



HEXAGON



HxGN MineMonitoring

Shan Naude – Business Development Manager



HxGN MineMonitoring

Integrated approach to slope stability monitoring in open-pit mining



Integrated solution for slope stability
monitoring in **open-pit mines**

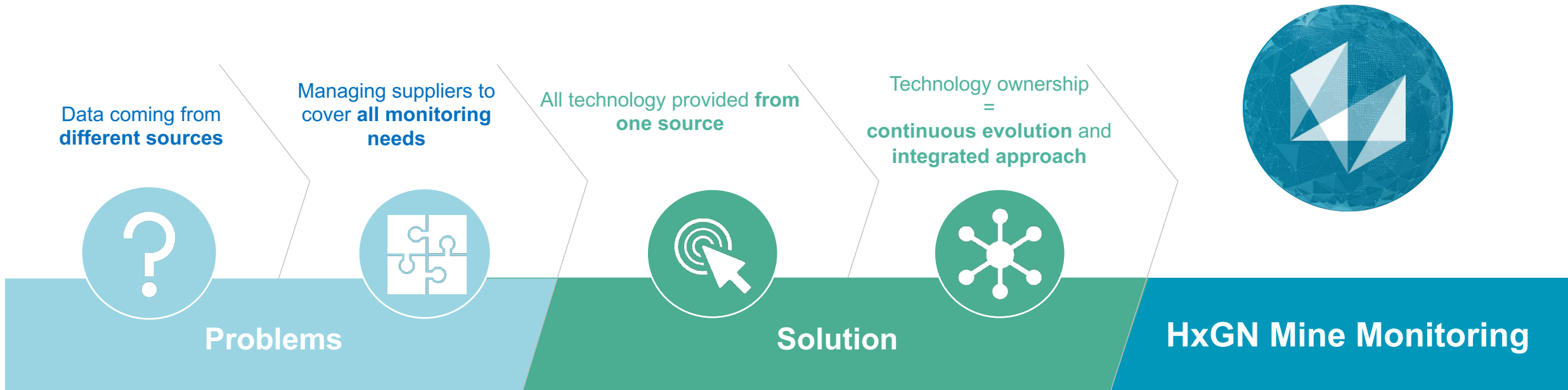
IDS GeoRadar



HxGN MineMonitoring

Leica
Geosystems

Why HxGN MineMonitoring



HxGN MineMonitoring Portfolio

Slope Monitoring

Collect, analyze and alarm on radar and geodetic sensor data in near-real time for fast decision making on known and unknown slope instabilities



Geotech Data Aggregation

Integrate geotechnical monitoring data in a holistic view



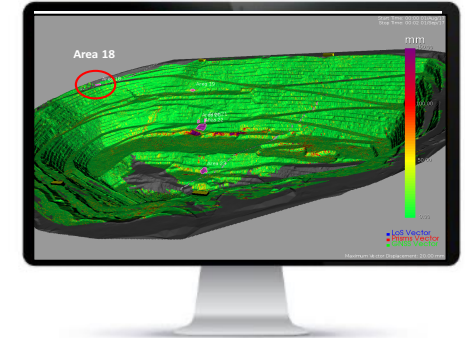
Rockfall hazard detection and management

