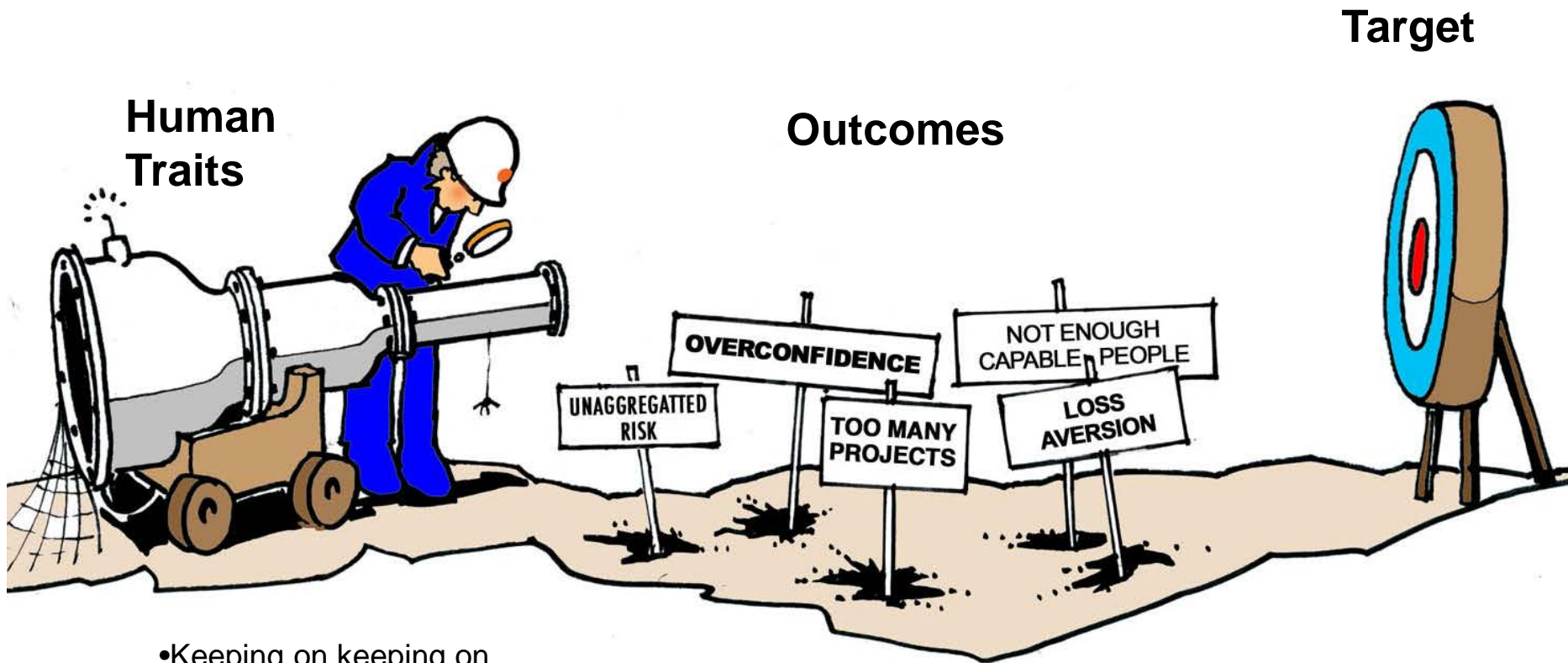


The compelling reasons to change are closer than you think



Needs courage and tenacity

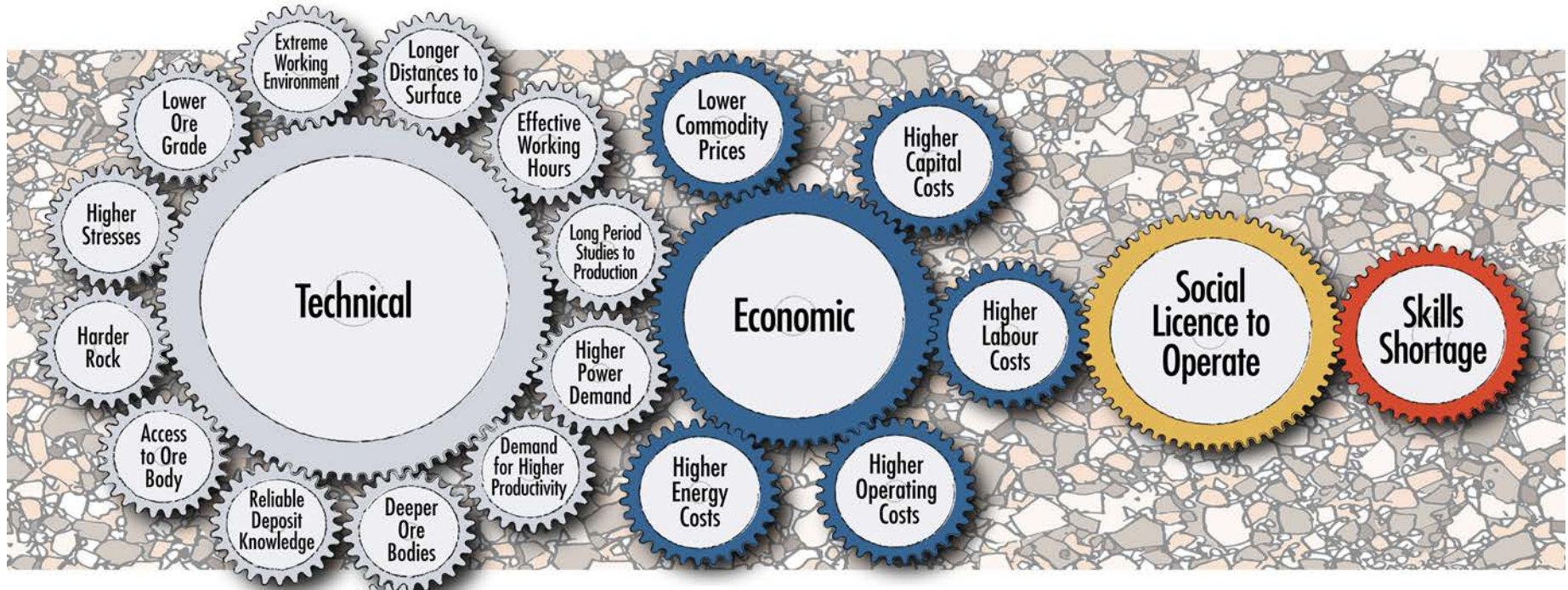
# Why do many innovations fall short?



