Seismic Monitoring of Mines
(Predicting and preventing mine collapse)

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SIMTARS

Rio Tinto, Copper Kennecott Mine, Utah, USA. 9 April 2013

Rio Tinto, Copper Kennecott Mine, Utah, USA. 10 April 2013

kennecott.com, July 2014

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

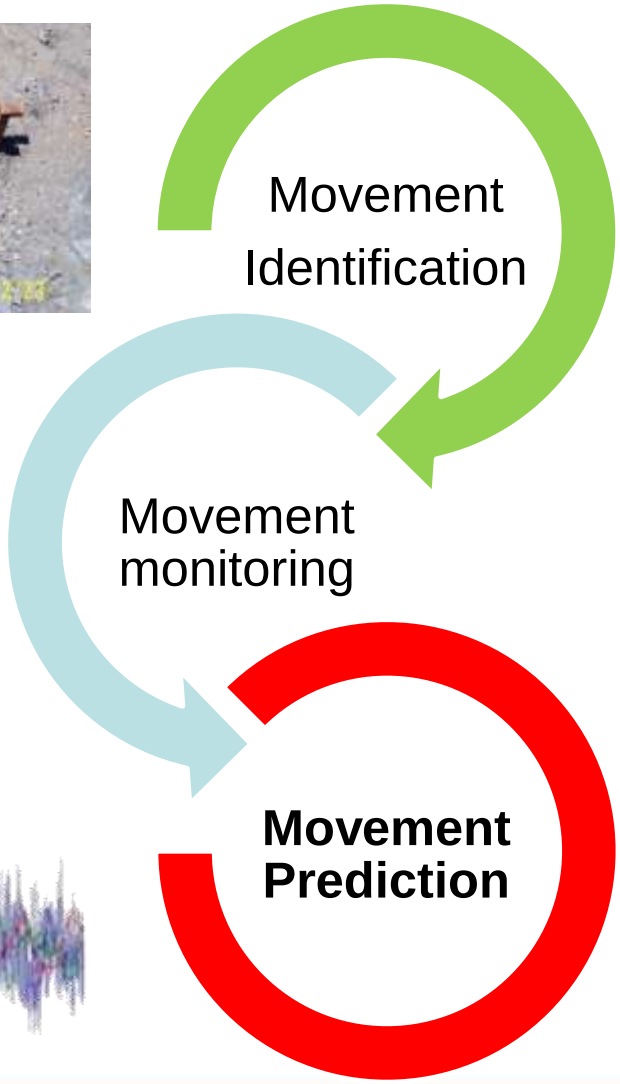
Edge, bench and pad Failures

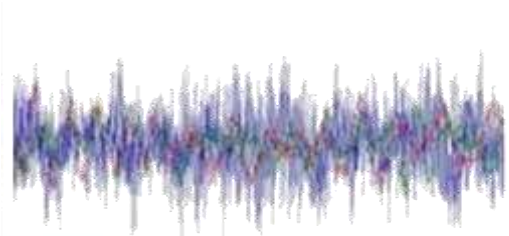
Rockfall

Highwall and slope monitoring options

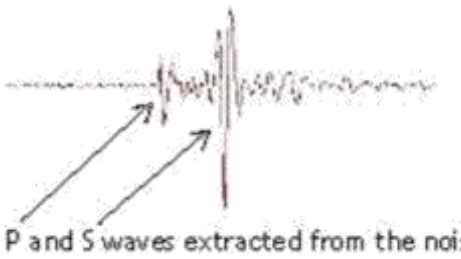
- Visual monitoring
- 3D visualisation/ assessment
- Use of Tell Tales
- Measuring between pins
- Wire line extensometers
- Prism monitoring of the high wall
- Inclinometers
- Piezometers
- Photogrammetry
- Slope Monitoring Radar

Where does micro-seismic fit in?





