

Integrated Slope Monitoring Solution

Fertilizer Mine, South America | Surface Mapping & Multi-Sensor Monitoring

A fertilizer mine in South America required continuous slope stability monitoring to ensure safe and efficient operations in a harsh environment with heavy rainfall, high humidity, dust, and rapidly changing weather. To complement existing point measurements, the mine required a solution capable of monitoring the entire slope surface, identifying large-scale deformation trends, and supporting better geotechnical decisions — without requiring personnel to access potentially unstable slopes.

INTRODUCTION & CONTEXT: OVERCOMING POINT-MONITORING LIMITATIONS

This success story highlights an active open-pit fertilizer mine in South America. Operating in a highly challenging climate characterized by heavy equatorial rainfall, extreme humidity, dense dust, and rapidly changing weather conditions, the mine required a robust slope stability monitoring framework. The site already utilized a Robotic Total Station (RTS), providing millimeter-level tracking of specific, predefined control prisms. However, point-based monitoring

has a critical limitation: it leaves geotechnical blind spots between the prisms.

To reduce risks and gain complete visibility of the entire pit wall without exposing field surveyors to hazardous areas, the mine deployed OPMMS® alongside the total station, creating an automatic and fully integrated dual-monitoring network. The system also enables fast calculation of volumetric changes across the monitored areas.



Fig 1. Overview of the active fertilizer mine site showing the challenging environmental conditions.

CHALLENGES

- **Extreme Weather Conditions:** Constant heavy rainfall and high humidity can destabilize slope geometries overnight.
- **Geotechnical Blind Spots:** Prism-based monitoring captures only discrete points, leaving unmonitored areas vulnerable to undetected failure.
- **Long-Range Access Difficulties:** Massive, steep pit walls are difficult or impossible to access safely for conventional surveying.
- **Comprehensive Data Fusion:** Effectively merging discrete 3D point coordinates from RTS with full-surface 3D reconstruction from laser scanners enables deformation data analysis and faster, more reliable safety assessments.
- **Deformation & Volume Computation:** Beyond geometric deformation, volumetric change measurements provided by the system deliver essential data for subsequent geotechnical analysis.

THE SOLUTION: TOTAL STATION & OPMMS® SENSOR FUSION

1. Hybrid 3D Defense Layer

The mine implemented an interconnected sensor ecosystem. While the total station focuses continuously on localized critical structural points, the OPMMS® system automatically scans the entire open-pit face from a completely safe stand-off distance of up to 2,000 meters. This entirely removes the logistical and safety nightmare of having to install physical targets on actively failing or unstable sectors.



Fig 2. The OPMMS® shelter installed at a safe stand-off distance, ensuring continuous monitoring.

2. Full-Surface Mapping vs. Single-Point Prisms

The primary advantage of this integrated approach lies in how the two technologies complement one another: the Robotic Total Station delivers highly precise, single-point displacement measurements and coordinate trends. OPMMS® fills the gaps by revealing centimeter-level deformation trends across the entire surface. It captures broad movement patterns, localized failures, and shifting masses that point-based monitoring alone could miss, providing a comprehensive view of wall behavior. By combining accurate point measurements with full-surface deformation mapping, the system provides displacement maps, movement trends, and early warnings of developing instability. When required, it can also calculate volumetric changes within selected areas of the open-pit mine.

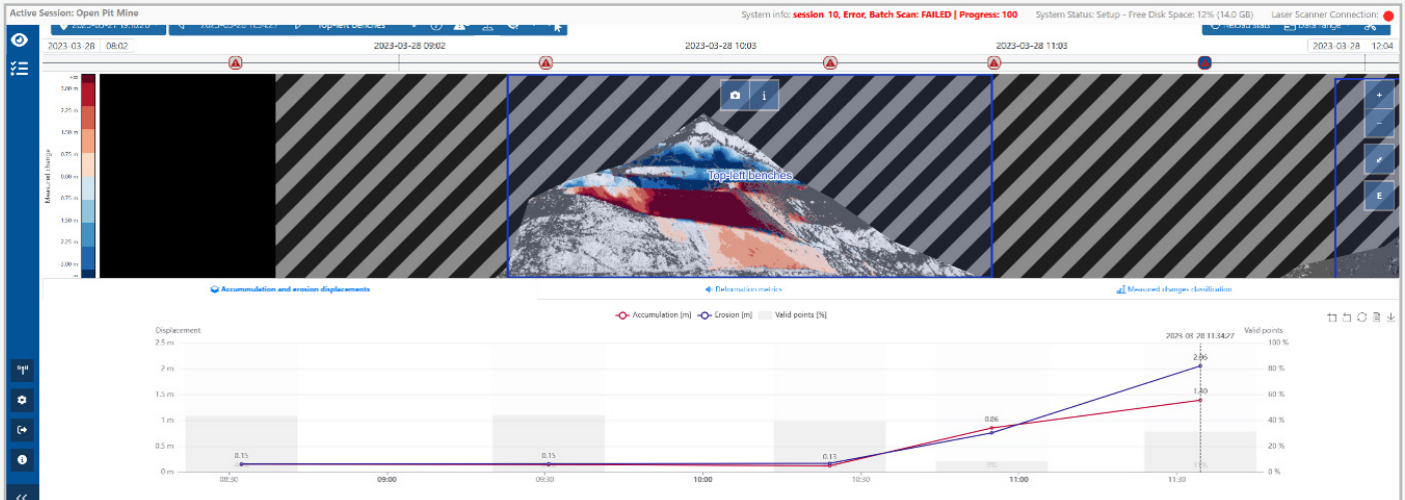


Fig 3. OPMMS® software dashboard showing full-area displacement mapping and deformation metrics.

ANALYTICAL DELIVERABLES & TREND TRACKING

The OPMMS® processing engine continuously transforms multi-temporal point clouds into live monitoring metrics:

- **Full-Area Displacement Mapping:** Color-coded heatmaps reveal the exact extent and distribution of surface movement across benches and highwalls.
- **Deformation & Velocity Metrics:** Time-based trend graphs quantify displacement rates and their evolution over hours, days, or longer monitoring periods.
- **Early Warning Safety Dashboards:** Automated processing delivers rapid risk indicators and highlights accelerating deformation for timely decision-making.
- **Accurate Data For Advanced Analysis:** Displacement and volumetric change values can be extracted for selected quarry sectors, providing essential input for subsequent geotechnical analysis.

BENEFITS

- **Elimination of Spatial Blind Spots:** Full-area coverage ensures that no developing instability goes unnoticed between traditional prism targets.
- **Long-Range Autonomous Protection:** Automatically monitors massive pit geometries from distances of up to 1 km, keeping personnel out of hazardous areas.
- **Accelerated Geotechnical Decisions:** Combining point measurements with full-surface mapping enables faster and more informed risk assessments.
- **Enhanced Site-Wide Safety:** Early warning insights improve the protection of haul roads, heavy equipment, and field personnel.
- **Quantitative Movement Assessment:** The system identifies not only where deformation occurs, but also measures the magnitude of surface displacement.