

# Sensing and automation research at the Centre for Mining Innovation

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# Acknowledgements

- Funders:
  - Mine Health and Safety Council
  - PlatMine
  - Gold Fields Limited
- Researchers and colleagues
- Bergforsk
- Meetingpoints Mining

# Agenda

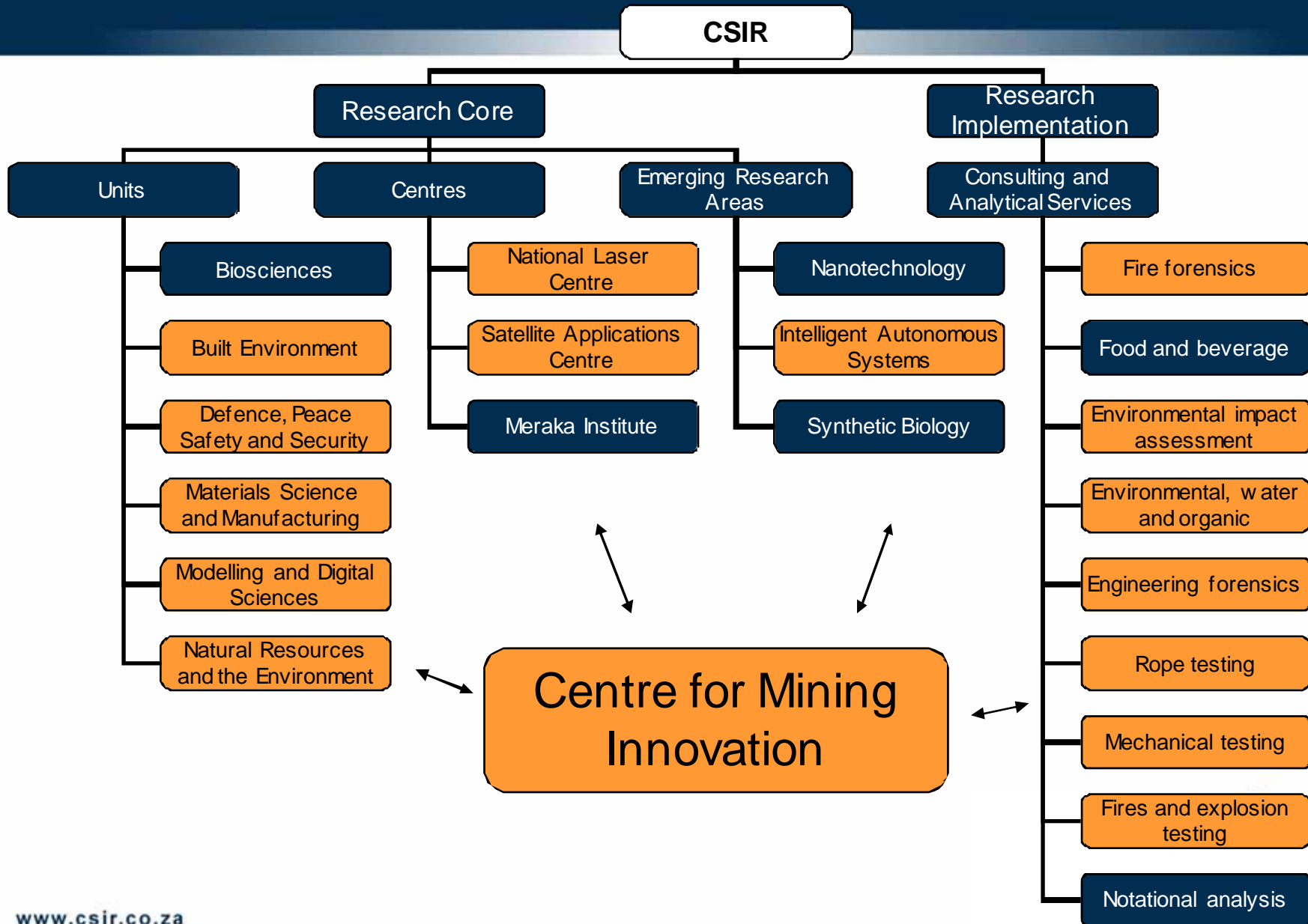
- Introduction
  - CSIR
  - Mining in South Africa
- AziSA and Smart Mine
- No-entry mining
- Conclusion

# The CSIR

- The largest R&D facility in Africa
- 2000 staff, across South Africa
- 6 Operating Units, 4 Centres



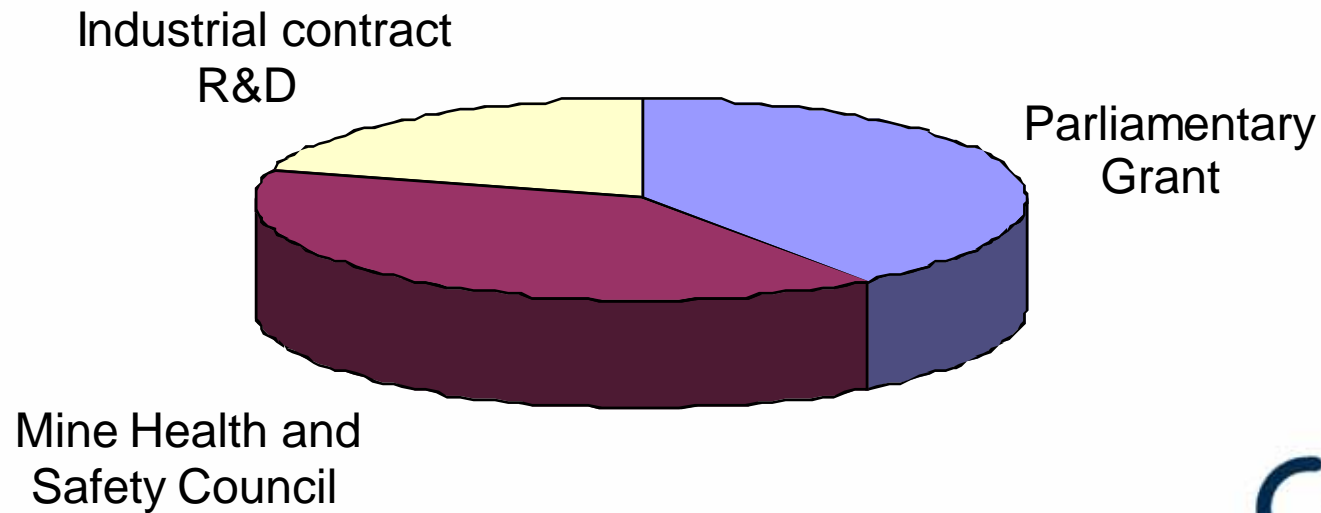
# The gateway for mining research in CSIR