Raw signal with working noise



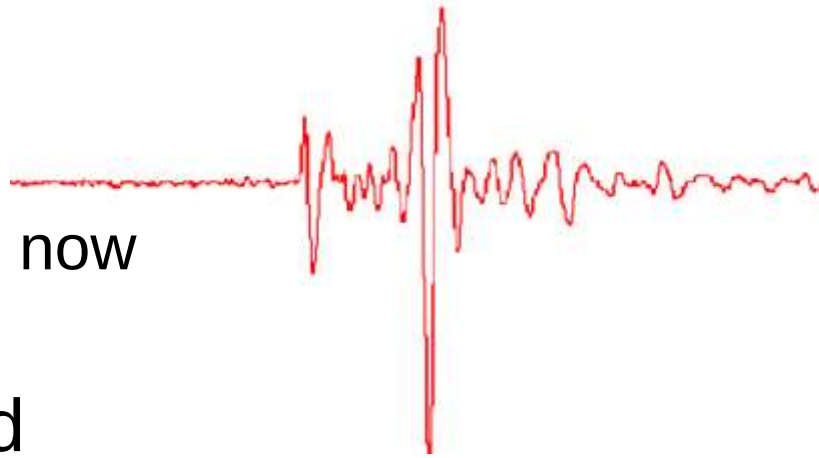
P and S waves extracted from the noise

Industry experience

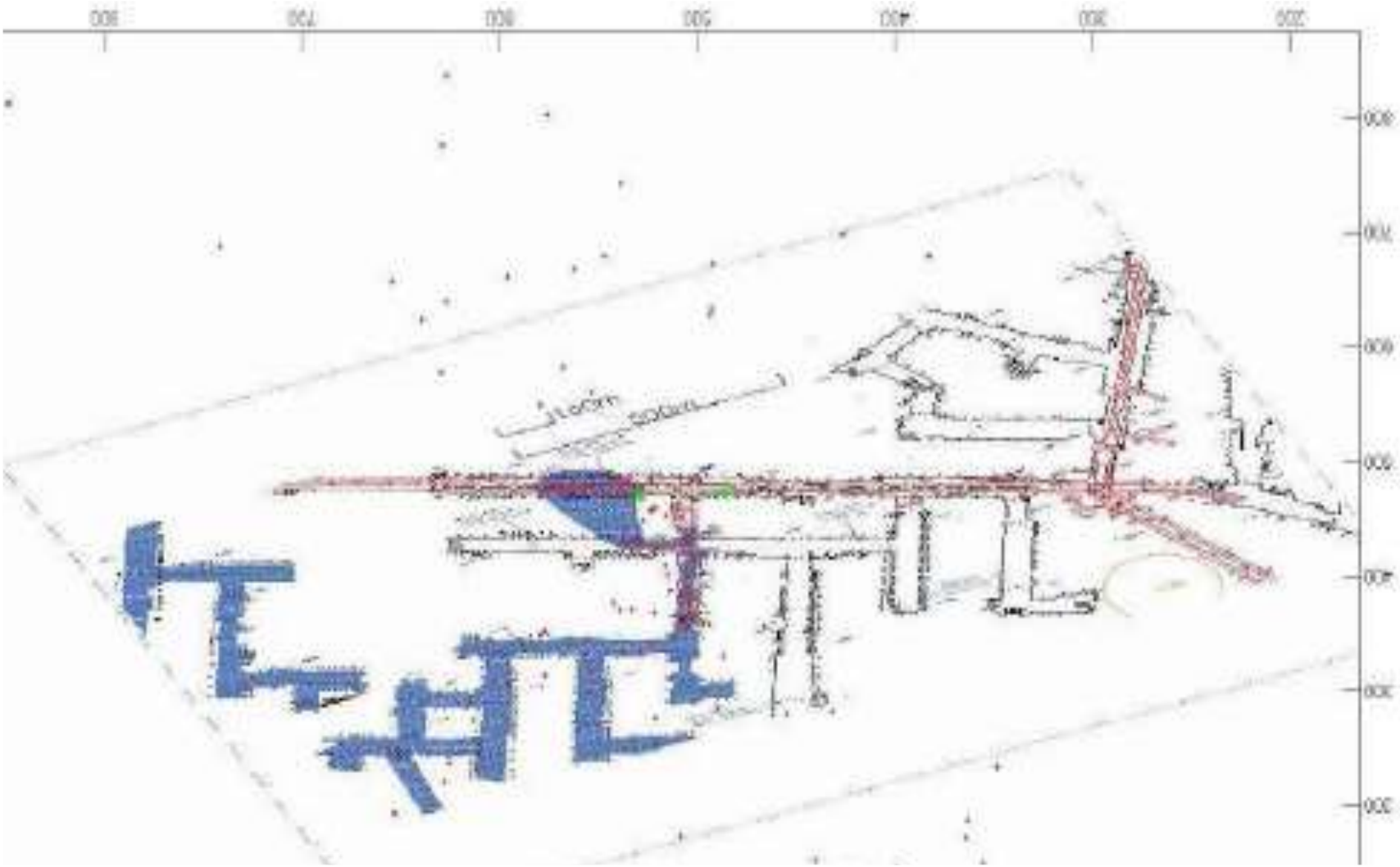
- Around 25 open pits had microseismic by 2009
  - (no more recent info)
- All systems required sensor installation in boreholes
- Cable and instrument management is a major issue and lead to static installation configurations
- Focus was on fracture initiation and propagation
  - Brittle fracture failure
- 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 >1km vs ≤150m
- Speed of deployment and redeployment
  - Rapid installation with zero (or very shallow holes) keeping pace with of mining activities
  - Previous generations needed deployment in boreholes $20-40,000 / bore hole



