

Compact Radar System for RockMass Movement Monitoring in Underground Narrow Stope

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Objective

Open pit showed success by introducing radar technology to prevent fatalities and damage to equipment from uncontrolled slope failures. Anglo American, in partnership and collaboration with Geobotica, researched and developed remote sensing radar technology for underground mines called NanoRadar.

Goal

- Sustain zero rock fall fatality performance
- Early warnings to workers
- Recording geotechnical data in real time



Solutions

- Fit for purpose
- Alarm trigger (buzzer and lights)
- User friendly and Simple deployment
- Accurate and precise measurements
- Data recording and integration capabilities
- Continuous real-time monitoring
- Monitor larger area
- Battery operated

Technology Development

Underground NanoRadar

MIMO

Multiple-Input Multiple-Output (MIMO) radar.

High resolution imaging

Spatial coverage

Accuracy

Detect small-scale rockmass movement

No moving parts

Reduces physical size and power requirements

NanoRadar Development

2 Years development (9 rounds of prototypes)

Sense Movement and Orientation

20 m detection range

Buttonless

Customizing scanning cycle time

Short- and Long-term recording functionality

Tri-pod deployment

Filtering Non-Rock Movements (RockDetect Algorithm)



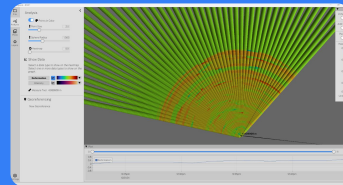
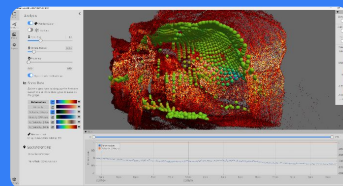
Software

Data visualisation tool

Analyse deformation

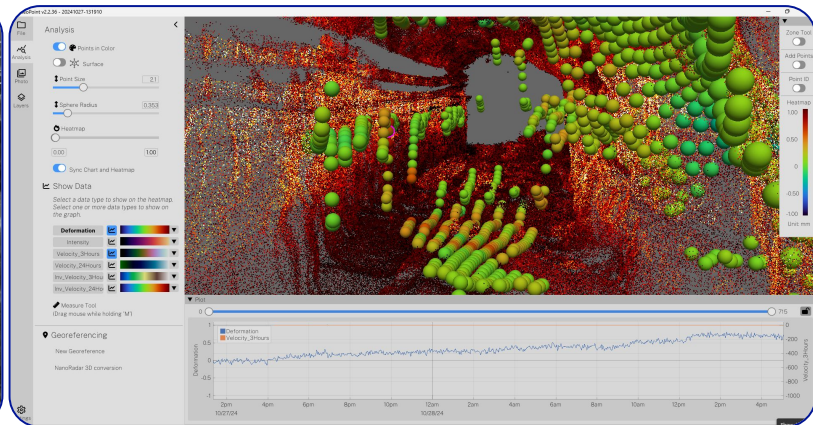
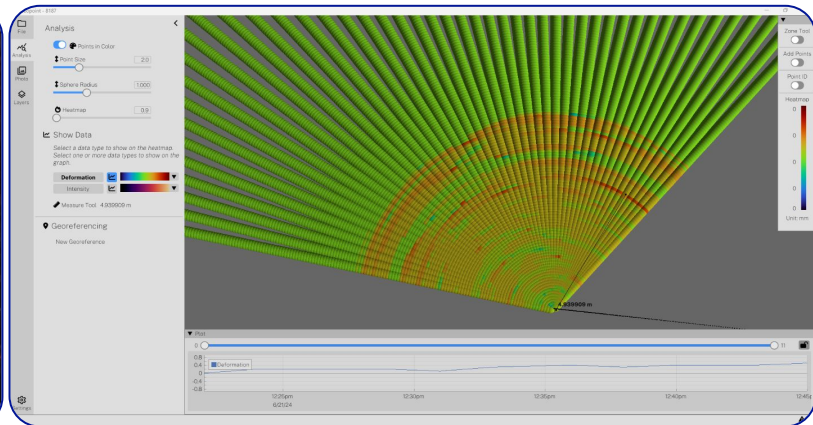
Post- alarms analysis

2D or 3D (PointCloud) map integration



UG Proof of Concept





Piloting

Short-term (8 hours)

Environment



- Narrow reef stope
- Slope angle 15° to 30°
- Working Height of 1.4 to 1.5 m

Application



Adoption Key Points

- Operation procedures and training documents
- Crew engagement sessions prior piloting
- Fully training on the crew
- Ongoing support was provided by a dedicated member of the geotechnical team

Ongoing process

- Units charge and download data every 10 to 14 days. (Overnight charging)
- Member of geotechnical team visit workplace regularly

Duration



- 6 Months

Outcome



- Crew was acceptable of technology
- Robust and fit for purpose
- Success of a rock dislodged and triggered alarm (Protocol was followed on alarm trigger)

Piloting

Long-term (> 24 hours)