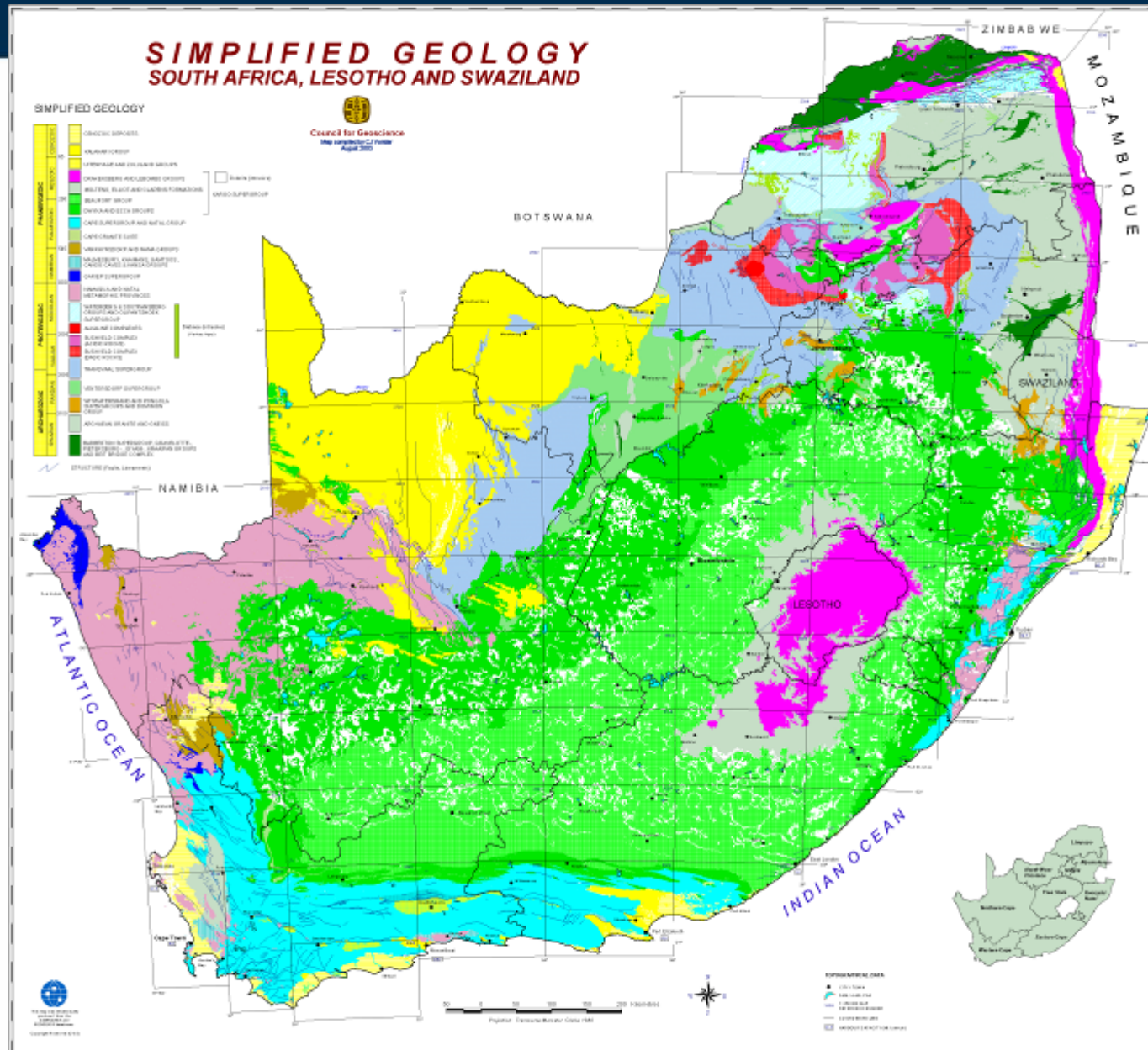
# The Center for Mining Innovation

- Human factors
- Real-time risk management
- Novel mining methods

## Income distribution:

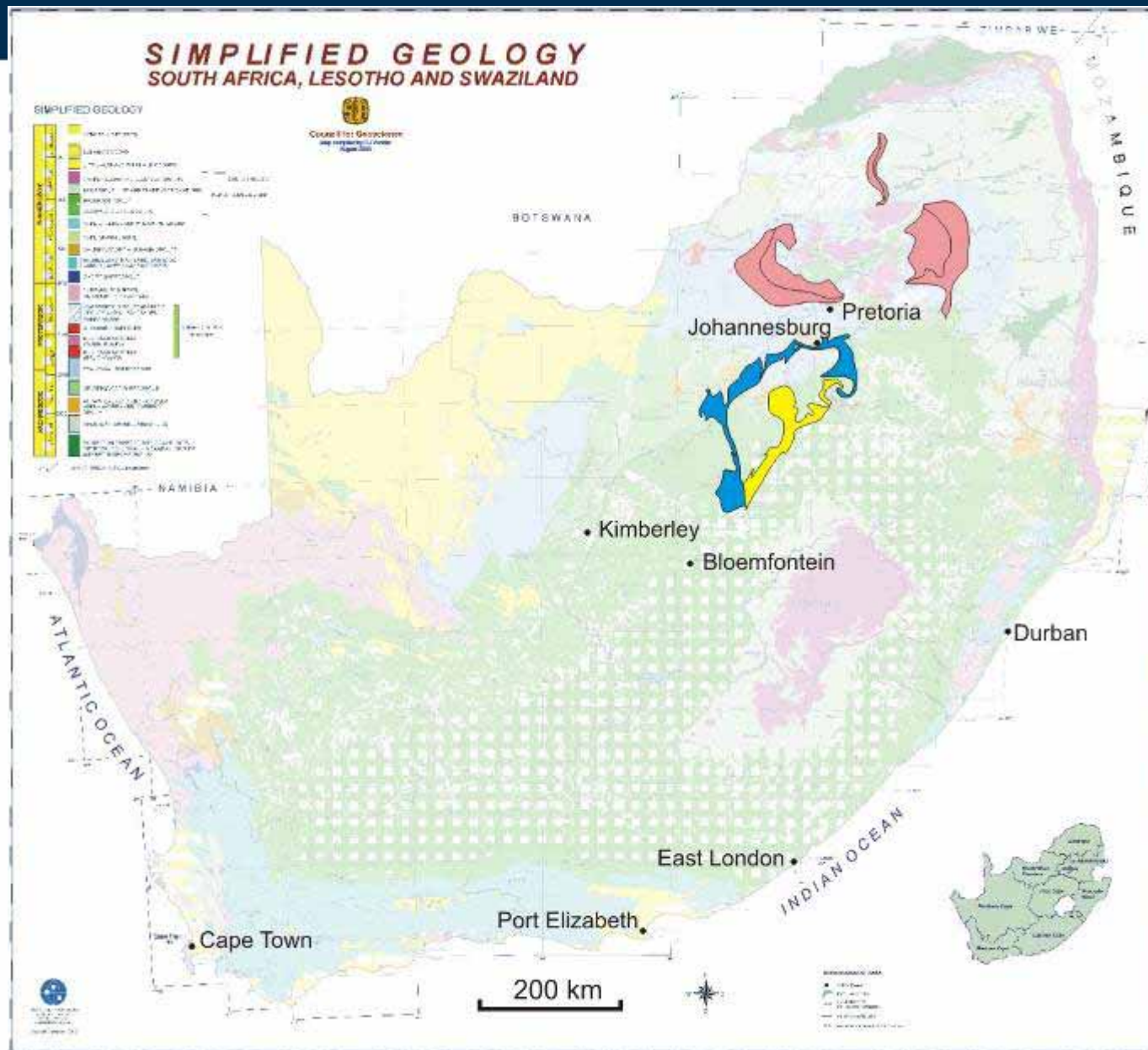


# Minerals in South Africa



- Big 3:
- Platinum
  - Coal
  - Gold

# Minerals in South Africa

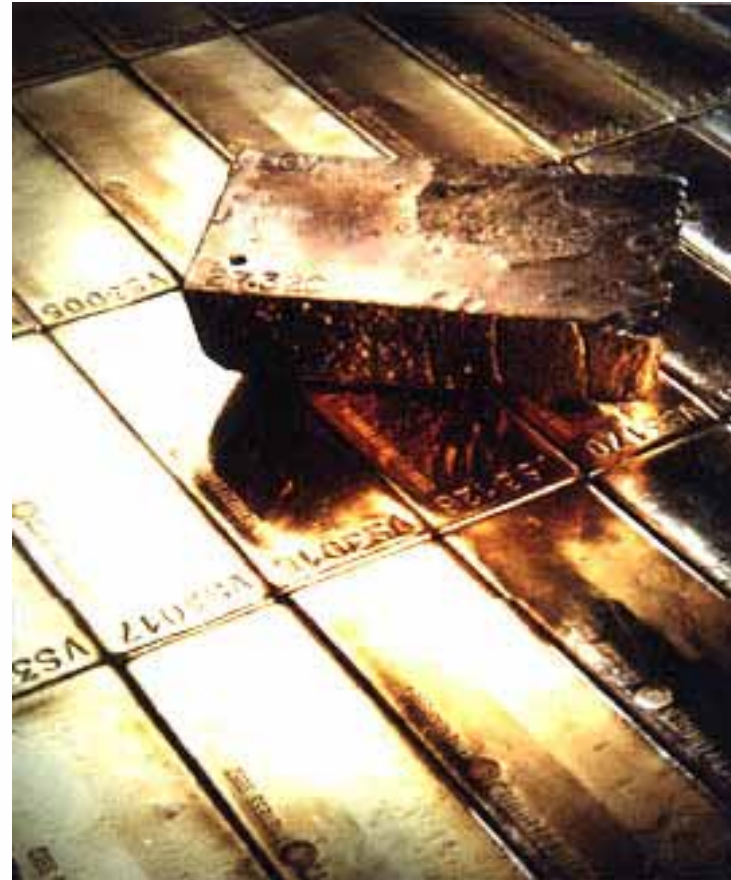


Unique two:

- Platinum
- Gold

# Gold and platinum orebody characteristics

- Huge lateral extents
- Low to moderate dip
- Poor grades
- Thin seams
- Very long life



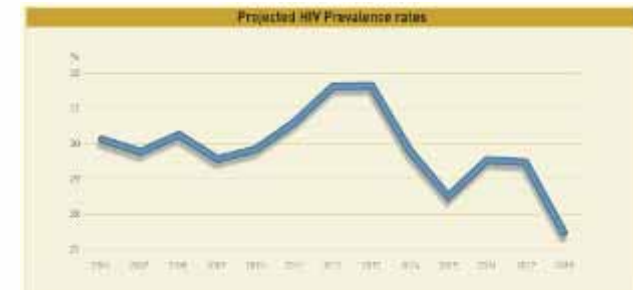
## Current practice

- Hand operated drill and blast
- Labour intensive
- Cyclic
- Unhealthy
- Dangerous



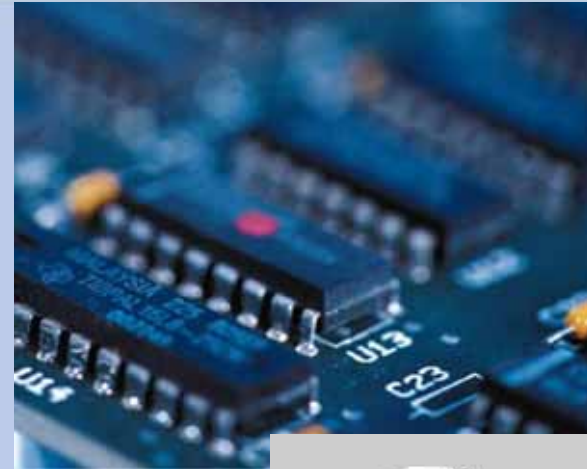
# Pressures

- Cost Control
- Human resources at all levels
  - Lack of high and low-level skills
  - Disease
- Social license to mine
  - Safety
  - Occupational health



# Take mining into the information age and beyond

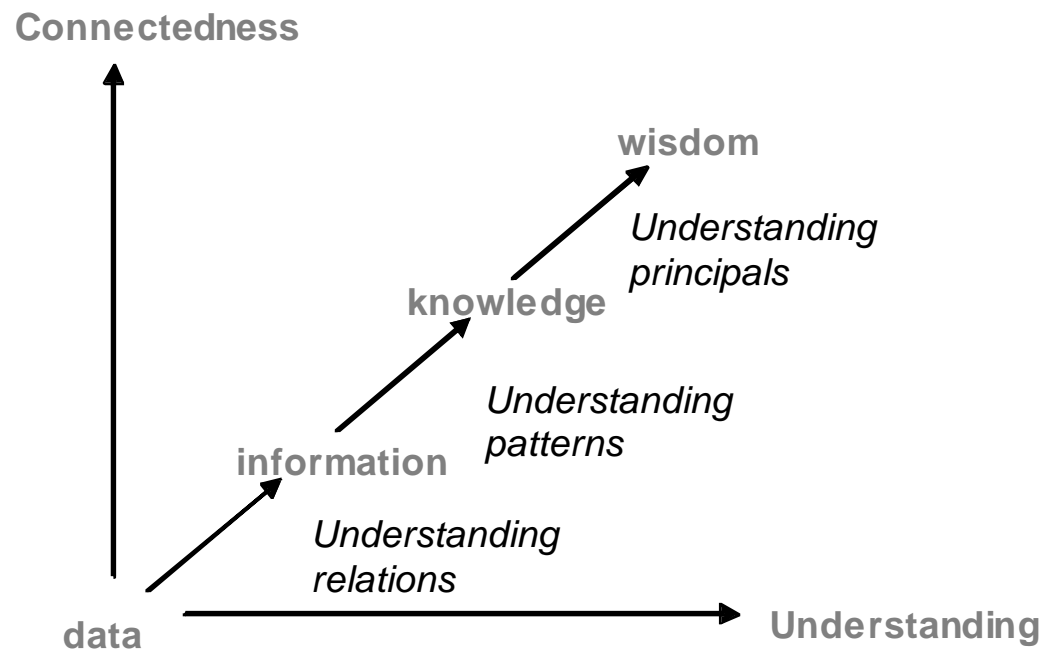
- Measure to manage better
- Remove people from hazards
- Make mining more attractive as a career through technology and risk management



# Agenda

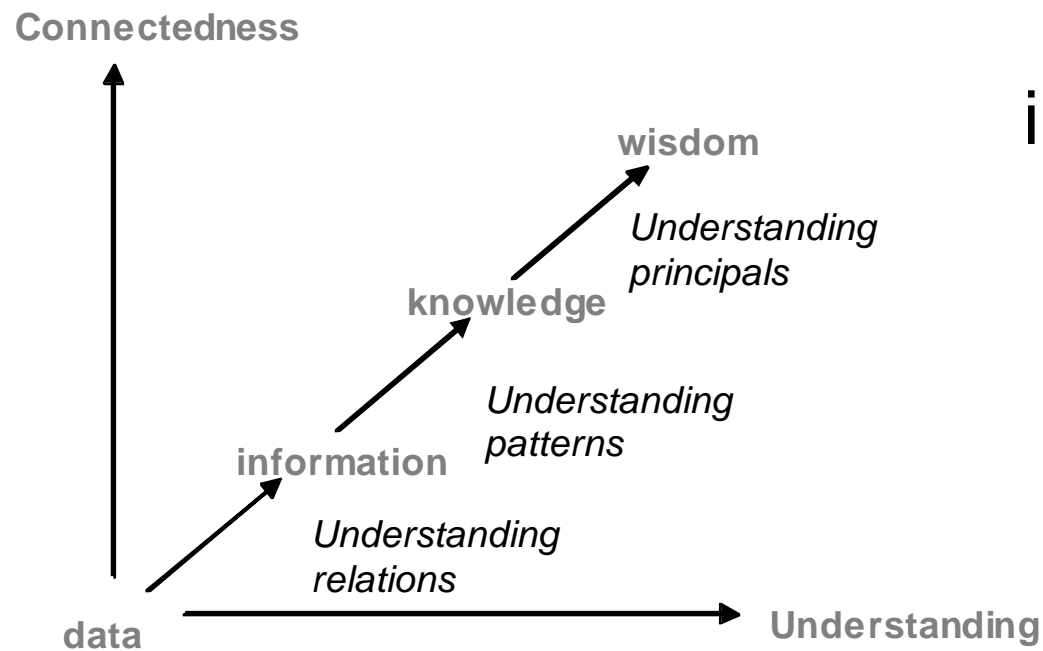
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# The DIKW hierarchy