- Keeping on keeping on
- Relying on first thoughts
- Seeing what you want to see
- Posing the wrong questions (focus)

# A new intent is required to survive and prosper

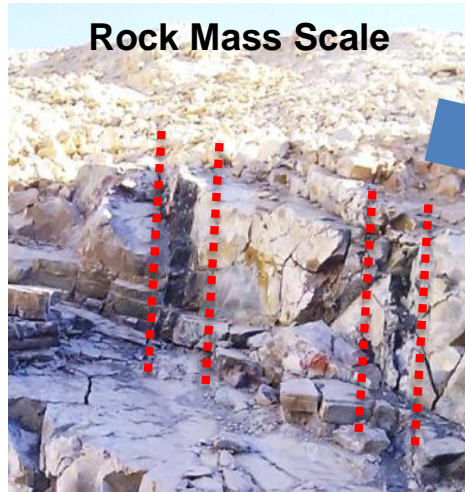
*Incremental changes are not enough.....*



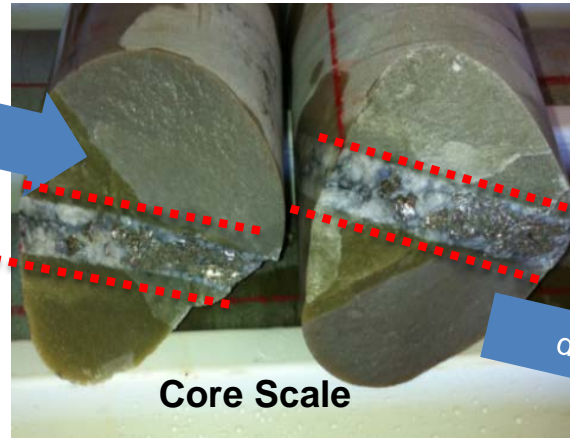
**Revolutionary Changes and New Paradigms are required.**

# A new view – by making the old new again

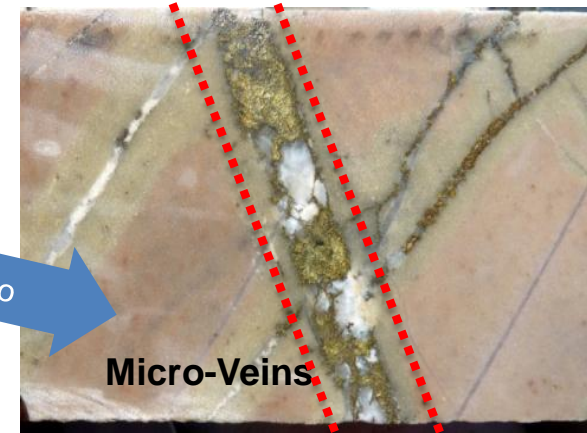
*Mine & process design knowing geology at various scales ... ..*