Environment



- 3.0 m x 4.0 m Tunnel
- Area was closed off due to rockmass instability

Application



- Radar placed 5.0 m from instability

Duration



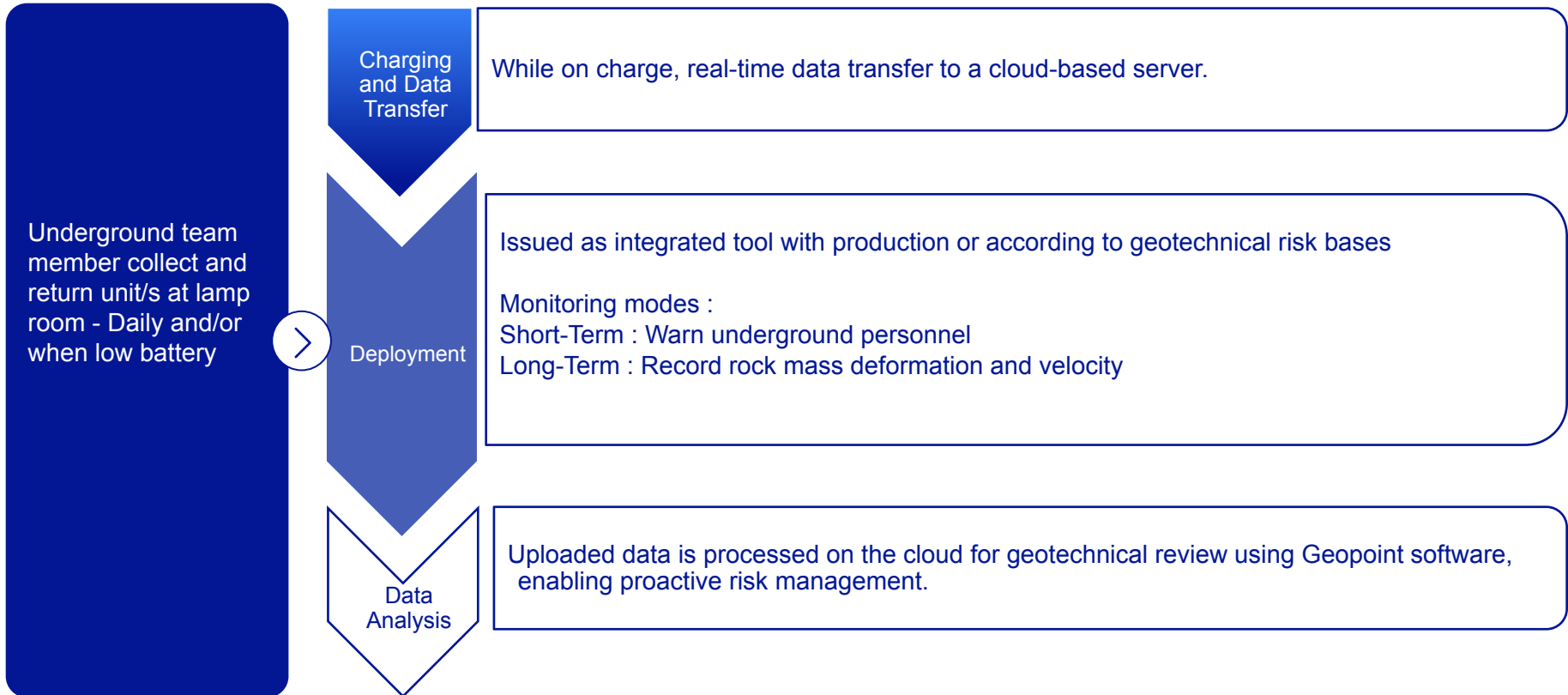
- Continues scanning for 8 days

Outcome



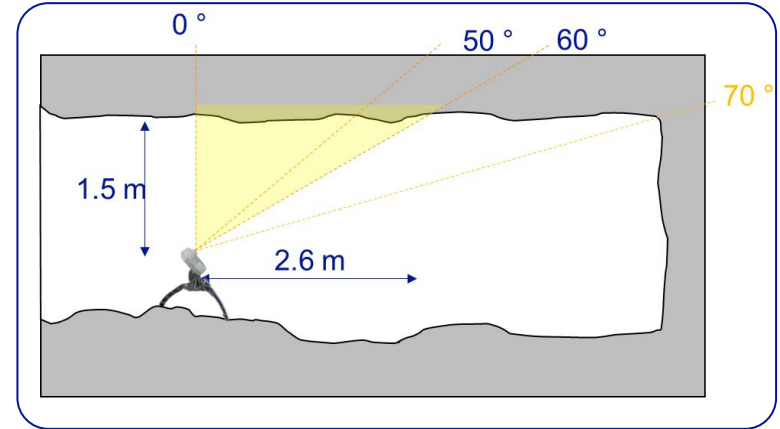
- Time over distance rockmass movement was recorded successful

Proposed Integration into Mining Operation



Learnings and Solutions

- Accuracy up to 60° reduced coverage range
- Deployment method was changed due rockdrill machines vibrations
- Wireless charging was not ideal
- Stable network important when downloading data



Other Applications

- Self-sustainable Surface NanoRadar
 - Supplement to the surface mine monitoring strategy



Conclusion

- Passed comprehensive multiple stages of testing
- Accurately detecting and recording of rock movement
- Providing early warnings
- Real-time
- Monitoring done from safe positions
- Versatile tool
- Achieving technology readiness level 9



Thank you