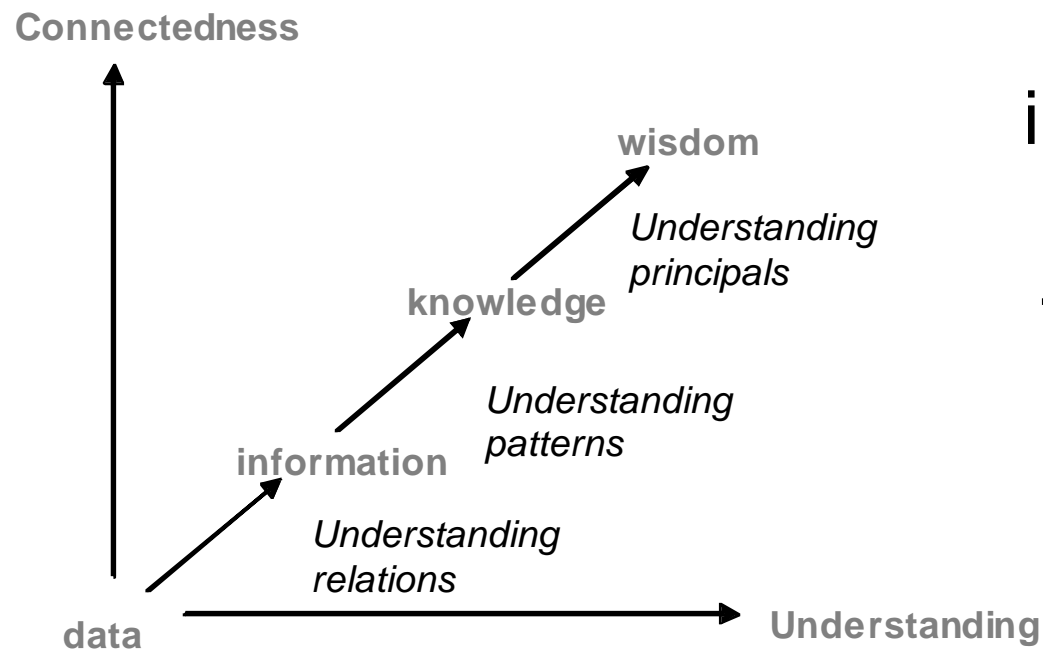
t=25°

# The DIKW hierarchy



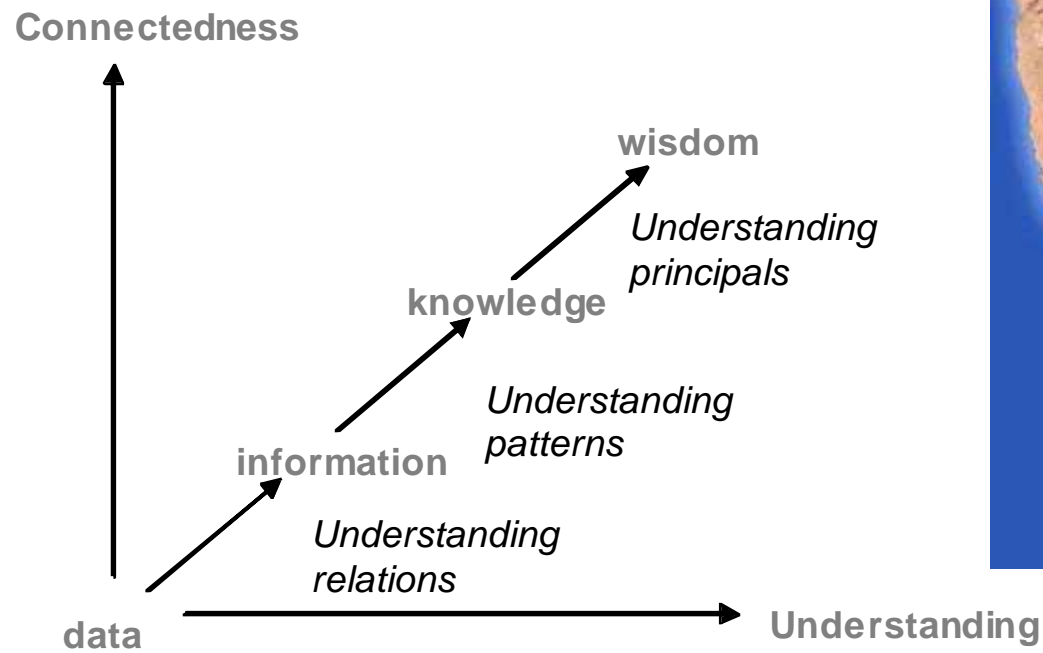
$t=25^\circ$   
in Windhoek yesterday

# The DIKW hierarchy

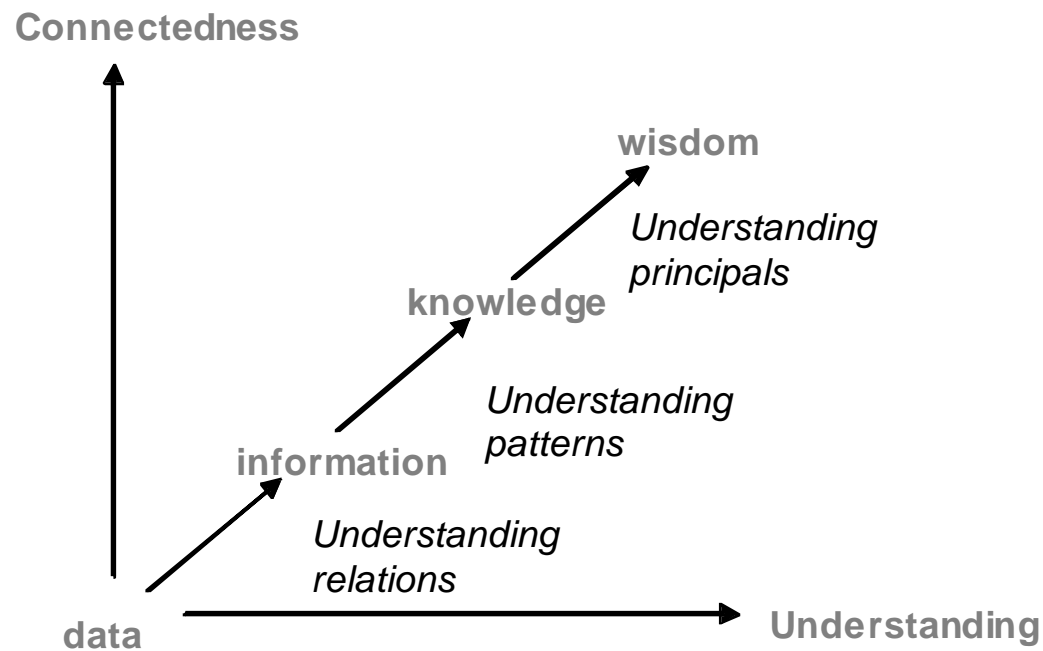


$t=25^{\circ}$   
in Windhoek yesterday  
wind = 5 km/hr,  
+ thousands of others