Mapping moving water

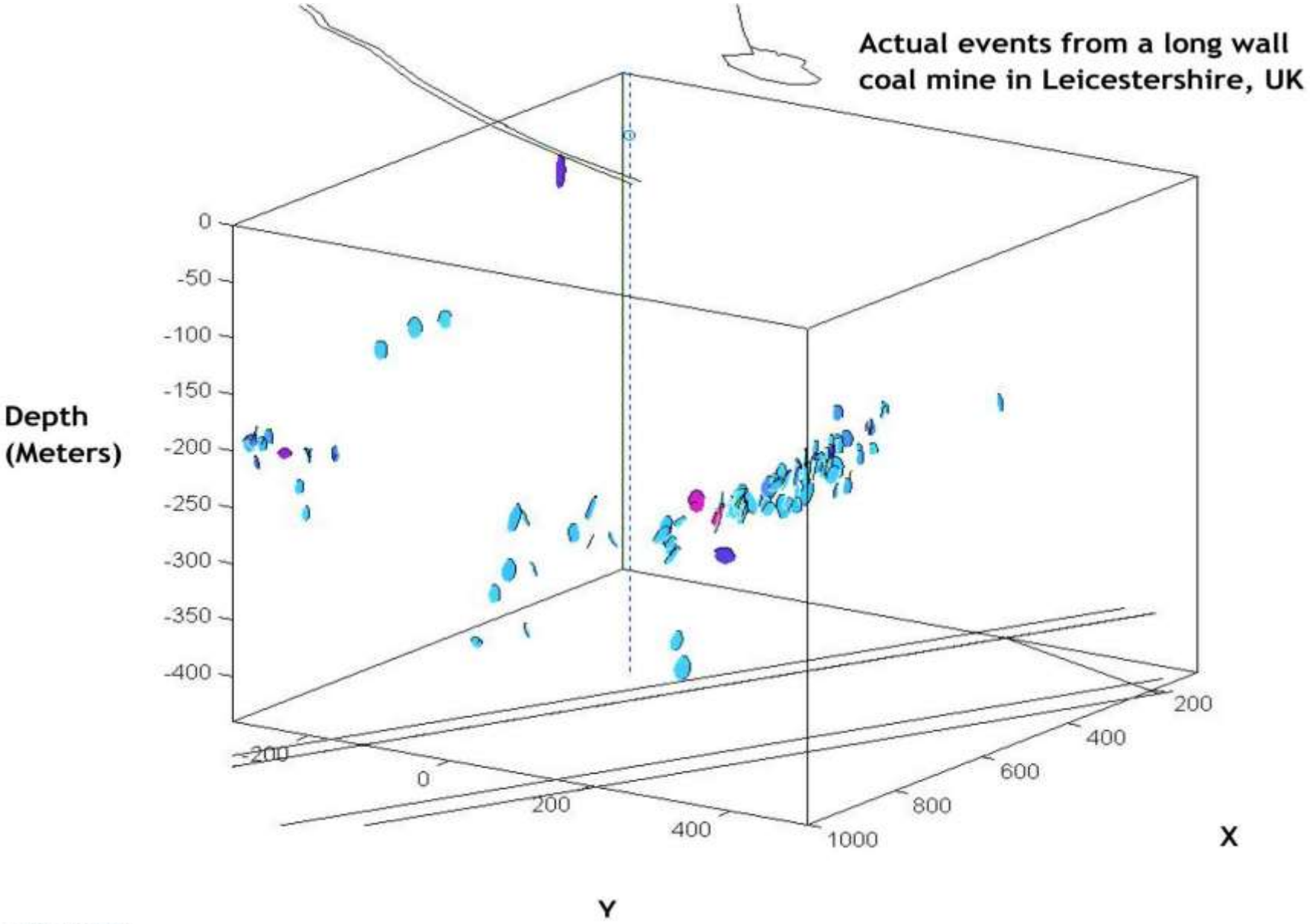


System Configuration

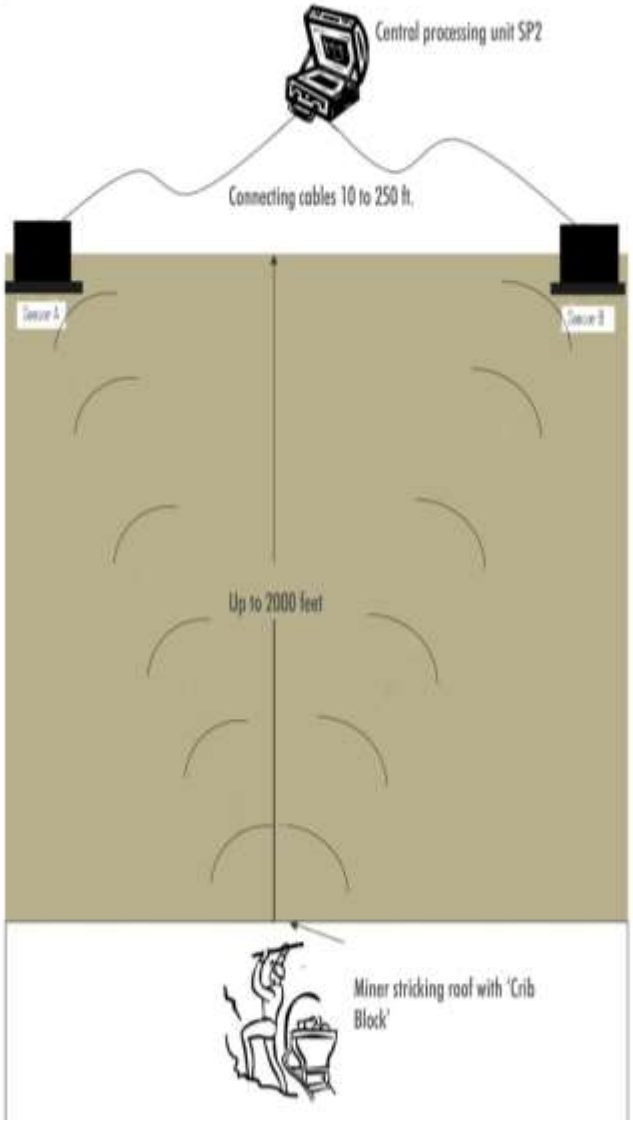
Previous deployments

- 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 Resourses
