

IBIS-L: SLOPE STABILITY MONITORING IN OPEN PIT MINES

Introduction

Slope failures in large surface mines represent a major challenge for the safety of mine operators and machinery that today more than ever before put pressure on the industry to find long-term solutions. According to NIOSH (the US National Institute for Occupational Safety and Health), slope failure accidents were responsible for about 12% of U.S. surface mine fatalities and machinery damage from 1995 to 2003.

Small surface movements on a mine highwall may be precursors of failure that, if detected, could provide sufficient warning to enable workers and machinery to be withdrawn to safety. In this field **IBIS-L** represents a totally different approach with respect to conventional measuring systems.

IBIS-L installation inside the open pit mine



IBIS-L, based on SAR interferometry, is able to remotely measure the displacement of thousands of points on the wall simultaneously (natural reflections of the slope), without the need for any kind of access to the slope under observation. **IBIS-L** provides a *Displacement Time Series* for each point with an accuracy of up to 0.1 mm. Thanks to the high number and the spatial density of good measurement points, **IBIS-L** can also provide *Displacement Maps* to clearly distinguish stable and moving portions of the slope.

The automatic acquisition and processing of **IBIS-L** data enables the device to provide early warning alerts if movements exceed a selected threshold.

Mining machinery working inside an open pit mine



Main IBIS-L Features

- Remote sensing device: range of up to 3-4 km
- No need for artificial reflectors on the slope
- High accuracy: up to 0.1 mm (l.o.s)
- Real-time monitoring on wide slopes (a few km²)
- Sampling for point movement every 5 minutes
- Autonomous operation and self-powered system
- Operates day and night in all weather conditions
- Mobile and easily to deploy system
- Remote control

Measurement Description

The **IBIS-L** monitoring session was carried out in collaboration with DMT GmbH to evaluate the stability of a slope inside a brown coal open pit mine owned by RWE Power* in Germany. The system was installed and configured with the operational parameters reported in the table below.

DISTANCE FROM THE SLOPE [m]	730-1600
SAMPLING RATE [number of acquisitions per hour]	8
RANGE RESOLUTION [m]	0.5
CROSS-RANGE RESOLUTION [mrad]	4.5
MAXIMUM DISTANCE [m]	1900

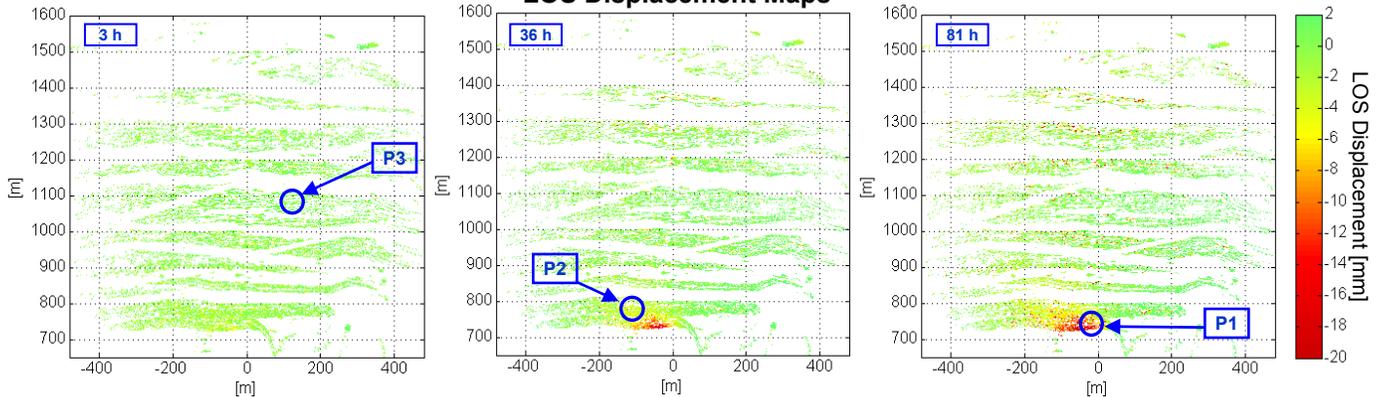
*Data courtesy of RWE Power

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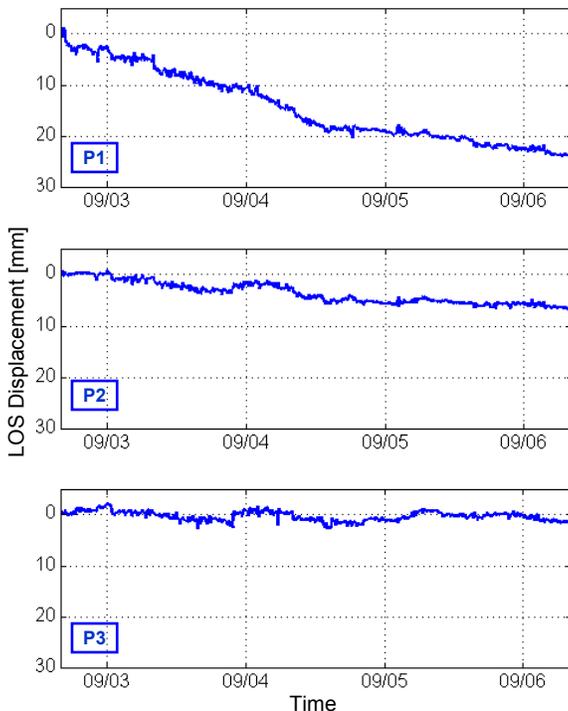
Monitoring Results

The cumulative displacement maps clearly identified a moving portion of the central lower part of the slope close to the location of the excavator. Movement is clearly coherent in the area, showing a gradual decrease in pixel velocity moving away from the most unstable part of the area. The central and upper part of the slope instead showed quite good stability with the exception of some localized moving areas.

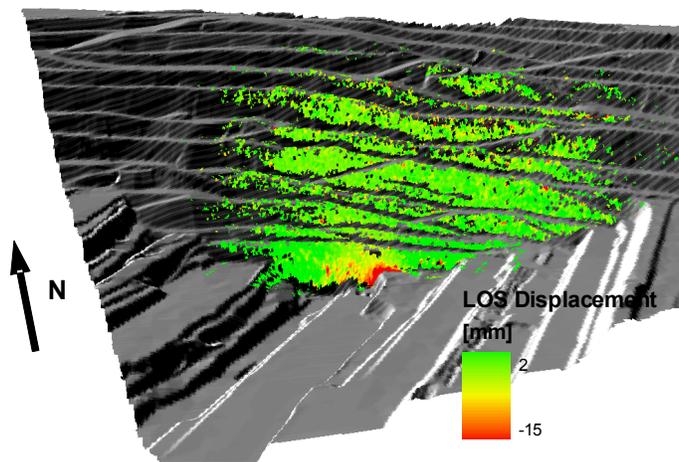
LOS Displacement Maps



Time Series of the Selected Pixels



3D view of a LOS Displacement Map



Conclusions

The results confirm IBIS-L capabilities to provide continuous, day and night and all weather sub-millimeter accuracy displacement measurements of wide mine slopes (entire wall faces) in real time without the need to access the monitored areas.

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