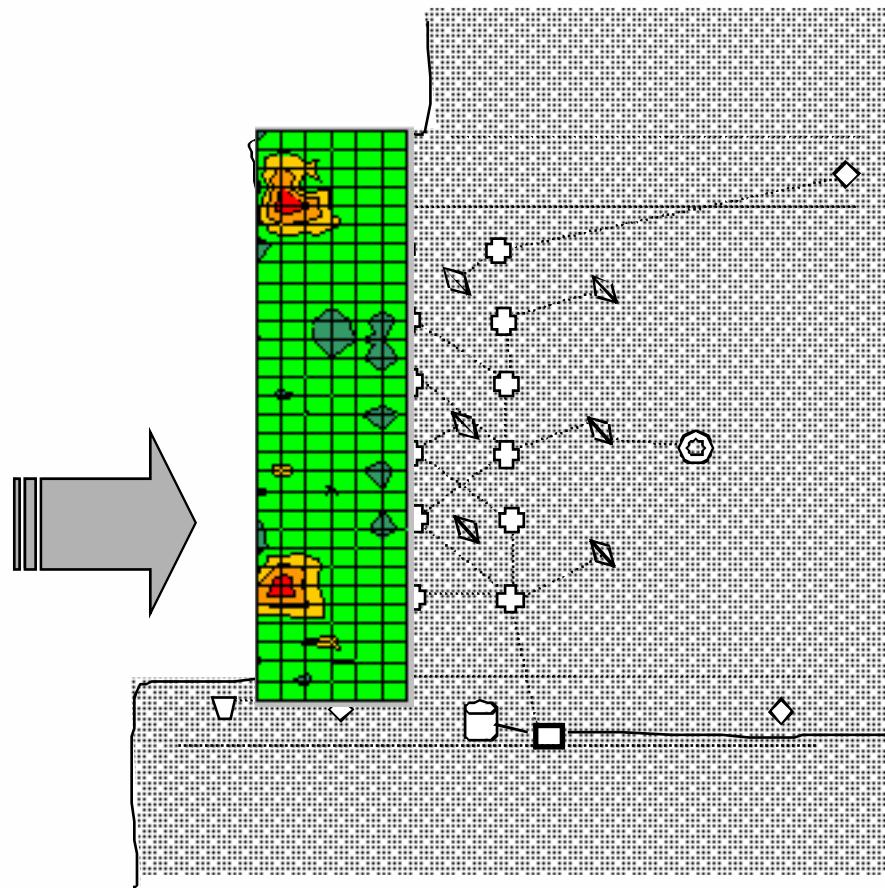
# The DIKW hierarchy



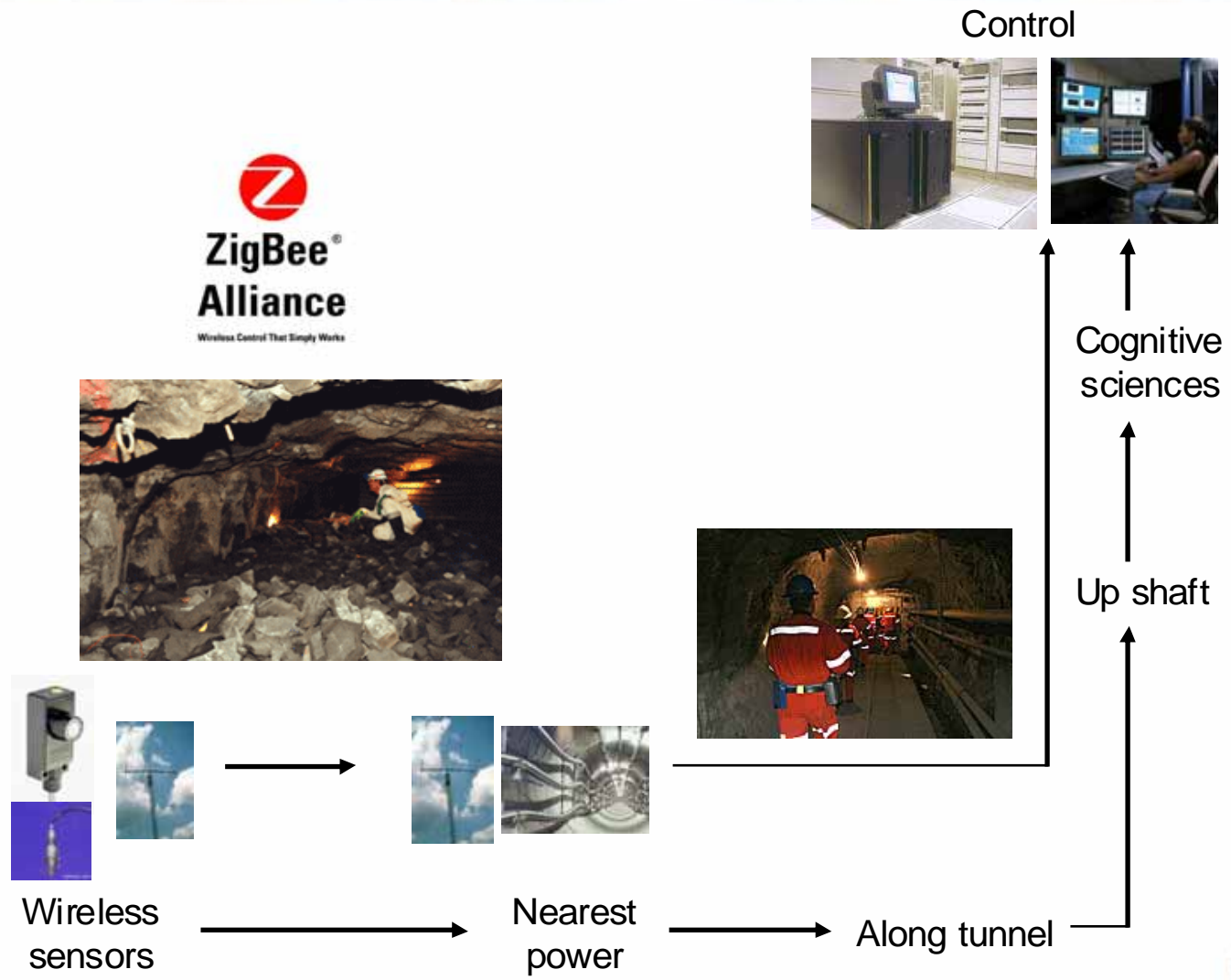
# The DIKW hierarchy



# Technology for in-stope real-time risk management



# AziSA architecture

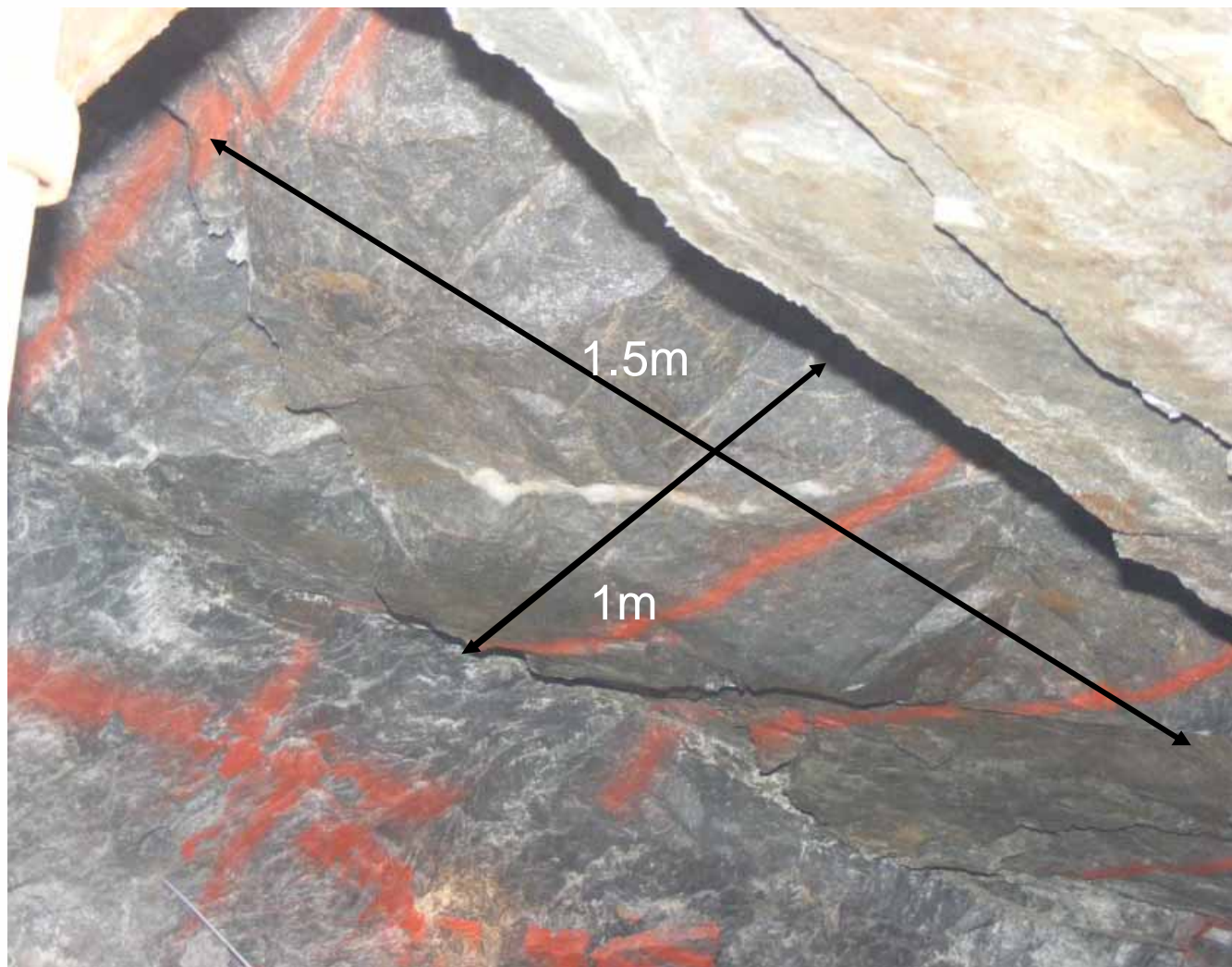


# CASE STUDY: Rockfall risk management

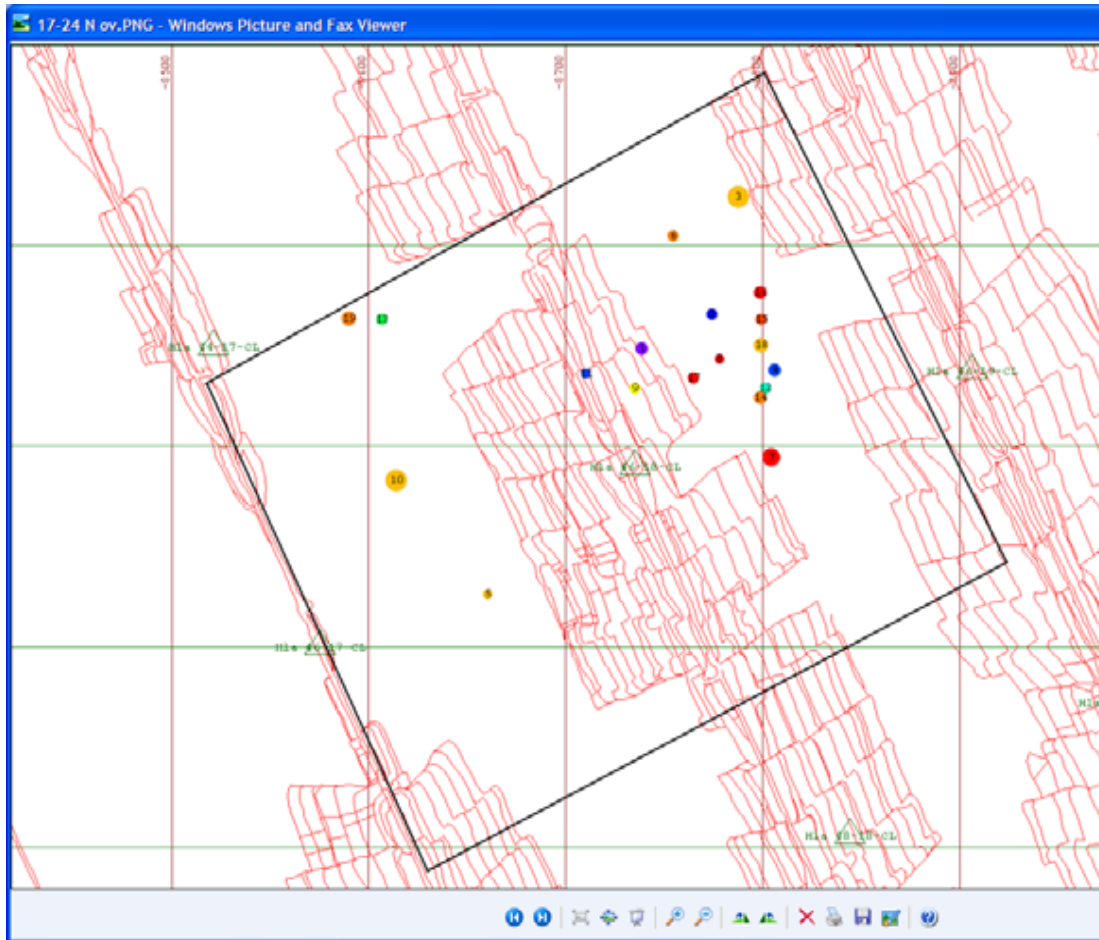
## The production stope



# The hazard

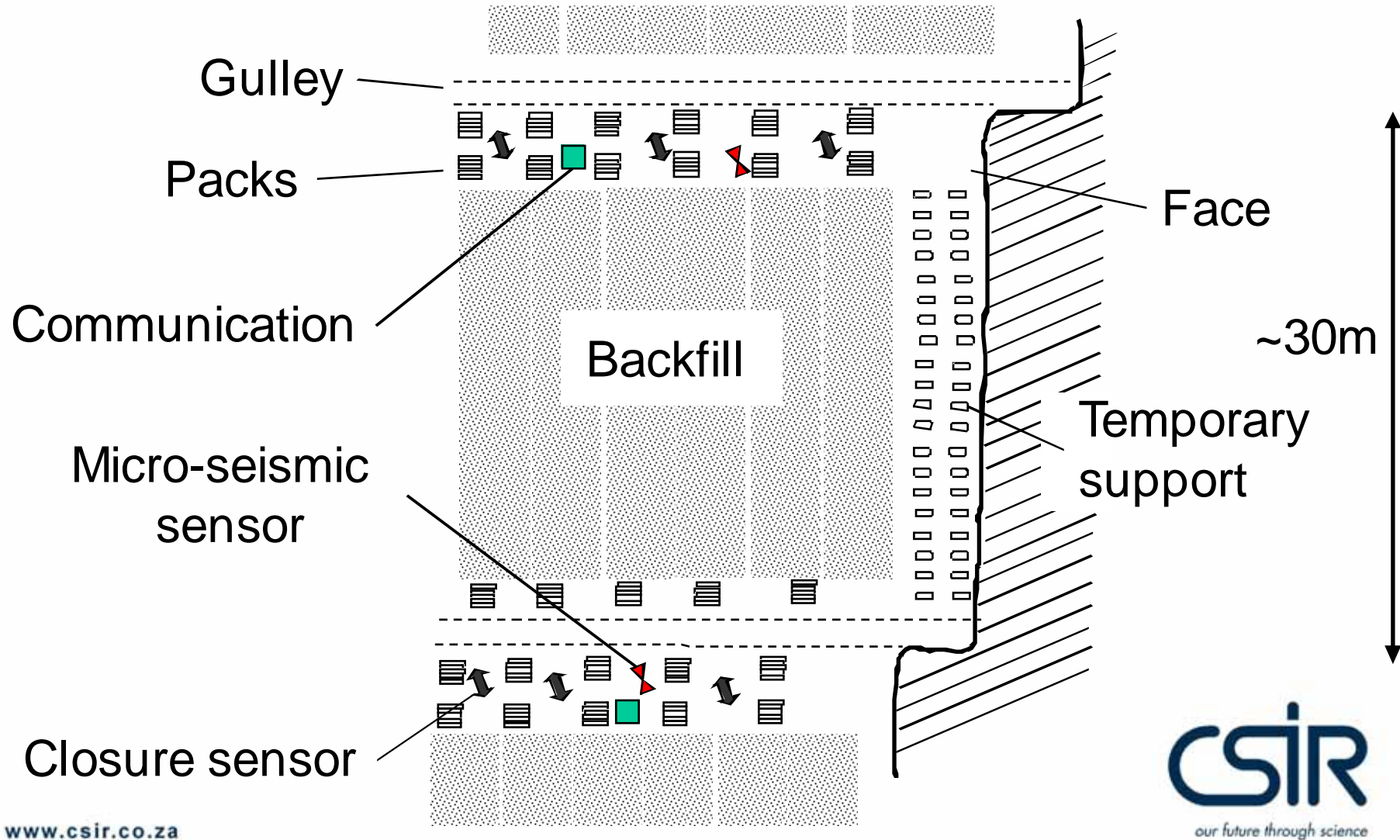


# Hlanganani installation



4 panels on 46/18  
East now fully  
equipped and all  
sensors functioning  
with communication  
to surface

