Seismic Monitoring of Mines
(Predicting and preventing mine collapse)

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Highwall Failures
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What could cause a pit wall to fail?

- Slope angle /steepness
- Height/depth >500m
- Underground mining activities
- Blasting activities
- Complex geologies
- Ground water pressure/ inundation /weather
- Vehicle movements
Slope Failures
Edge, bench and pad Failures
Rockfall
Highwall and slope monitoring options

- Visual monitoring
- 3D visualisation/assessment
- Use of Tell Tales
- Measuring between pins
- Wire line extensometers
- Prism monitoring of the high wall
- Inclinometers
- Piezometers
- Photogrammetry
- Slope Monitoring Radar
Where does micro-seismic fit in?
Industry experience

- Around 25 open pits had microseismic by 2009
  - (no more recent info)
- All systems required sensor installation in boreholes
- Cable and instrument management is a major issue and lead to static installation configurations
- Focus was on fracture initiation and propagation
  - Brittle fracture failure
- Effective in delivering useful data on the mine behaviour
Hasn’t micro-seismic been done?

- High sensitivity
  - $10^{-15}$mm/s
  - Effective monitoring range now $>1\text{km}$ vs $\leq 150\text{m}$

- Speed of deployment and redeployment
  - Rapid installation with zero (or very shallow holes) keeping pace with mining activities
  - Previous generations needed deployment in boreholes $20-40,000$ / bore hole
Mapping moving water
System Configuration
Previous deployments

- 1998 Asfordby, UK with University of Liverpool
- 2013 Deep potash mine
- 2013 Trapped miner exercises
  - University of West Virginia (Heasley)
  - Consol Energy, Federal #2, Alpha Natural Resources
- 2013 comparative trial against ESG, IMS, Lockheed Martin and Boeing for illicit tunnel detection
Seismic events overlay on mine dxf

Actual events from a long wall coal mine in Leicestershire, UK
Trapped miner
Simtars seismic investigation

• Will a surface deployment deliver results?
  – Can it be redeployed to keep pace with mining?
• Event localisation – accuracy and precision
  – Can we ‘tune’ the system by generating impulses at surveyed locations
• Will it deliver on the promise of kilometre+ ranges?
• Characterise signal response to normal mining activities and to blasting
• Will the data inform TARPs and alerts
Installation

Range from each sensor up to 5KM

Up to 5KM depth

Surface Sensors

SP2 (Model: MM2) System with wireless IP Connection

Solar Power
What is the plan?

- Confirm trial partners, test sites and target outcomes
- Deploy monitoring system
- Characterise events and correlate results and interpretation against real-time systems
Thank you for your attention

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