Real time alert and tracking of rockfalls, rockfall risk zonation and statistics



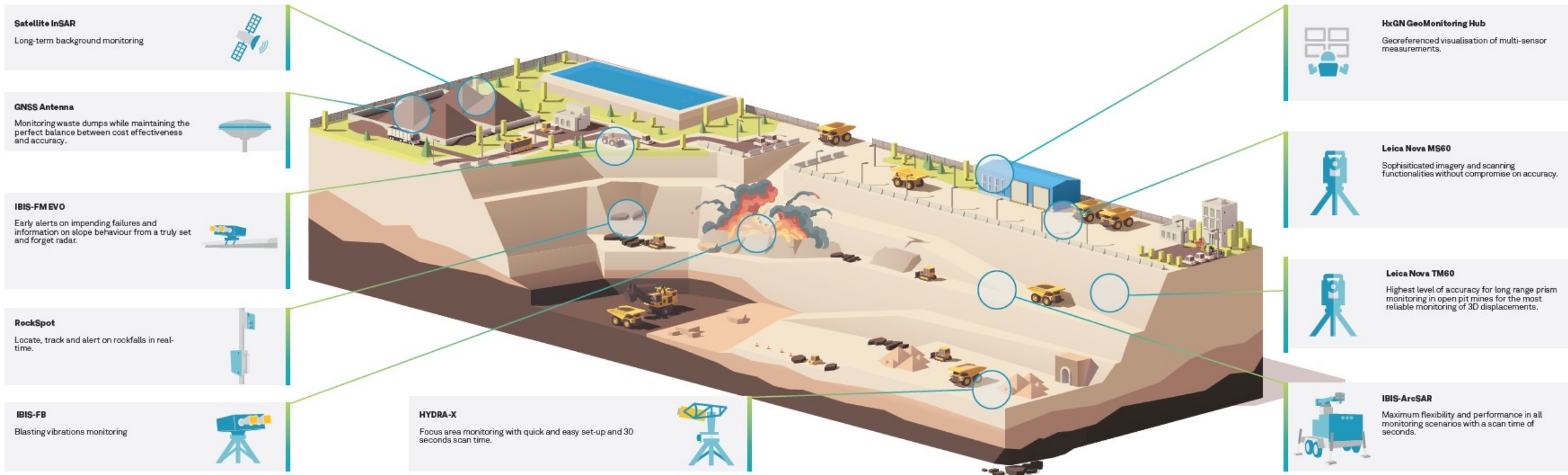
Support & Services

Technical support, advanced data interpretation and training. Monitoring network design and implementation.



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A comprehensive solution for any stability monitoring requirements