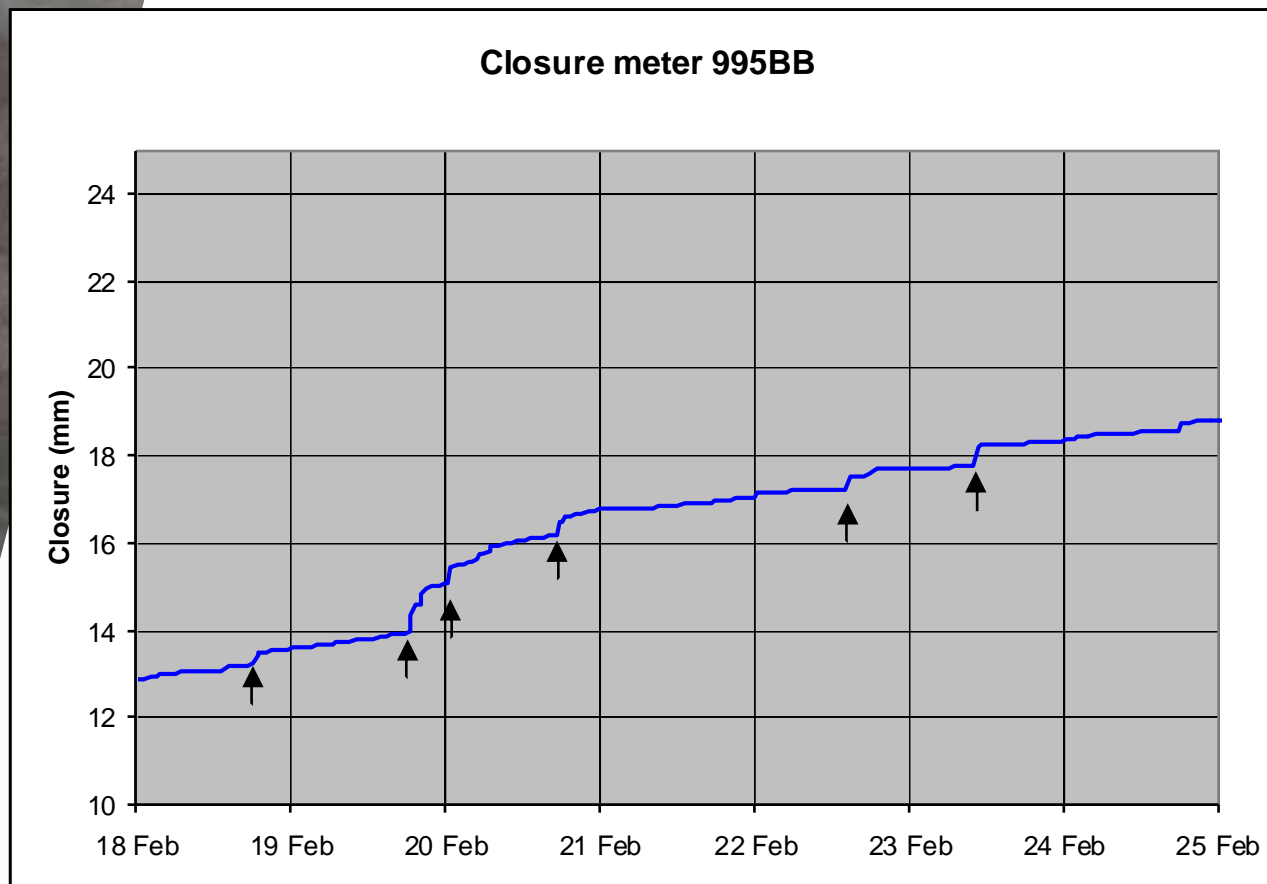
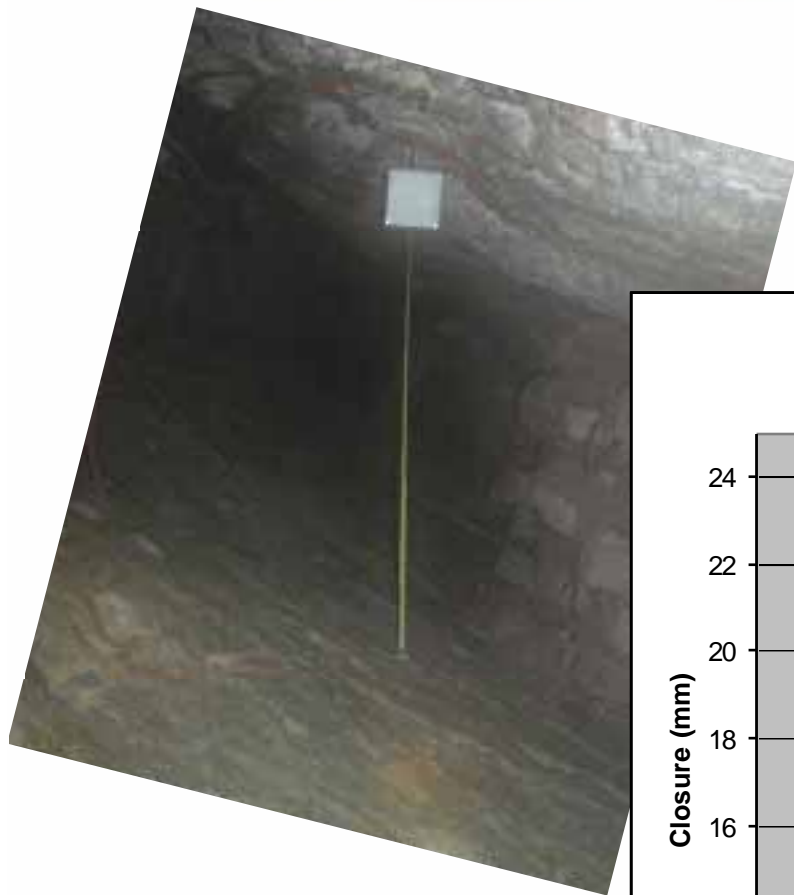
# System layout