- 2013 comparative trial against ESG, IMS, Lockheed Martin and Boeing for illicit tunnel detection

Seismic events overlay on mine dxf



Trapped miner



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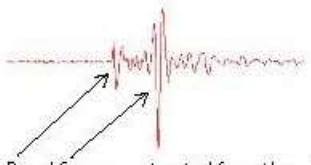
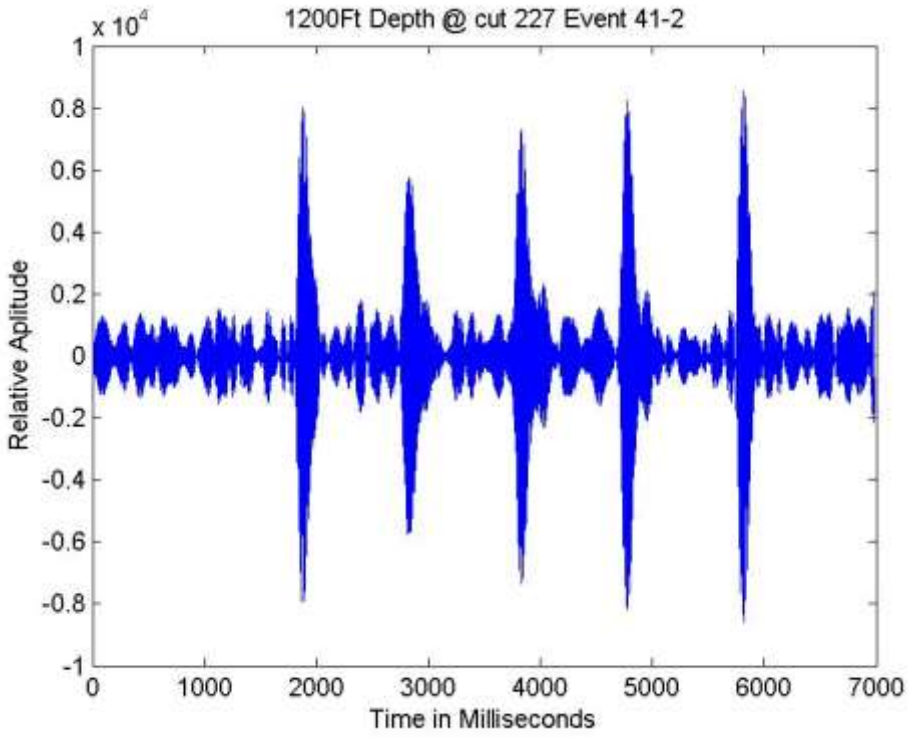


