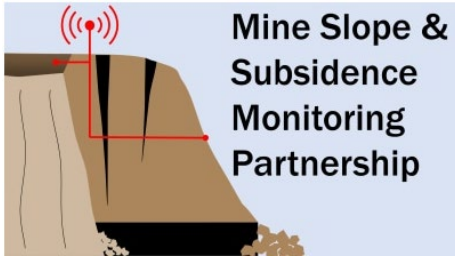


# Mine Slope and Subsidence Monitoring Partnership



- This partnership investigates the use of existing stability/subsidence monitoring technologies used in the mining and quarry industries and evaluates the potential for early instability detection design.
  - Approaches, results, and practices are shared to facilitate safety benefits throughout the mining industry.
- 
- The partnership will operate with the following principles:
    - Use the latest and best available scientific methods and procedures in the accomplishment of the work.
    - Work closely, openly, and in a spirit of cooperation with all organizations.

2024

Personal  
Journey





- *The partnership is neither constituted to carry out negotiated rulemaking; nor to function as a federal advisory committee.* The specific goals of the partnership are as follows:
- *Work toward solutions to issues related to successfully implementing proper slope/subsidence monitoring technology at mine sites*
- Develop and support best practices related to effective use of the monitoring technology.
- *Build relationships with researchers, engineers, and operators across federal agencies, and extramurally (e.g., universities, consultants, mining companies).*
- *Identify related monitoring applications in mining projects and share work openly between groups.*
- *Identify training needs and opportunities related to data collection and processing.*
- Look for collaboration points through organizations and societies associated with the mining industry.
- Evaluate the success of the partnership on a regular basis.