# Communication



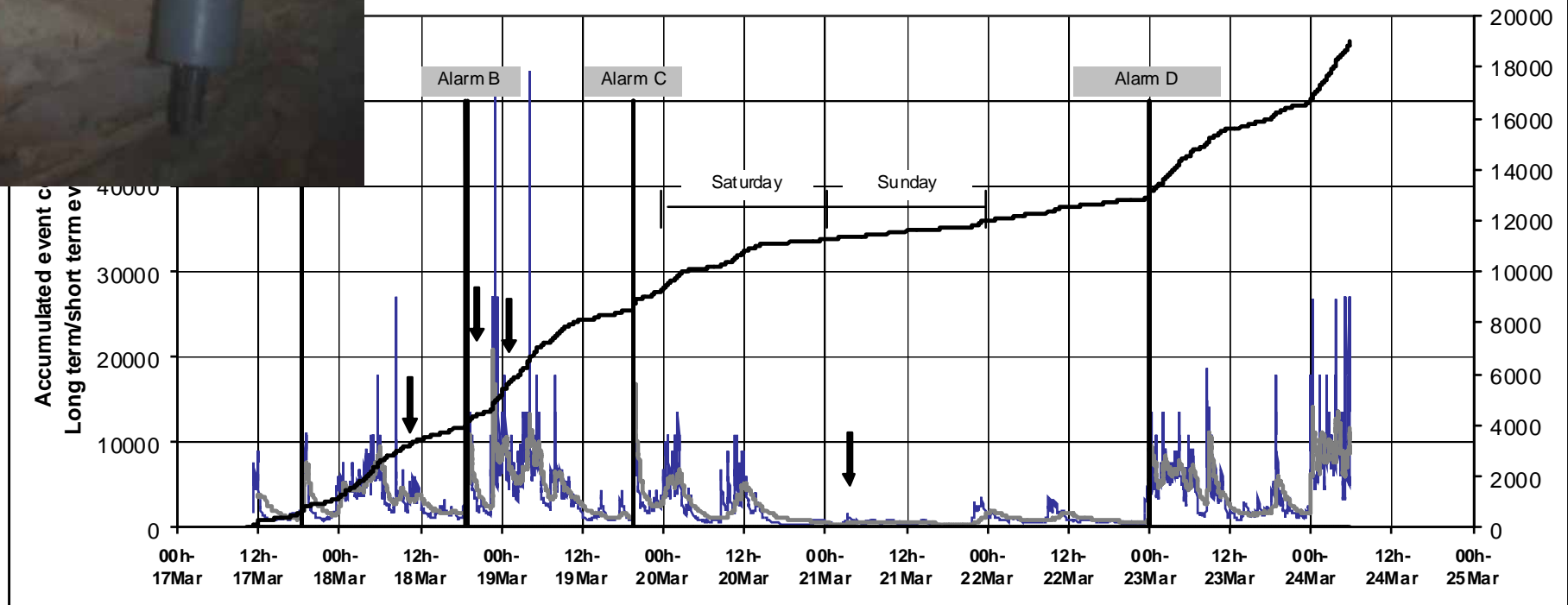
# Stationary sensing – Closure meters



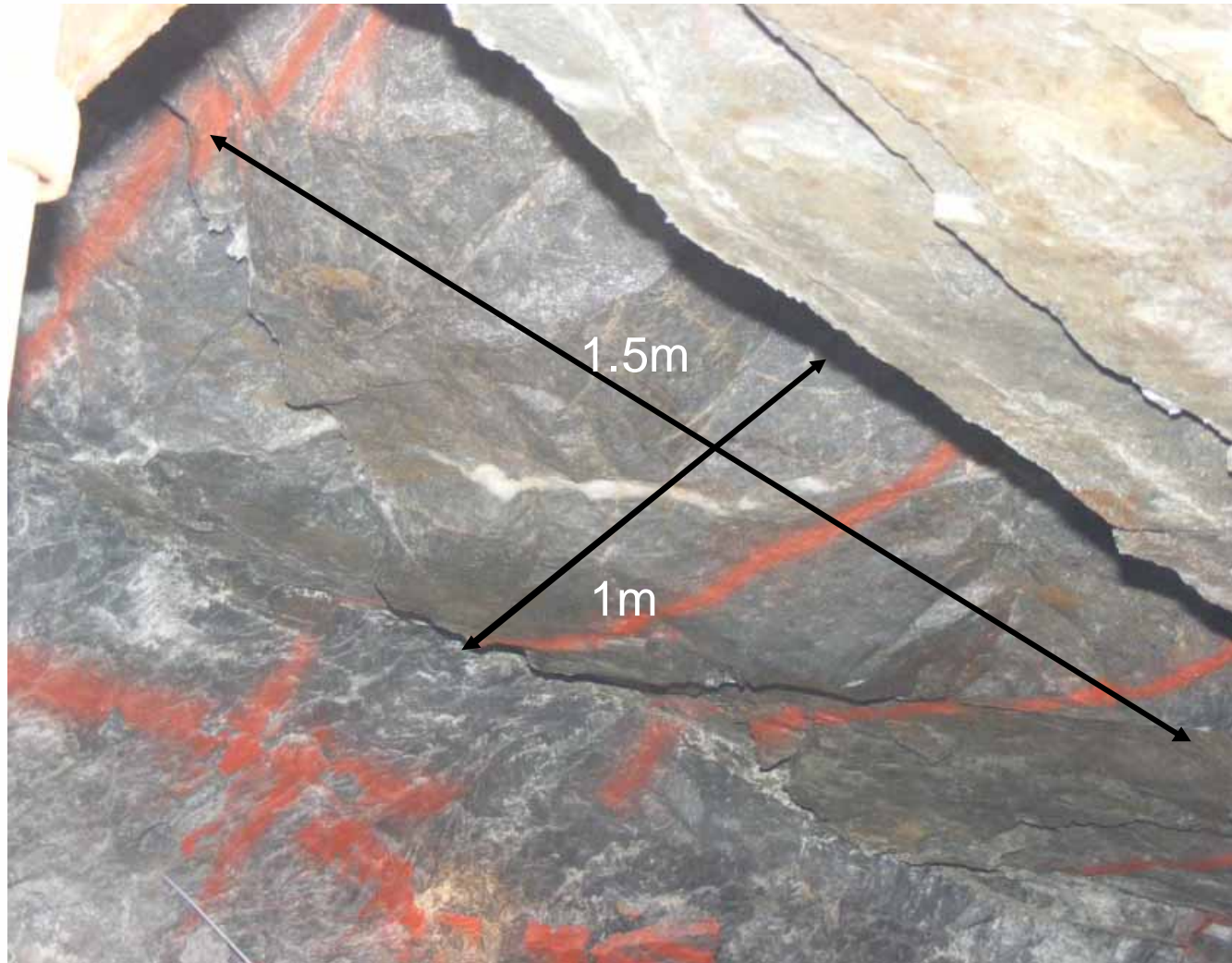
# Stationary sensing of fracturing process



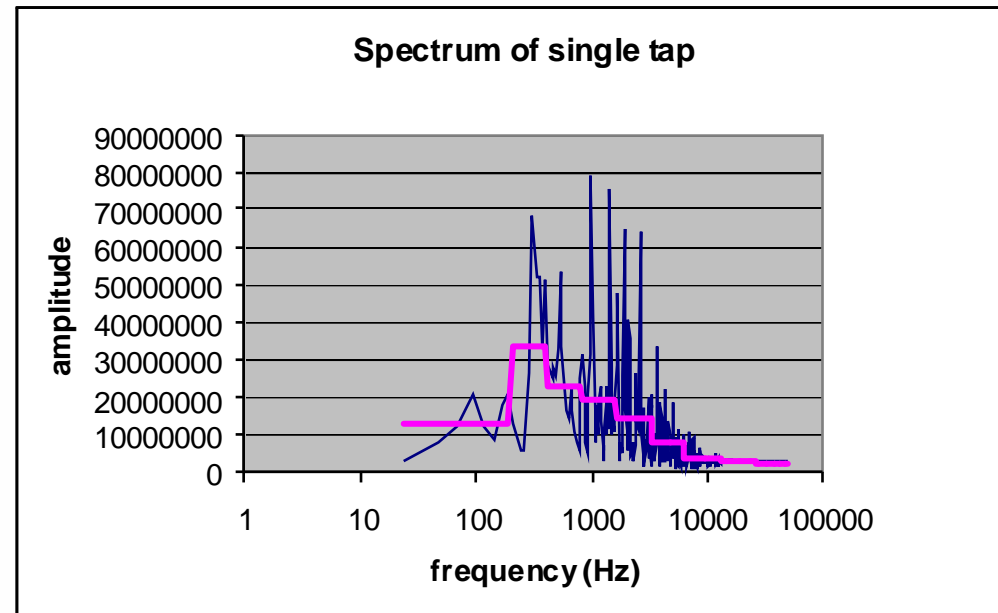
Fogwarn output over a week



## NOVEL SENSORS: The hazard



# The entry exam

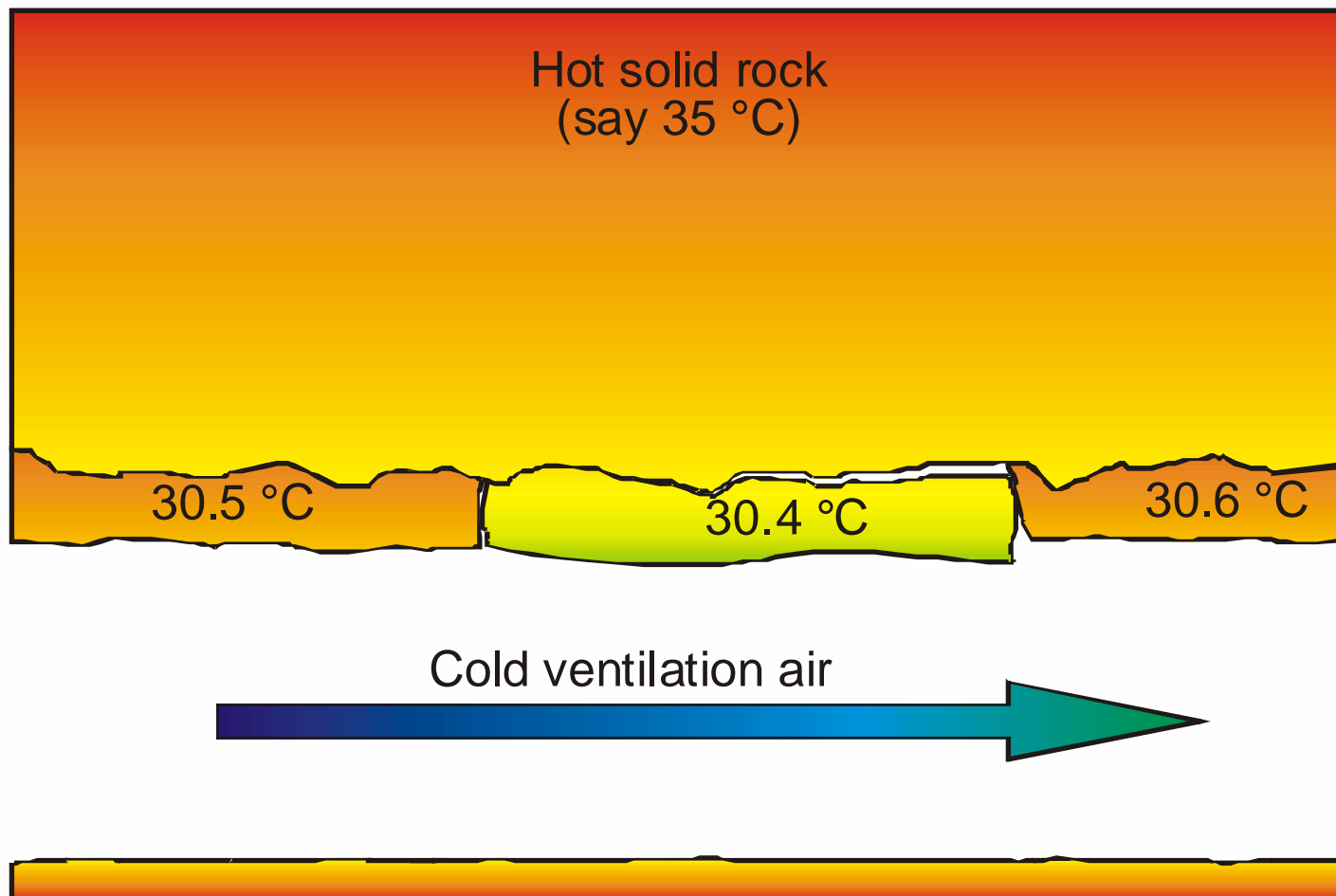


Frequency response  
of tap

## The acoustic sounding device



# Thermal imaging - principle



# Result



# Agenda

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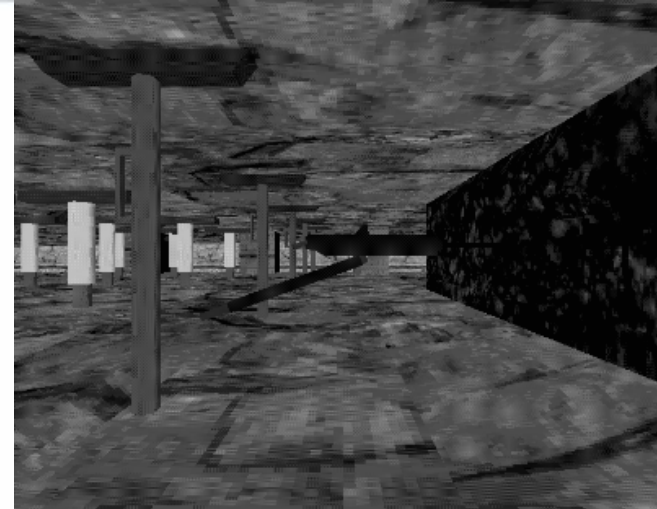
## How it is done elsewhere



- Continuous
- Safe
- High capital cost
- High production rates

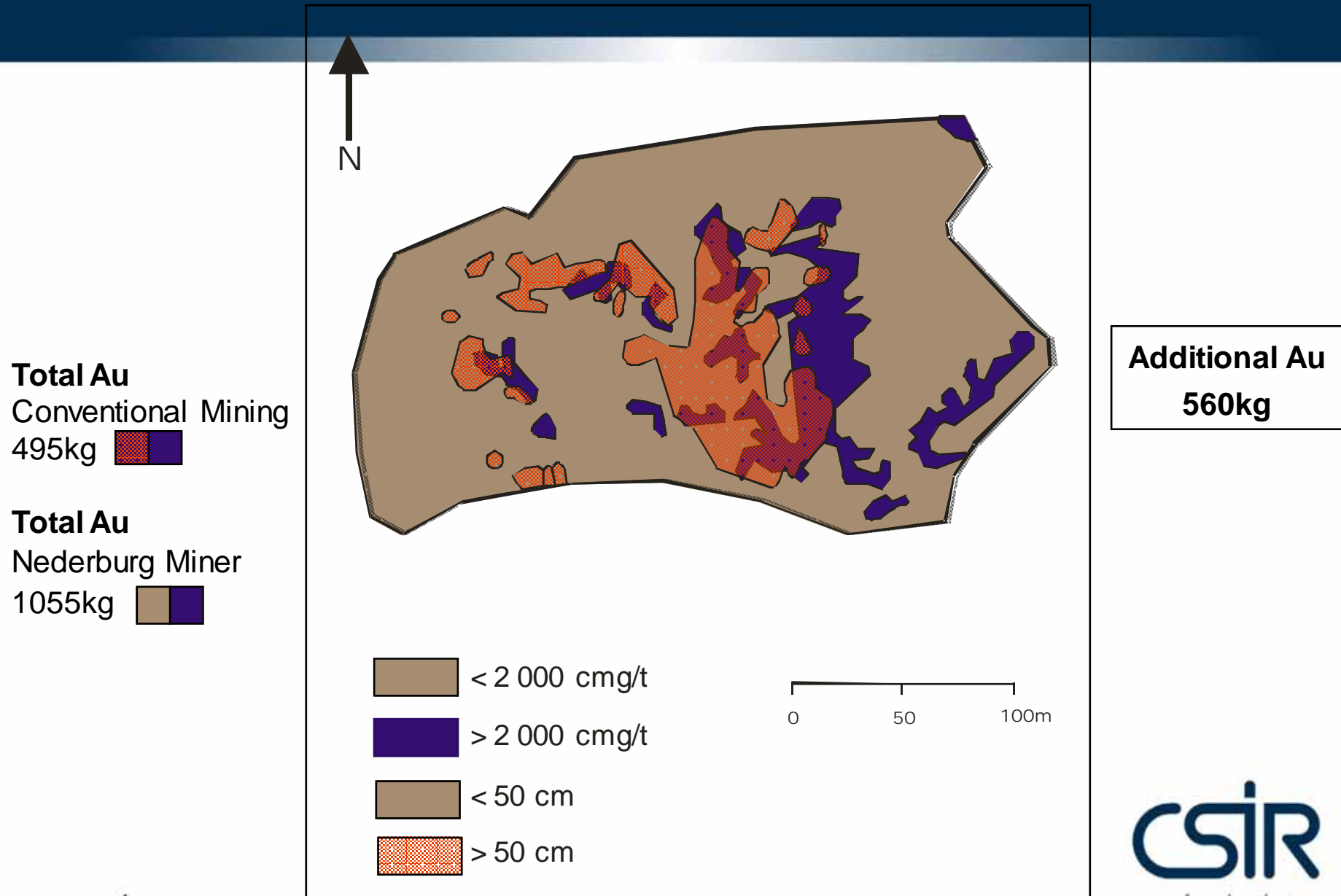
## A narrow stope mining system

- Mining depends on people
- People have a particular size
- Stope heights are people sized or higher
- Uneconomical to pursue narrow gold reefs of limited grade

