

Networked Smart Marker System Mine Scale Trial

Smart Open Pit Deformation Management

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Networked Smart Markers (NSM) are novel subsurface deformation monitoring devices able to transmit data wirelessly through the rock mass. They have the potential to overcome some limitations of currently available technologies: short lifespan, limited application depth, limited number of sensors per borehole among others.

Two mine scale trials were conducted to assess the reliability of wireless data transmission through rock and the ability to get qualitative subsurface deformation measurements. The System performed successfully fulfilling both objectives of the trials and allowing the installation procedures, data acquisition and management and communication protocols to be tested and validated.

Networked Smart Marker Open Pit Trials

Networked Smart Markers are devices specifically developed for open pit mines monitoring. The system is composed of a reader on surface (datalogger), in-hole markers and antenna.

The markers in the hole communicate the data to the upper marker. This process is repeated until the data reaches the antenna (uppermost marker in the string). The antenna communicates the data through cables to the Reader where it is stored and sent to the cloud.

NSM's Properties

- Blast - resistant.
- Wireless data transmission through the rock mass.
- No in-hole cables.
- Long operational lifespan - up to 10 years.
- Real-time and remote data acquisition and processing.

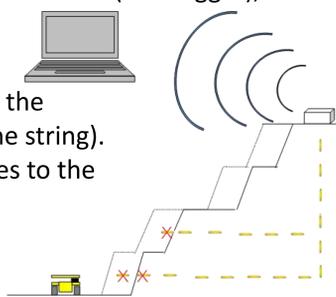


Figure 1: NSM system.

Objectives of the trials

- Validate NSMs functionality under open pit mining constraints with minimum disturbance to the operations.
- Test wireless data transmission through the rock mass and grout.
- Validate installation procedure, remote data acquisition and automatic data processing.

Summary of NSM installation				
	Trial 1		Trial 2	
Borehole depth [m]	53	53	40	10
Sensors Quantity	22	22	35	5
NSMs' spacing [m]	2	2	1	2
Trial duration [months]	3		9	



Figure 2: NSM string.

Trials Setup

- Four (4) vertical boreholes drilled in two stages (trials 1 and 2), 5 meters behind the crest of a vertical slope.
- NSM sensors installed inside the holes and grouted into position.
- Inclimeters installed in holes next to NSM holes for data validation.

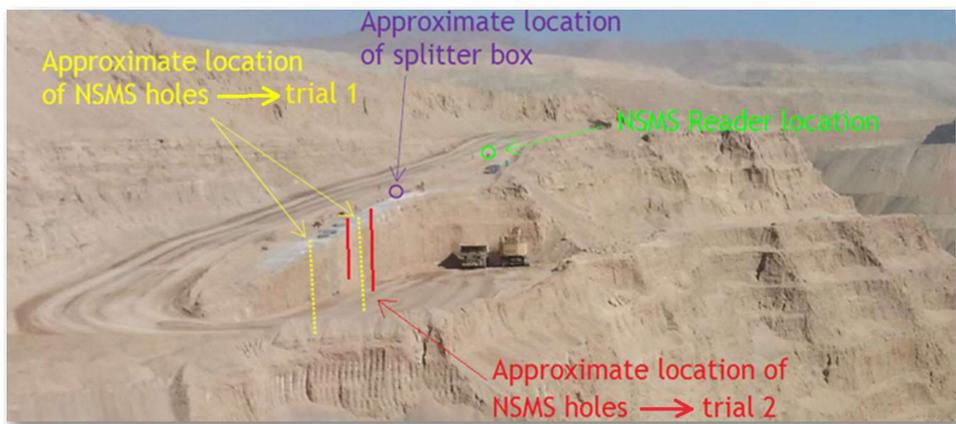


Figure 3: NSMs system layout at CODELCO's Mina Sur, Chile.

Data Acquisition and Processing

Manual (first version):

- Handheld scanner connects with the Reader via Bluetooth to obtain the log files. The gathered data manually processed.
- Visual representations of the data were manually developed.

Remote (enhanced version):

- Antenna and GSM modem installed on the Reader enable remote access for data acquisition and system settings modification with automatic data processing.
- Server does online automatic data gathering and processing. It creates visual representation of the data arranged by day, month and/or year in near real-time.

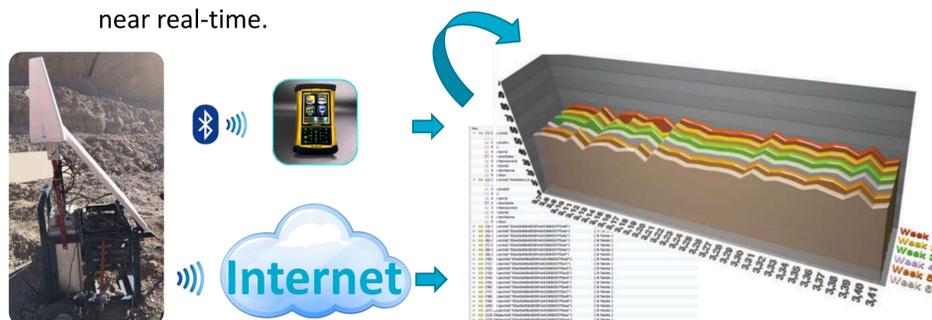


Figure 4: Data acquisition, management system and data representation.

Trial Results

- NSM markers installed correctly and communicating without problems.
- Successful data acquisition and processing via 3G in real time.
- Successful grouting of NSM → no interference with signal processing.
- The system performed adequately and showed qualitative readings consistent with inclinometers data.

Future Developments

- Enhanced sensors ENSM with pore pressure sensors and inclinometers.
- Advanced numerical models (Slope Model) for predictive analyses.
- Data fusion and correlation (pore pressure and rock movement).

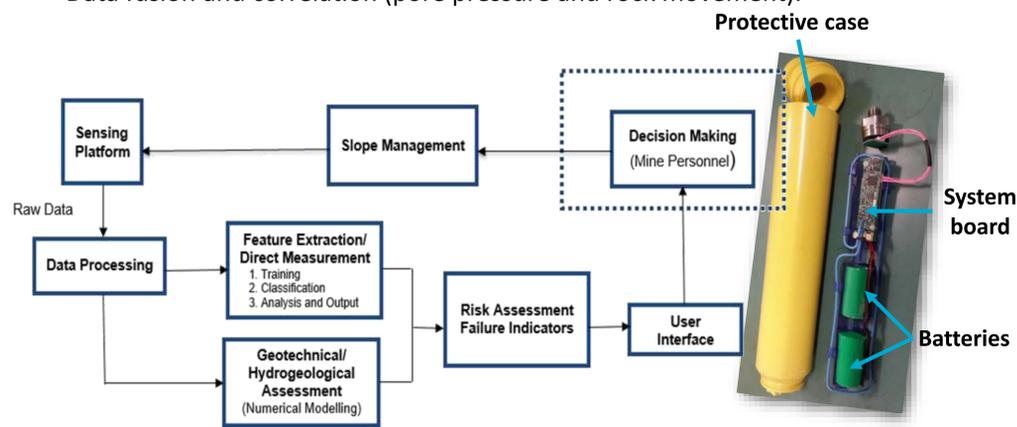


Figure 5: Slope Management System Components and ENSM internals.

FOR FURTHER INFORMATION

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