2024

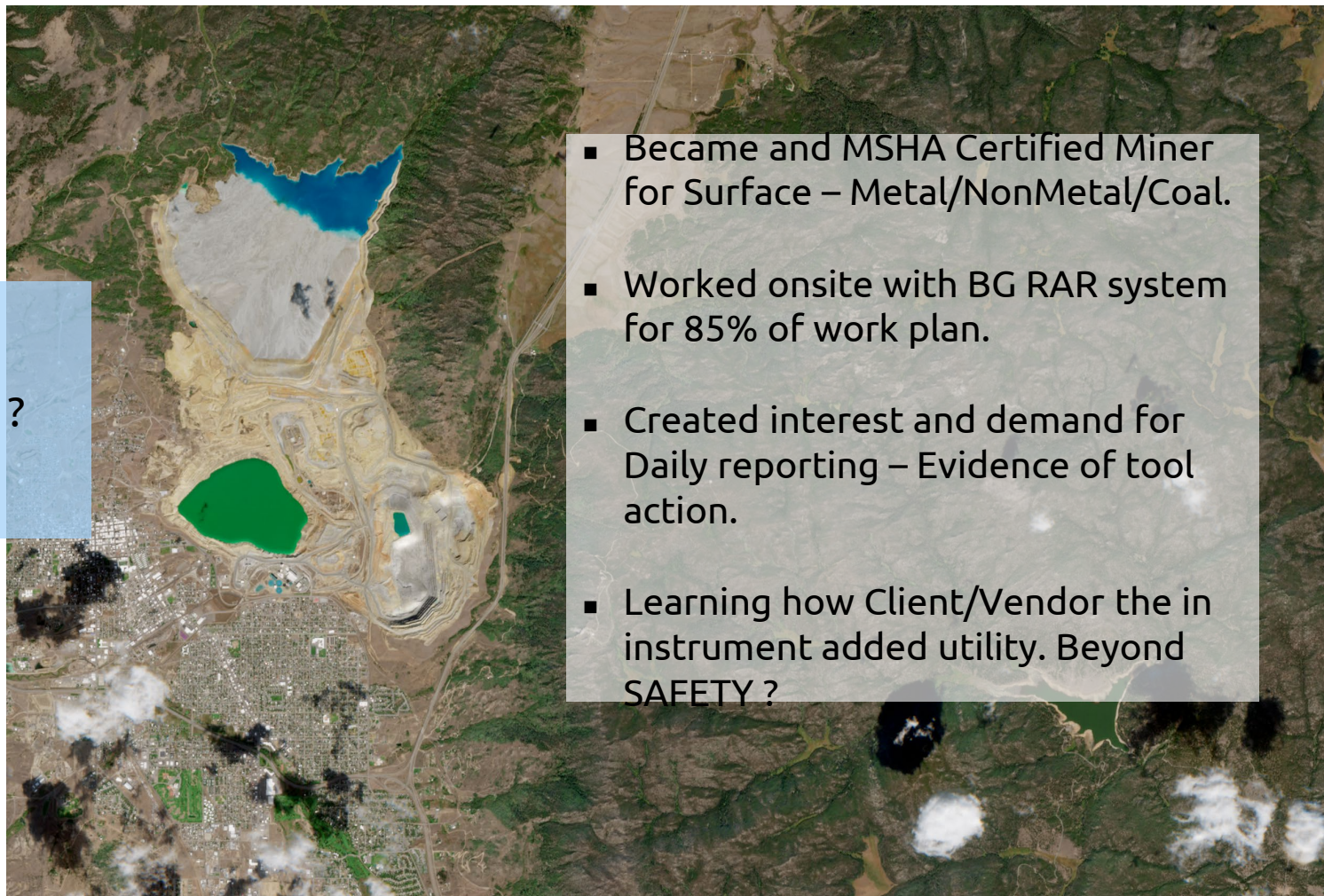
Institutional Support



How did we get here ?

Why was this important ?

An equitable goal ?



- Became and MSHA Certified Miner for Surface – Metal/NonMetal/Coal.
- Worked onsite with BG RAR system for 85% of work plan.
- Created interest and demand for Daily reporting – Evidence of tool action.
- Learning how Client/Vendor the in instrument added utility. Beyond SAFETY ?

2006

# Daily Reporting at GPNA

- 2006 – began “daily reporting”, while onsite as a technical specialist.
- Became a “demand” from client sites for staff sharing – Data Only.
- Result – item for discussion, sharing, education across mine staff
- First visit to MSHA Technical Center – Bruceton, PA.

Opportunities to reach out




History – While deployed at a mine site in northern Nevada in 2006, GPNA staff began creating a record of daily SSR service, configuration, and site events.

Because of the **SSR presence, the effort of our team, and the communication between GP and the mine personnel**, the SSR was an essential component in the mine’s plan to remain active into November of 2006. It had been slated to cease operations 3-4 months earlier.

Today – at Diavik we have shown the usefulness and utility of interacting with customers on a daily level, particularly the geo-technical, geology, and operations people we work with every day.

Diavik - Lac De Gras

Diavik - Lac De Gras

DATE	TIME	OPERATOR	NOTES
2006-01-20	14:17	GPNA	Loss of #1 transport at 14:17 for 40 minutes.

Figure 1: VIEWER - 3D presentation for the current VDF. Red to Blue indicating increasing movement (down) and away (back) from the SSZ. This is indicative of stress and/or presence in the scan area.

Figure 2: System alerts are sent out by e-mail or SMS. A variety of alerts can be enabled and sent to mine staff and response teams.

2008 - 2011



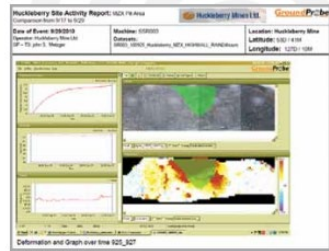
www.groundprobe.com



- Development of data sharing “practice” and documentation.
- 2<sup>nd</sup> Visit to MSHA – Bruceton for System Awareness sharing.
- Intital BEYOND MINING deployments – Civil Works, Geohazards.
- 1<sup>st</sup> Awareness of Satellite Data (DTMs, InSAR – early years).

2007 - 2010

### Case Study



#### All Weather Service, Site Support and Visual Data Integration

Data was monitored continually through the event and a summary of activity was sent to all engineering staff for review. This data-set resulted in moves to address the high wall issues by mining a pushback into the tree-line and down through the unstable area. This was essential to achieve expansion plans and further successful mining. John Metzger, GroundProbe Technical Specialist at the time commented:

*“Seasonal weather and wind events made for rapidly changing atmospheric conditions – proving SSR system and data algorithms to be adaptive while continuing to provide excellent returns.”*



▲ Heavy rainfall created large volumes of water entering the diversion channels.

The SSR and GroundProbe team onsite, in collaboration with Huckleberry engineers and external consultants, had allowed for smooth ongoing operations, equipment extraction from a slope event, and valuable pre-summer and rainy season data.

GroundProbe is a market-leading Australian company that develops and supplies measurement systems and services to mining and infrastructure organisations for the management of risk. Since the launch of the revolutionary SSR in 2003 GroundProbe have been providing high value information to mines around the globe making mining safer and more profitable. GroundProbe holds internationally valid patents in key areas of the technology and was the first company globally to introduce slope monitoring radar to the mining industry.

With the SSR and the WAM, GroundProbe provides the most suitable systems to measure short and long-term mine wall movements. Many slope failures have been successfully captured using GroundProbe’s systems, providing sufficient warning for the safe evacuation of people and equipment. With the experience of having deployed hundreds of SSRs around the globe, with millions of hours of operation, GroundProbe achieves world-class standards in reliability and has an unrivalled understanding of slope stability in open pit mining.