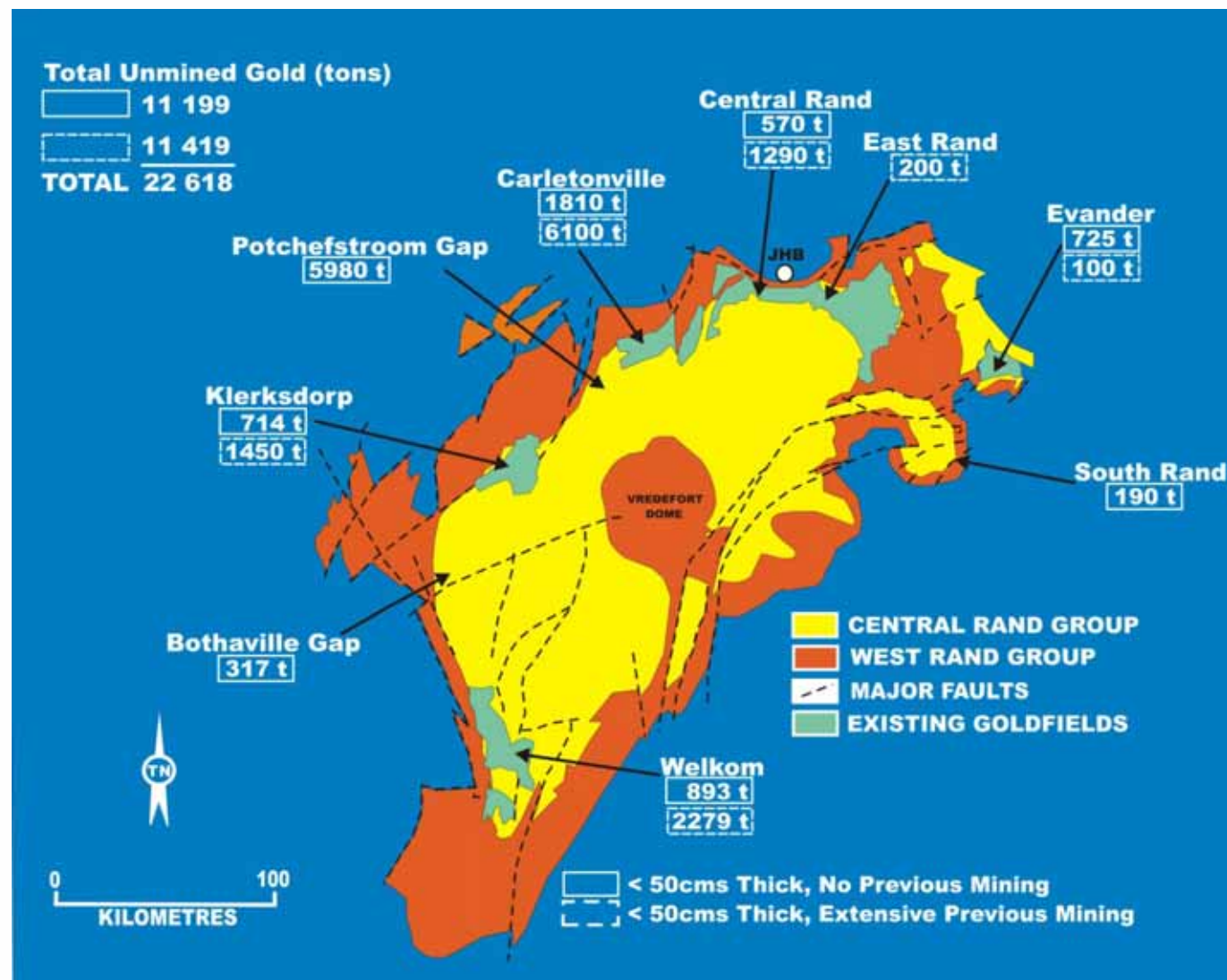




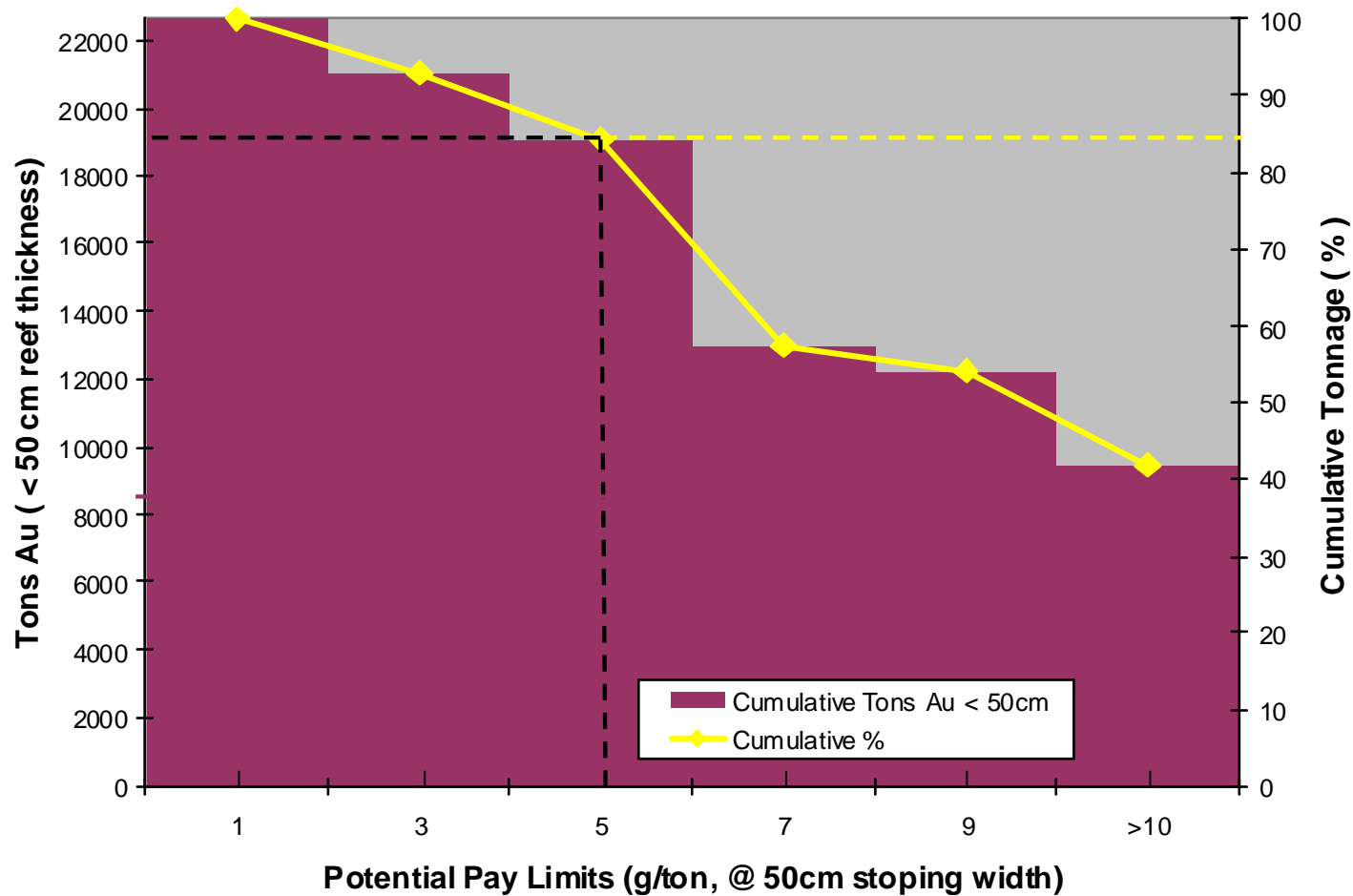
# Case study – Middelvlei Reef on Doornfontein Mine



# Witwatersrand Gold in stopes < 50 cm



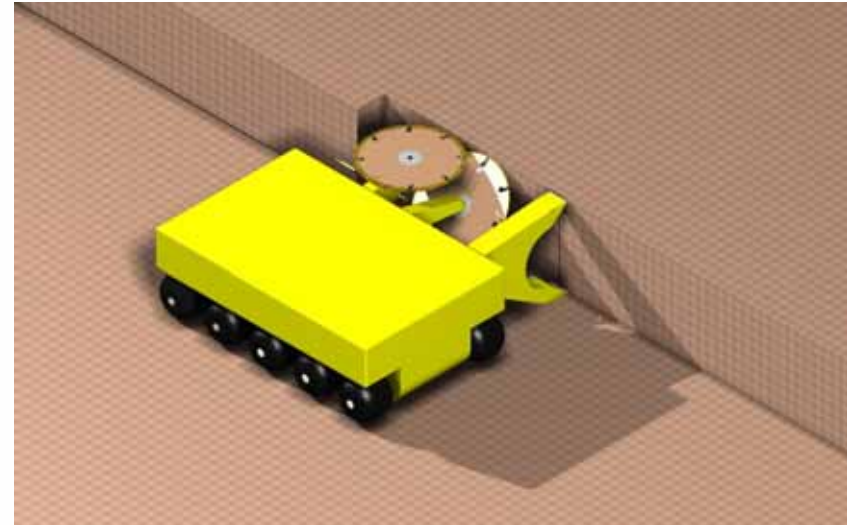
# The potential is enormous



Value on 4 May 2011: US\$ 890-billion

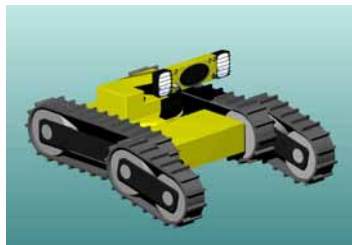
# How?