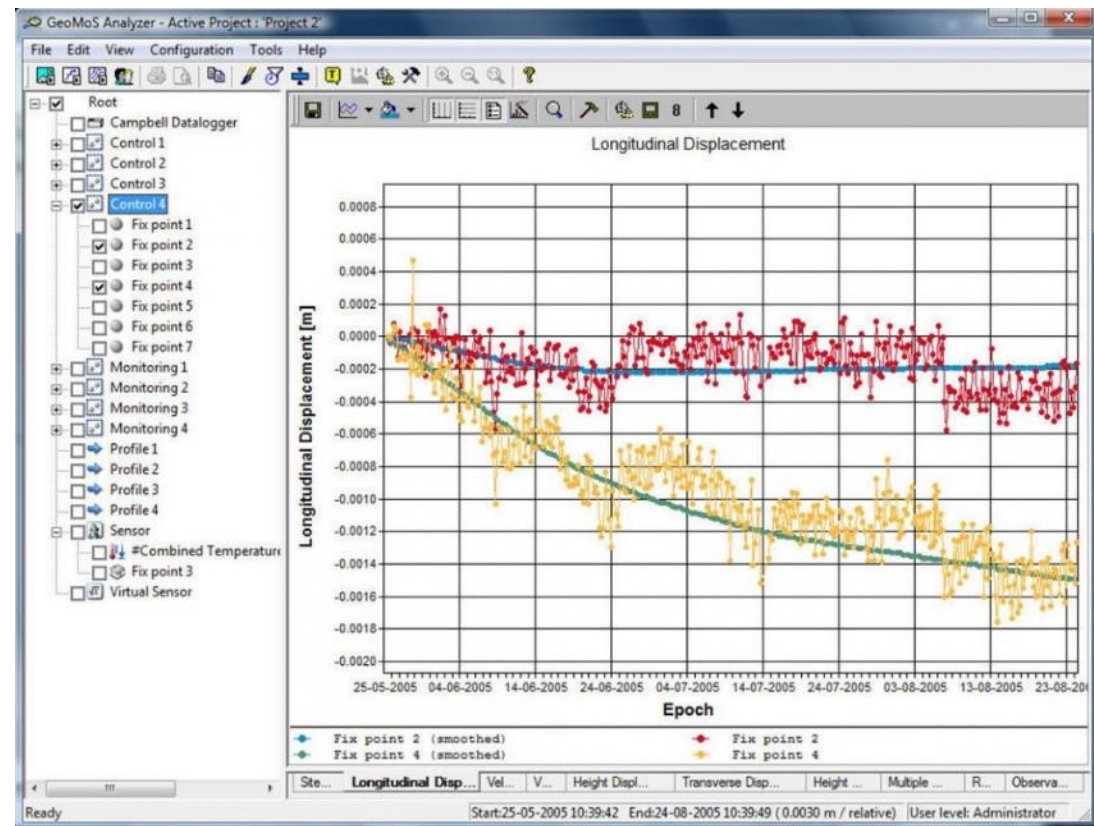
Monitoring Applications



Background long-term



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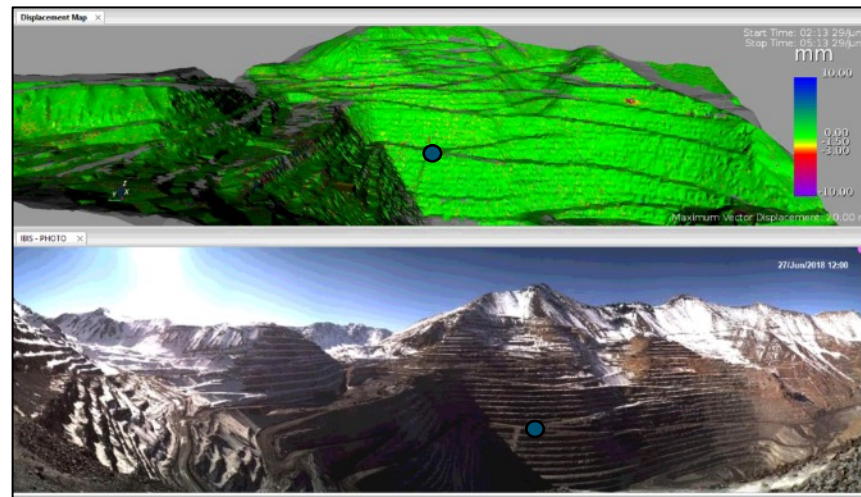




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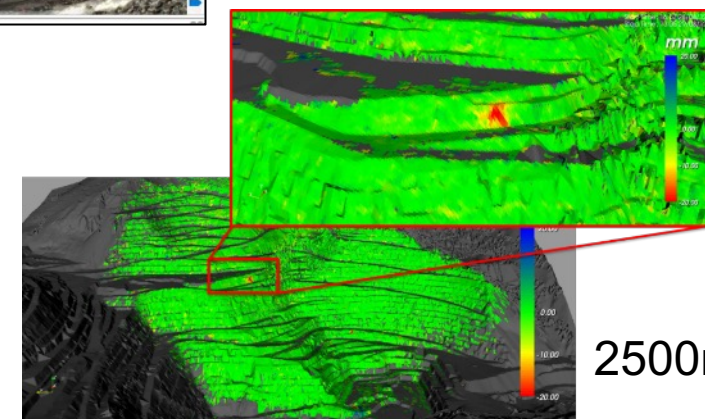
Background long-term

3000m



Provide extra time to **evaluate** slope conditions and **develop** solutions before displacement begins to interfere with **mining operations**

2500m



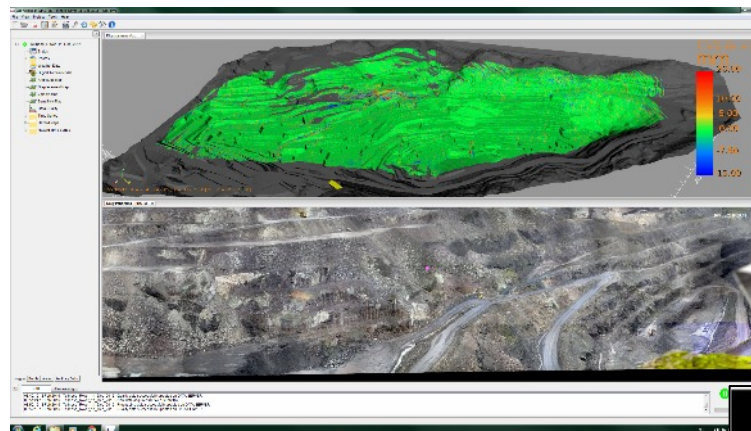
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GeoRadar