down to



down to



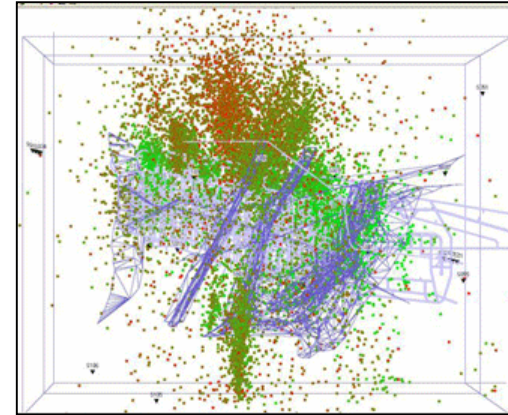
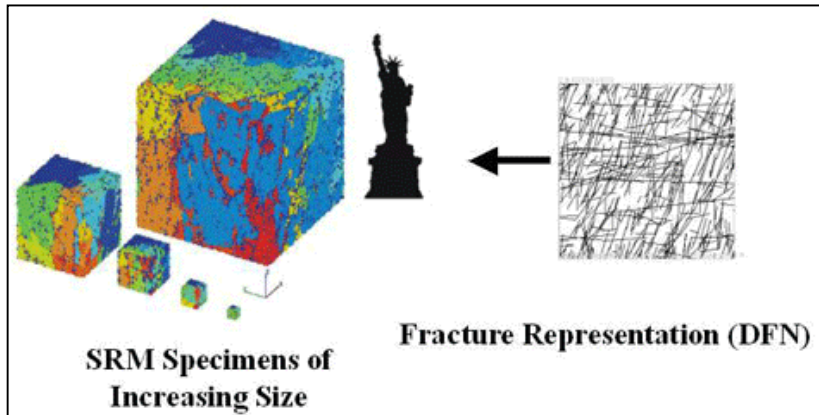
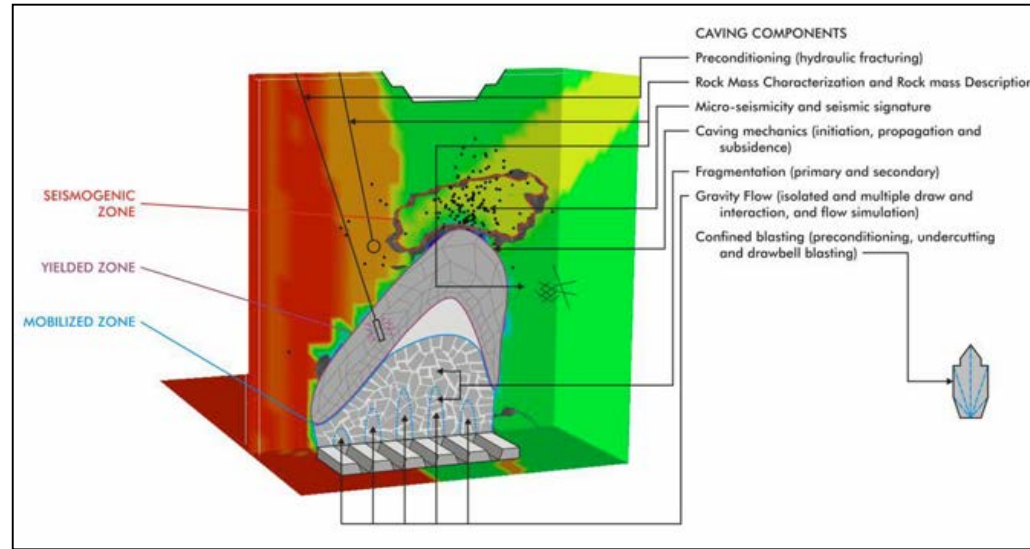
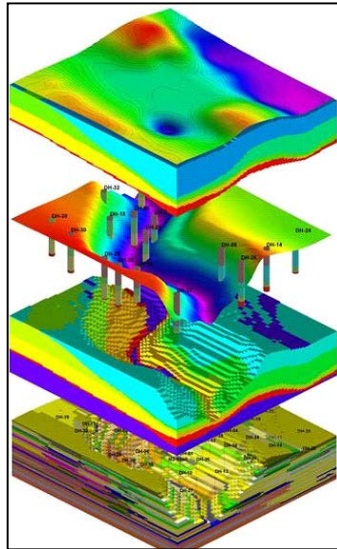
The key to success is early, low energy liberation



Dissemination is a challenge for low energy liberation – the decision to reject is an economic, not metallurgical one.

# New action – simplifying, system changes

*Now have the analytical power to 'solve' rock mass complexity*



# New action – innovation is a contact sport .....

*Try simply smart, insights into better ways*

Linked In

+

Simply Smart

+

Try More

At the process



'WorkOuts'



From others



Scale models



At the orebody



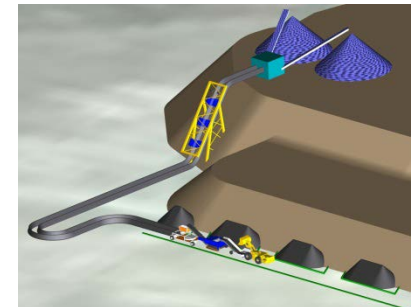
Next Steps?



Role play



Prototyping



LOOK

ASK

LEARN

TRY

# Summary

- Leverage
  - Our historical track record
  - Get more out of what we have
  - Design new modern mines
- Make the ‘old new again’ approach
  - Linked in’ openness
  - Adapt existing technologies
  - Simply smart systems design
  - ‘Collaborative design
  - Courage try more, together
- Step change opportunities
  - Land farming
  - Waste rejection
  - In place processing
  - Distributed, remote operations