- Moved from Field Technical Staff to Technical Sales.
- Installed 1<sup>st</sup> SSR for China Coal 2011 – For Safety Consultantcy – Institute.
- *Travelled to Industry Events – Slope Stability, Mine Expo, SME.*
- *Lack of shareable data – technique/education of “monitoring”.*
- Consulted for and moved to IDS GeoRadar – GbSAR.

2011 - 2013

The broad area coverage makes it possible to monitor the pit wall from a semi-permanent installation on the opposite side of the pit, at a working distance of about 2 km (Fig. 6).



Figure 6. IBIS-M installation at Çollölar.

During the monitoring period June 2011-January 2012 IBIS-M was able to pick up several moving areas highlighted in Figure 7.

From radar data it is possible to observe a general stability of the pit with a few areas of localized movement. The most active areas have been Area 3, Area 4 and Area 6.

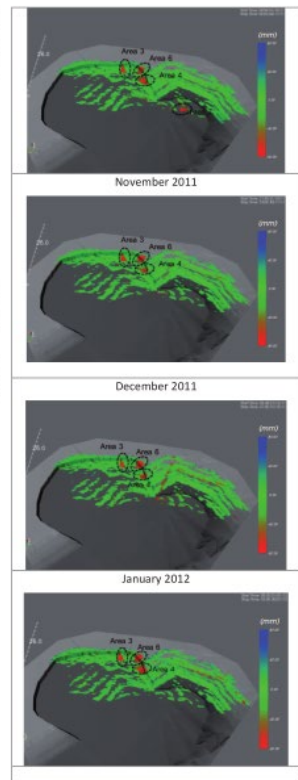
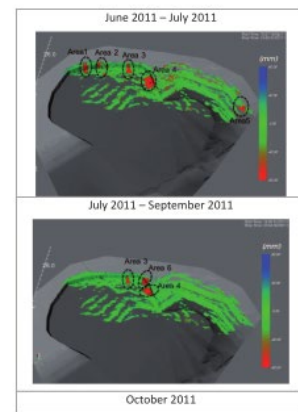
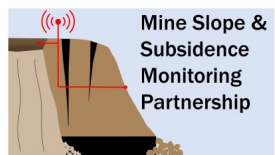


Figure 7. Monthly cumulative displacement radar maps covering the period from June 2011 to January 2012, highlighted in red the areas of movement.



- Second and Third visits to MSHA – Bruceton with staff from Surface, Underground, Subsurface team.
- Created Reporting and Monitoring program for Mining and Civil Deployments.
- Met OSMRE, NMMR, BOR, USGS, NIOSH- (Mining) Staff.

2014 - 2019

Date: 8/06/2015  
Reference No: FMT\_002

**IDS**

### 2.3 Areas of Interest

Three areas indicated higher than background noise movement. Labeled as Hotspot 1 and Hotspot 2. There are several of these areas inside of the Southwall area. We will continue to watch these two areas more closely.

5/9

IDSNA Inc.  
 10000 W 87<sup>th</sup> Ave.  
 Suite 104  
 Golden, CO 80401 USA  
 Phone: 303.232.3047  
[www.mhospm.com](http://www.mhospm.com)

Date: 8/06/2015  
Reference No: FMT\_002

**IDS**

### Displacement Time Series since start of project:

### Velocity Time Series since start of project:

6/9

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- Heavy Civil engagements with GBSAR, and onset of InSAR integrations. InSAR – another Technology/Application with very little documentation/visibility.
- Experience - benefit of 10,000s of serial interferograms and 1,000 reports.
- BLIND data discovery (NMMR, S2, InSAR) Subsurface realizations – “surface expression”.
- Request for support from NIOSH team to create National discussion opportunity.