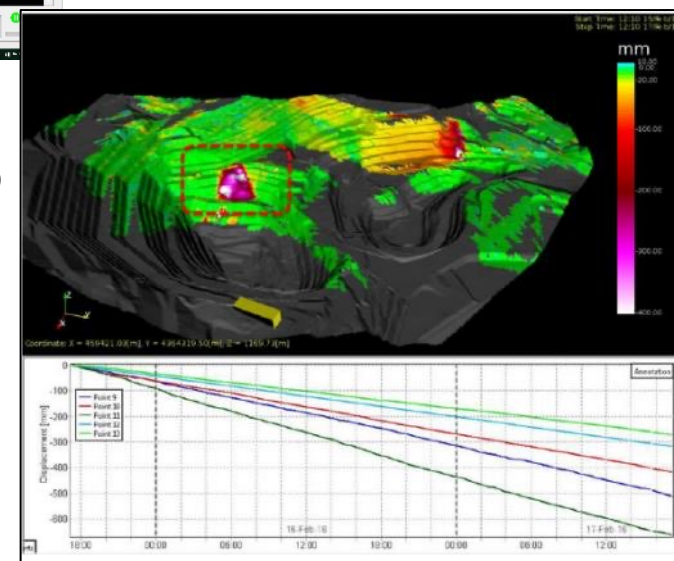


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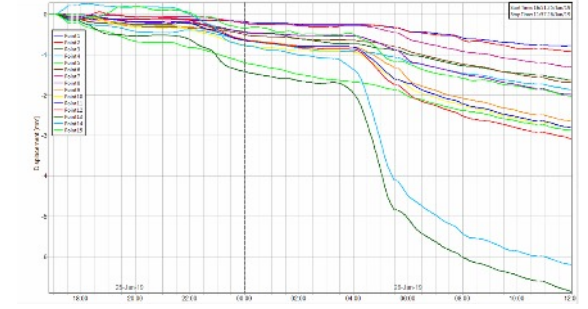
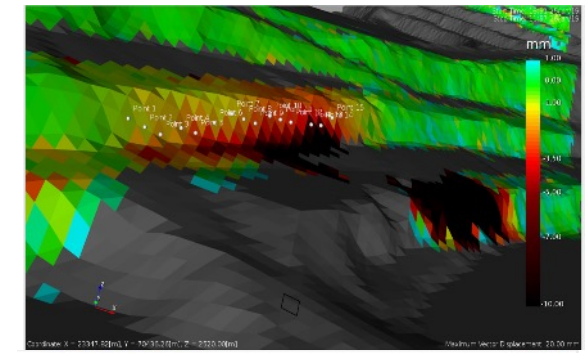
Flexible mid-range



Mobile solutions with a range up to **2.5 km** for complex **structural**, **monitoring** and **extraction** scenarios.



Focus area monitoring



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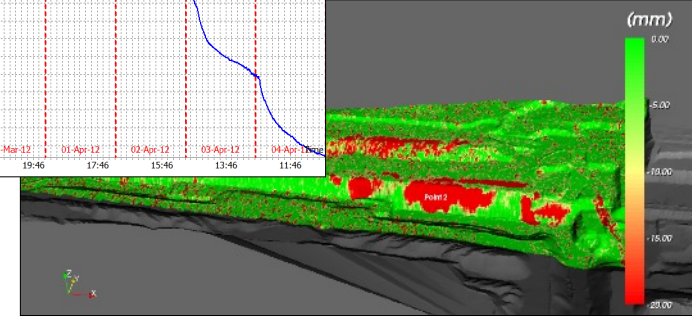
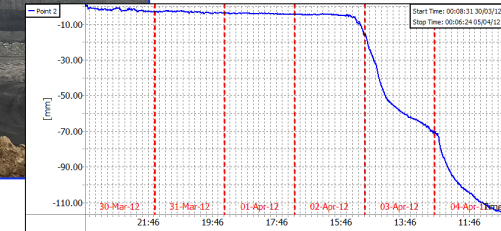
A **compact** and **portable** solution for **known instabilities**, **complex geometries** and high resolution **sub-bench instabilities**. **Fast scan times** for quick reaction even in case of **sudden accelerations**.