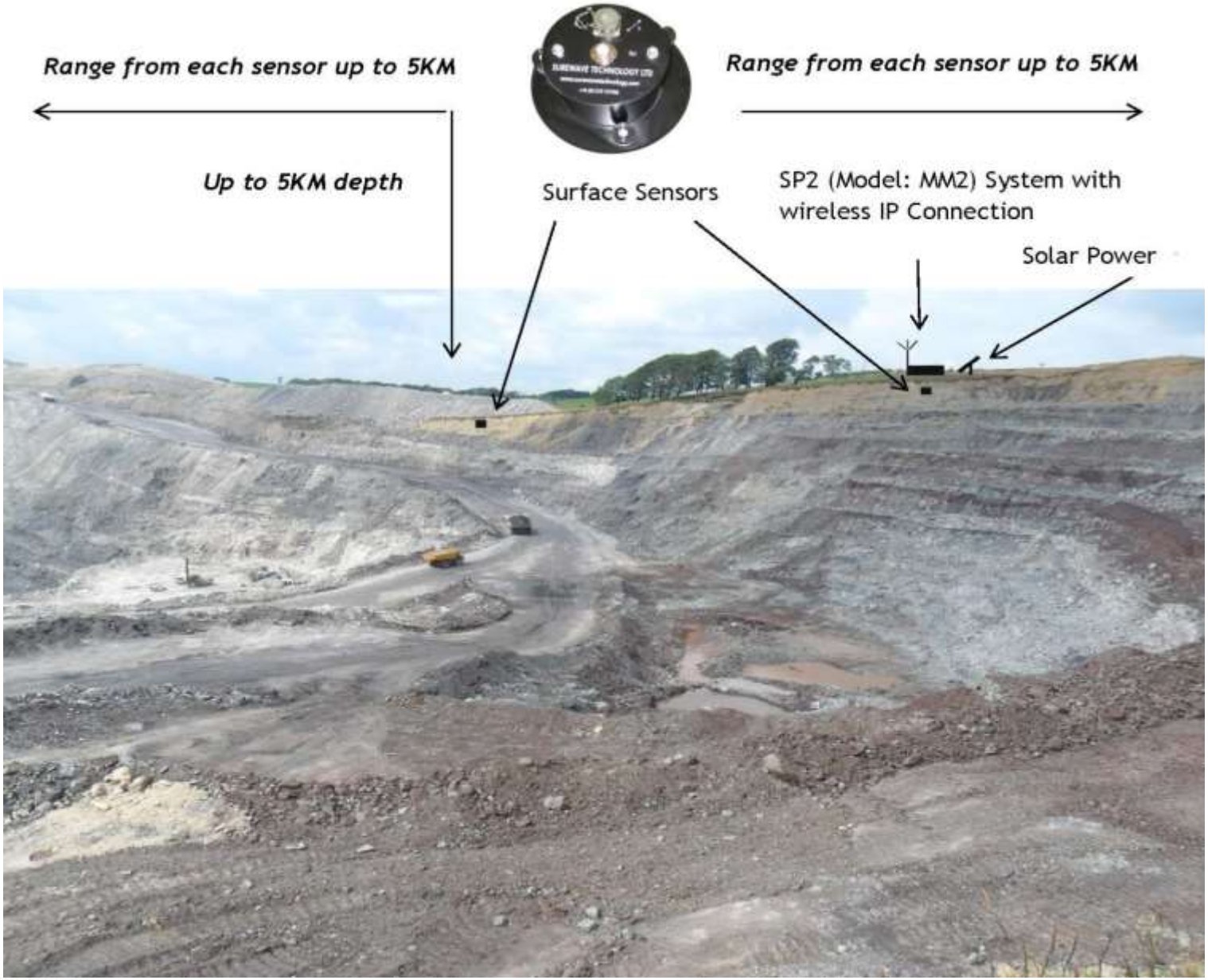
P and S waves extracted from the noise



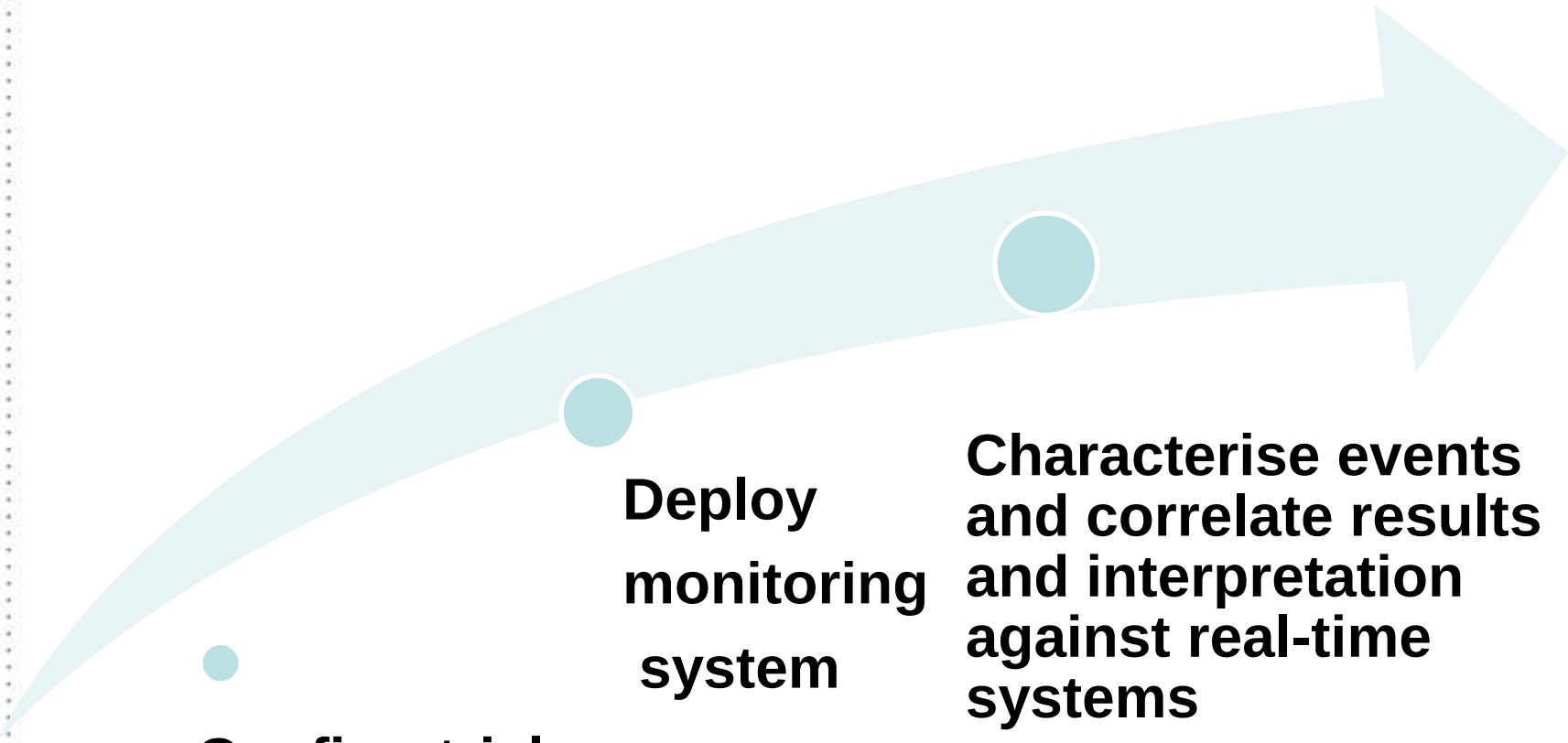
Simtars seismic investigation

- 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



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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