2020 - 2022

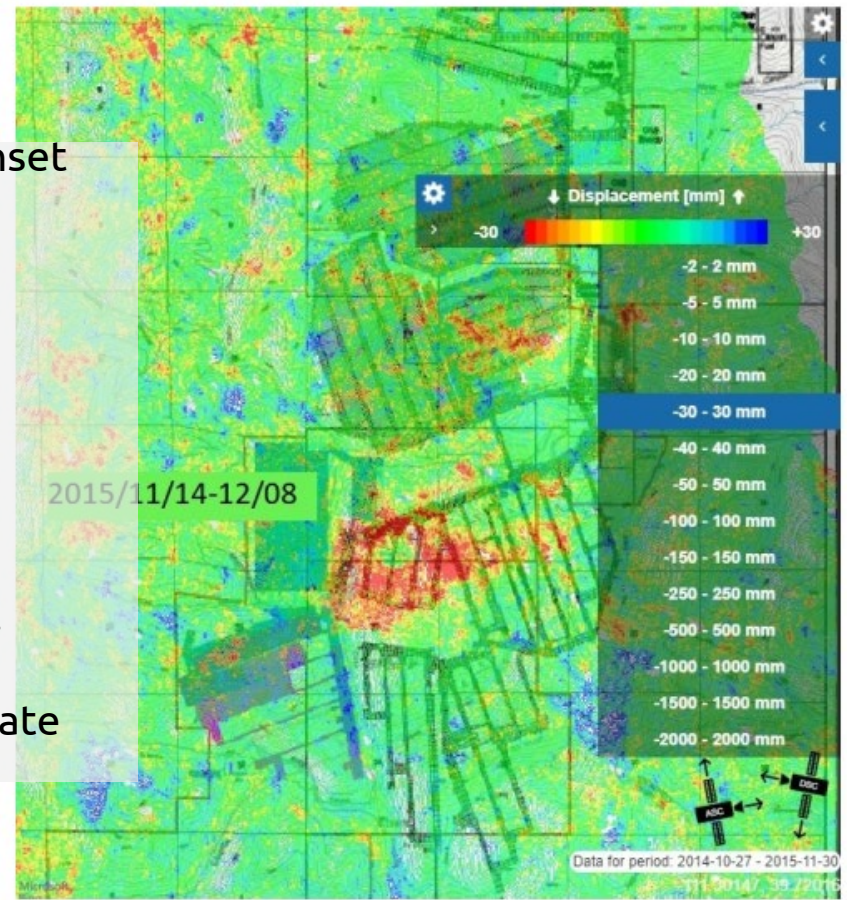
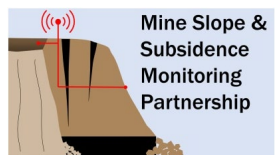


Figure 19. Sentinel-1 Data Interferogram of Data Over Panel. Images are the result of differential displacement between interferograms.





- Created with the NIOSH Team – Charter for the “Partnership”.
- Established AssetAssurance Monitoring – supporting all technologies and client solutions – cross sectoral.
- Got support from OSMRE, MSHA, NMMR staff (SME) – supporting national opportunity.

Mine Slope and Subsidence Monitoring Partnership  
Partnership Charter

[7/24/2023]

2022 - 2024

### 1 PURPOSE AND GOALS

The evolution of real-time geotechnical monitoring at mining operations has progressed rapidly in the last few decades, with recent efforts largely focusing on improving safety performance and predicting the onset of instability that could endanger personnel and equipment. The effectiveness of monitoring systems, and monitoring programs in general, hinge on the appropriateness of mine-specific alarm thresholds that are selected by mine personnel.

In response to this, the Mine Slope and Subsidence Monitoring partnership investigates the use of existing stability/subsidence monitoring technologies used in the mining and quarry industries and evaluate the potential for early instability detection design. The mission of this partnership is to facilitate sharing of best practices with regards to the use of these technologies in order to conduct and disseminate impactful research that benefits the mining industry as a whole. The knowledge gained within this partnership will improve the research impact of NIOSH as well as diversify and expand its partnerships.

The partnership is neither constituted to carry out negotiated rulemaking; nor to function as a federal advisory committee. The specific goals of the partnership are as follows:

- Work toward solutions to issues related to successfully implementing proper slope/subsidence monitoring technology at mine sites
  - Develop and support best practices related to effective use of the monitoring technology.
  - Build relationships with researchers, engineers, and operators across federal agencies, and extramurally (e.g., universities, consultants, mining companies).
  - Identify related monitoring applications in mining projects and share work openly between groups.
  - Identify training needs and opportunities related to data collection and processing.
  - Look for collaboration points through organizations and societies associated with the mining industry.
  - Evaluate the success of the partnership on a regular basis.

The partnership will operate with the following principles:

- Use the latest and best available scientific methods and procedures in the accomplishment of the work.
- Work closely, openly, and in a spirit of cooperation with all organizations.

The short-term value of this partnership will be the opportunity to ask questions, hold discussions, and share experience and best practices for identifying applications of appropriate slope and subsidence monitoring technologies within the mining industry. The long-term value of this partnership will be increased guidance and documentation of geotechnical monitoring use from federal agencies; increased number of funded projects at universities investigating the use of proper monitoring technologies in the mining industry; and increased adaptation of monitoring technologies at mining operations to solve issues that otherwise may seemed infeasible.