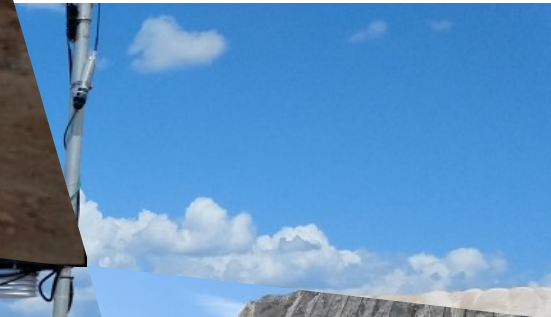
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Coal strip mining



Operations that require **tactical positioning** and focus on critical areas, **frequent relocation**.

High and mid-range solutions for **long-wall operations**.

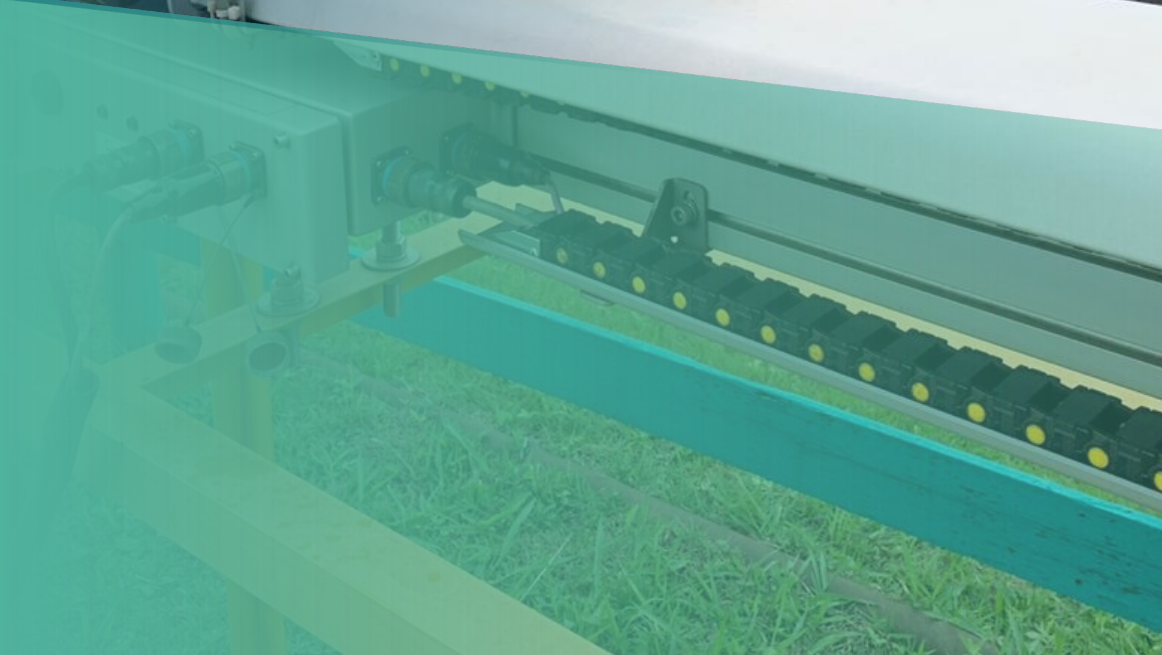
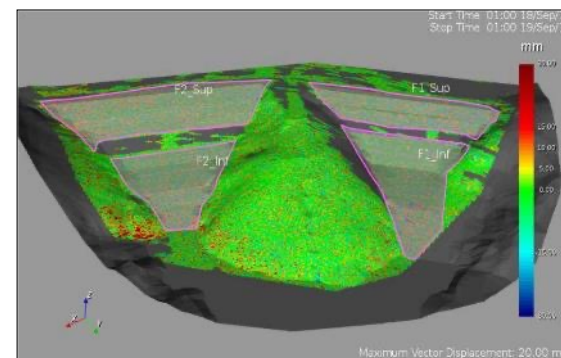
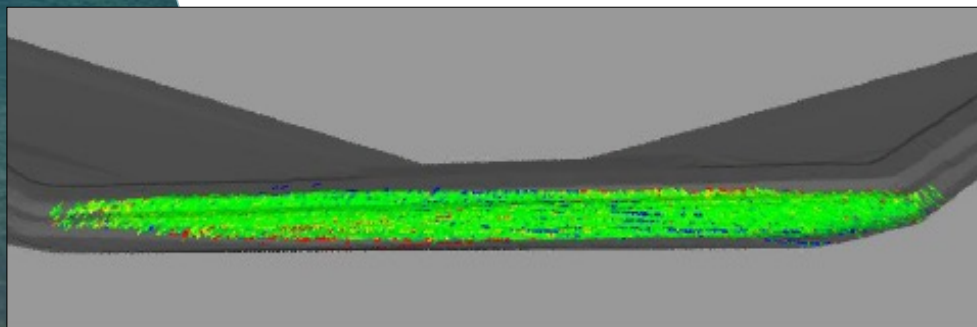