- Re-evaluating the fundamentals
- Exploring new technologies
- Thinking small
- Thinking new rock breaking



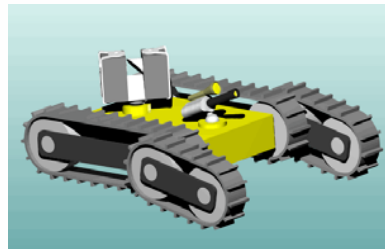
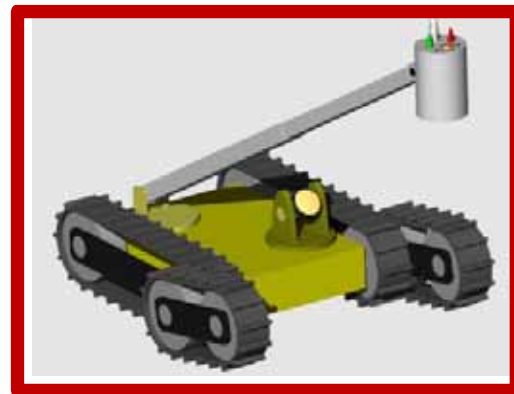
# Road map

2012



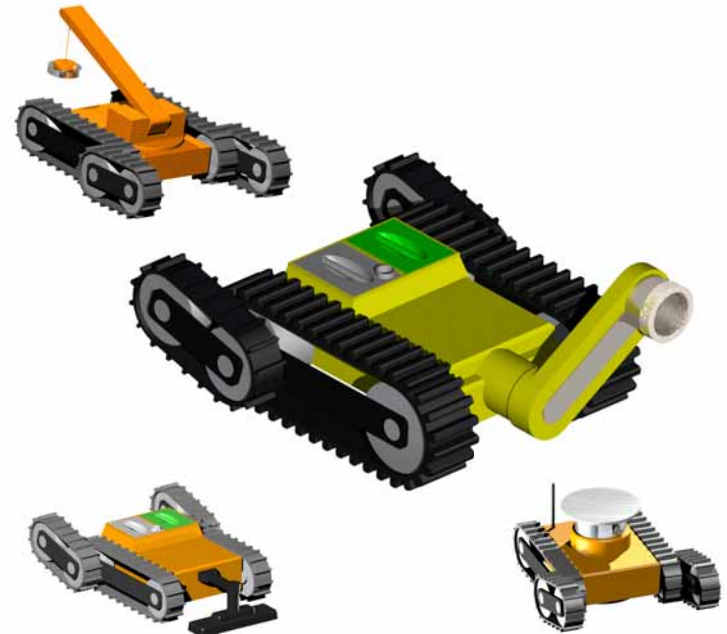
Emergency recovery

2013



Sensing

2018



Mining fleet

# Progress – rock breaking

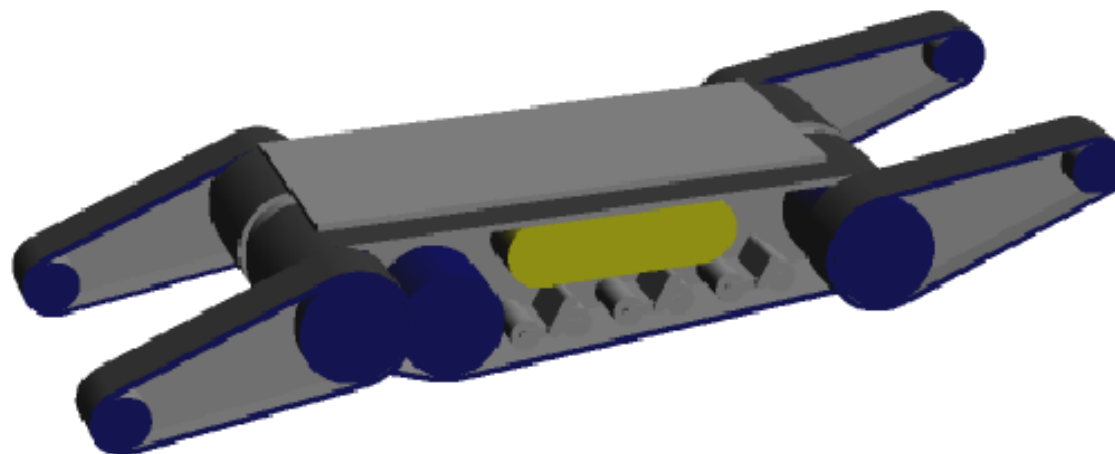


- Electric rock breaking
- 10 kV 60 kHz AC
- Concept proved in specific rock types

# Progress – platform



2010



2011

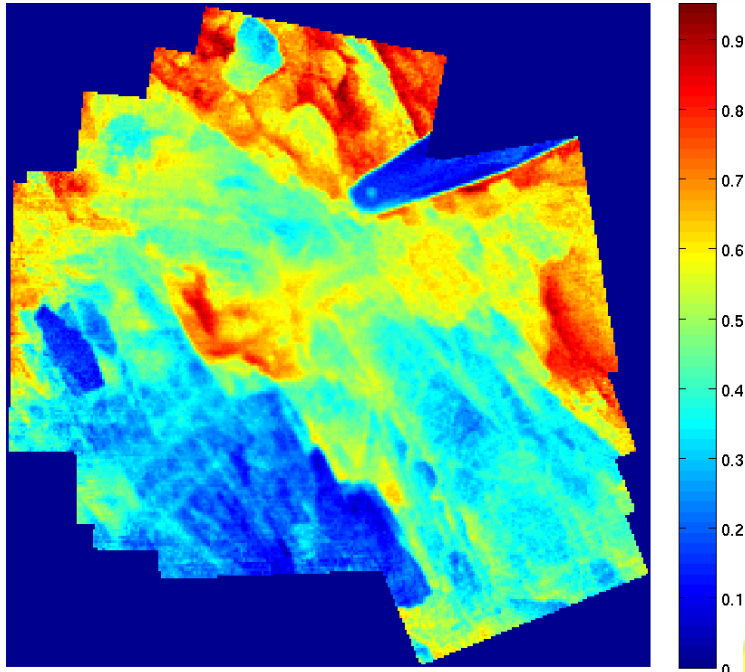
# Navigation



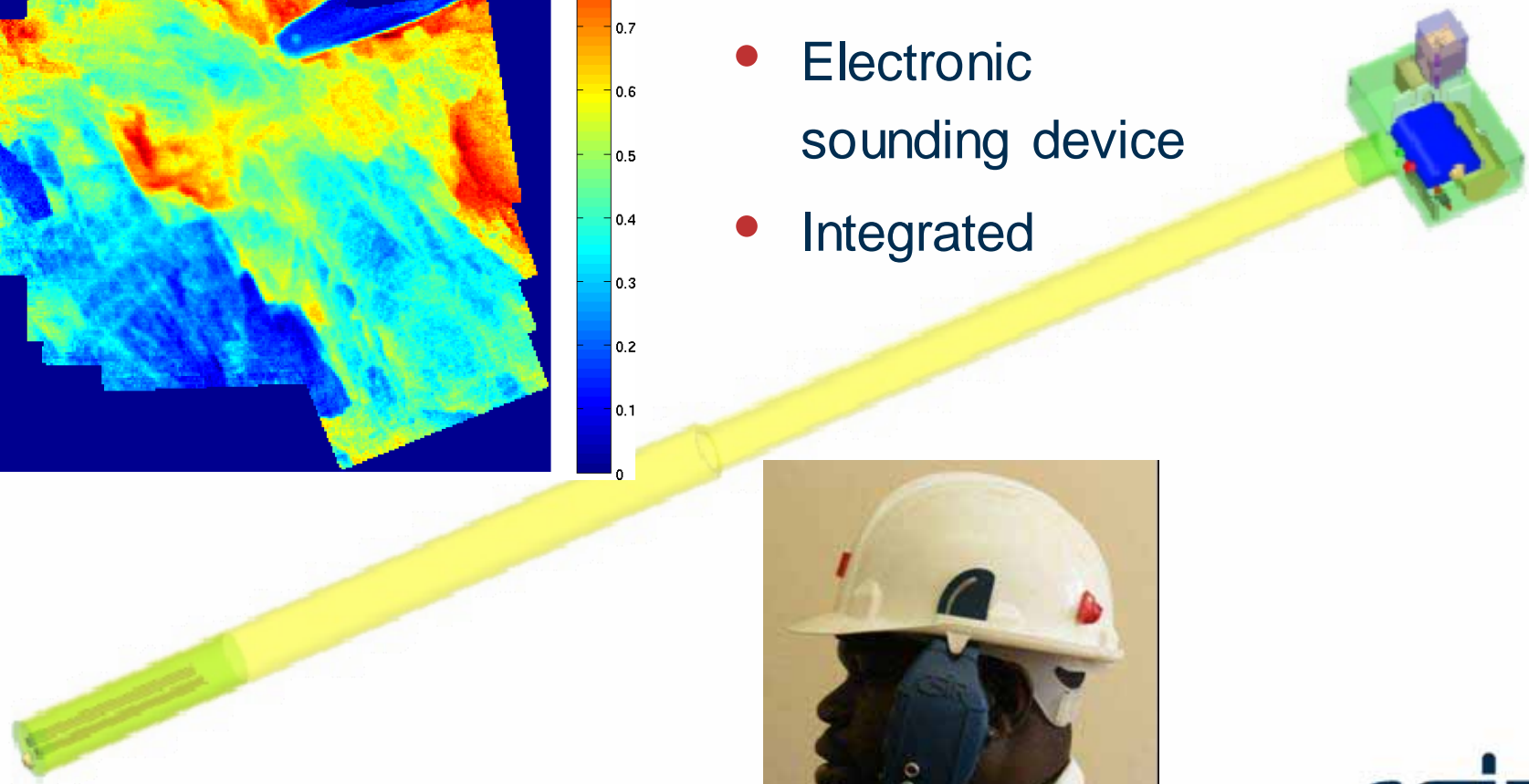
- Beacon based
- Supplemented with low cost inertial



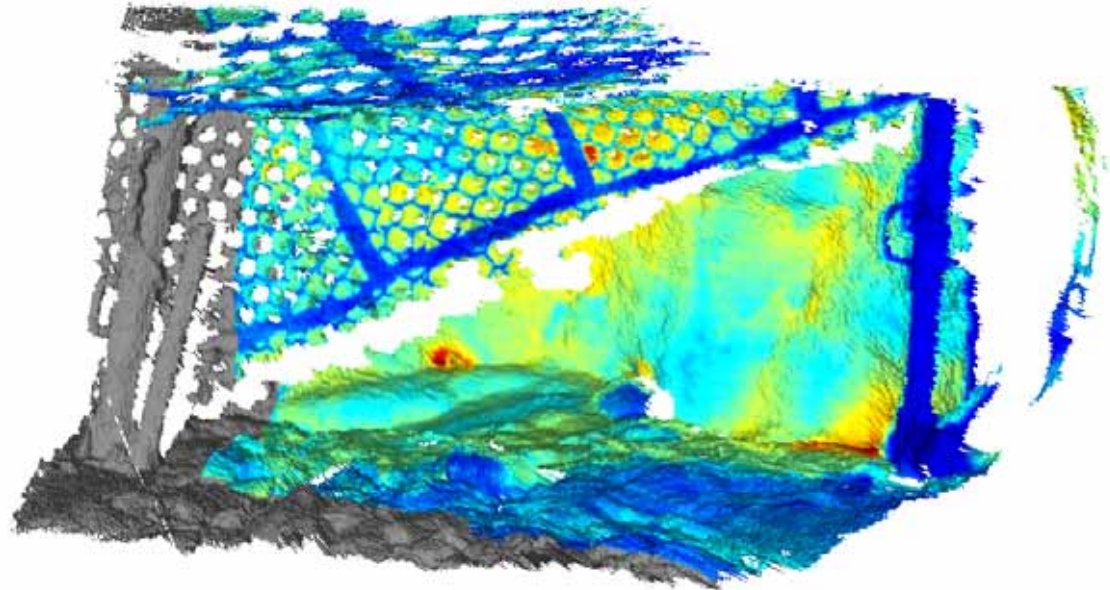
# Sensors



- Thermal
- Electronic sounding device
- Integrated



# Mapping



- Good results from all
- Kinect is ideal:
  - Fast
  - Cheap

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# Challenges

- Harsh environment
- Small market size
- Labour resistance
- Lack of skills
- Risk aversion

# Conclusion

- Sensing promises a new age in mine management
- Automation allows access to new orebodies
- The challenge is implementation
- Cooperation is required