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Tailing Dam Monitoring

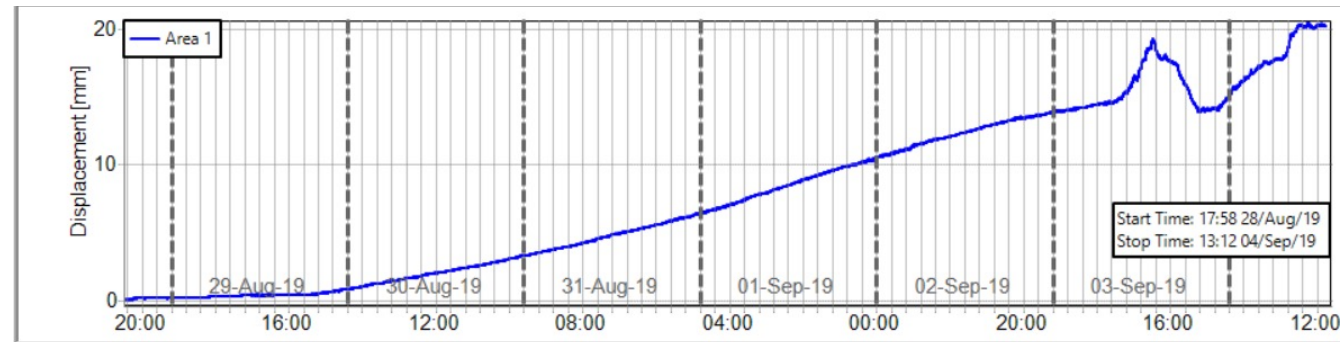
Full understanding of the **structural behavior** of dams and slopes within **short** (including real-time), **medium**, and **long** term





HxGN MineMonitoring

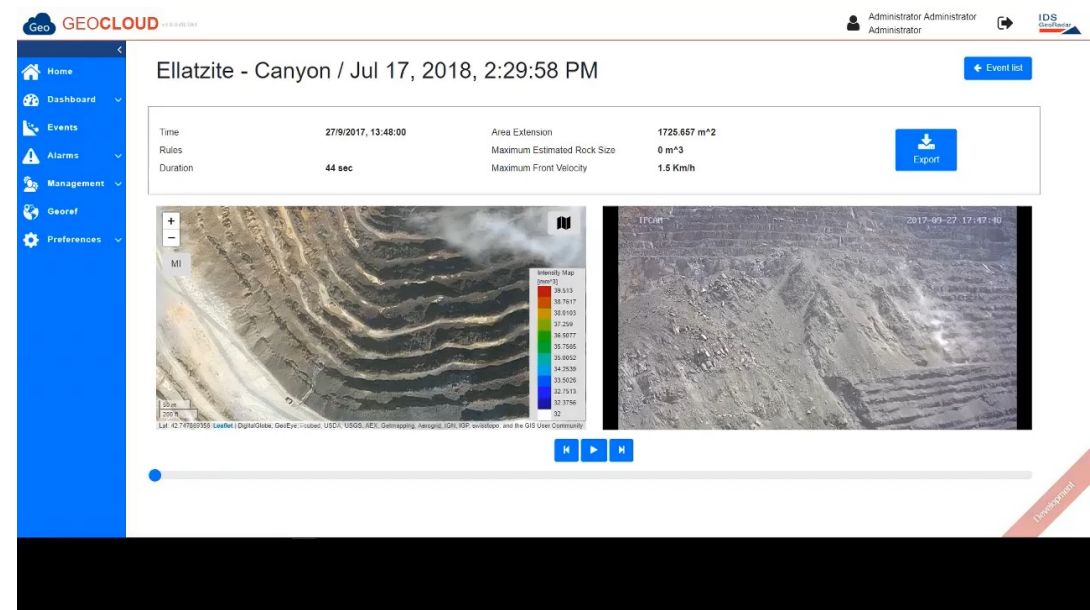
Emergency monitoring



A **compact** and **portable** solution for quick shipment and rapid deployment to assist during **emergency** monitoring requirements.



Rockfall hazard mitigation



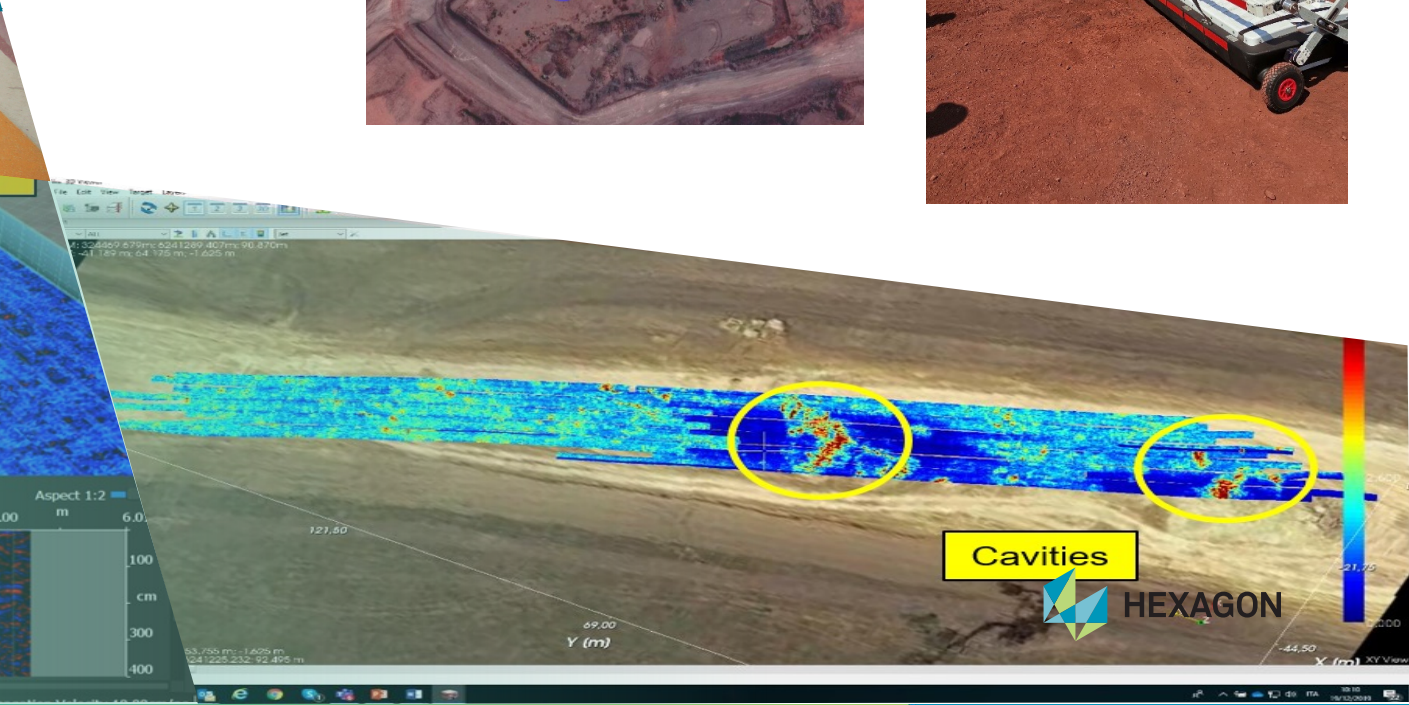
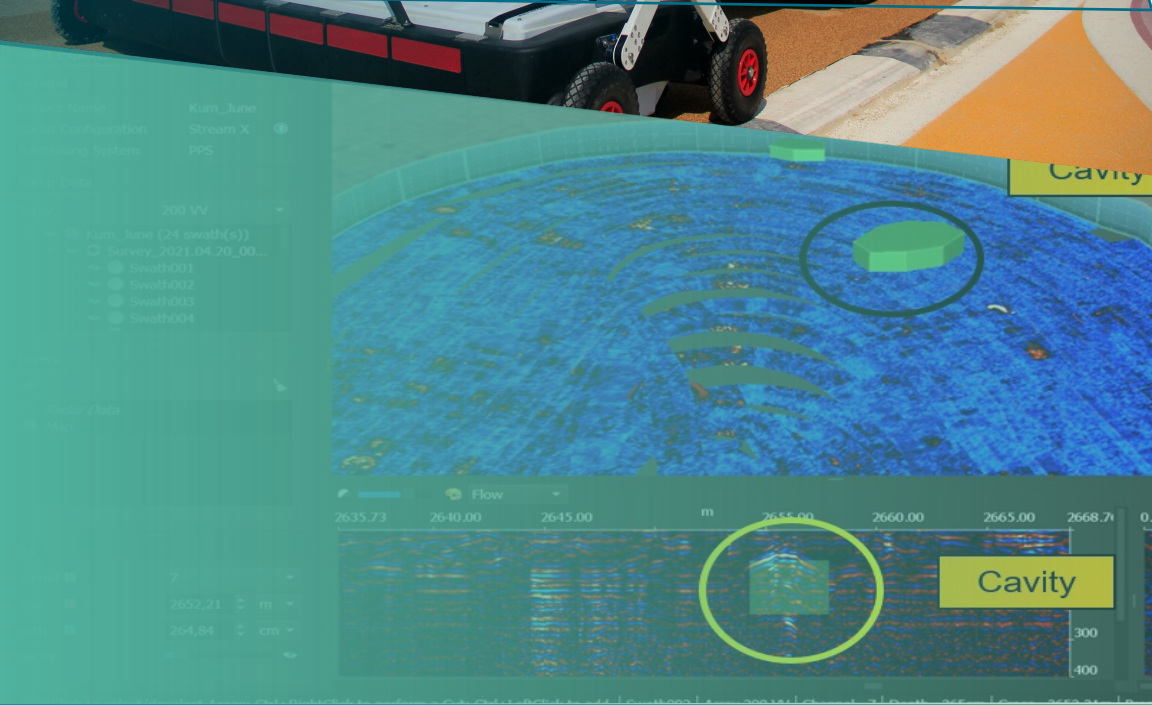
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A true real-time rockfall **hazard mitigation strategy** is now possible with high **confidence** and **reliability**!



Cavity detection

- Towed by a vehicle to cover large areas
- High resolution images
- Real-time navigator and tomography
- High acquisition speed and high productivity
- Software with automated transfer to CAD/GIS





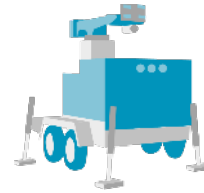
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SENSORS

Monitoring Radars



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IBIS ArcSAR

- Maximized FoV (up to 360°)
- Fast scan time (60 sec)



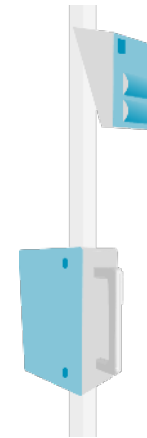
Hydra X

- 120° coverage, 800 m range, 30 seconds scan time
- Quick set-up and portable solution



IBIS-FM EVO

- Safety critical (fast movements) and long-term monitoring
- Ideal for semi-permanent installations, possibility of system housing



RockSpot

- Real-time alerts
- Operates in all weather conditions



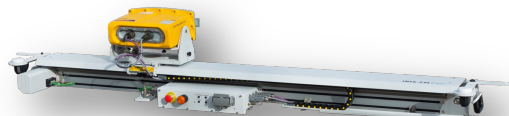
IBIS FB

- Blasting area monitoring
- Compact and mobile

IDS
GeoRadar

HEXAGON

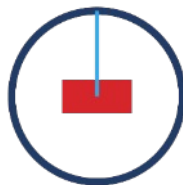
Interferometric radars



IBIS-FM EVO

The evolution of the IBIS-FM “legacy”
Safety critical monitoring with the lowest maintenance.
A true set-and forget

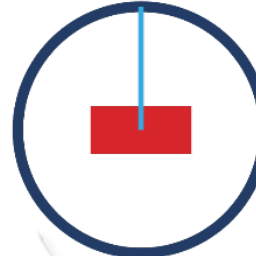
2.5 km



ArcSAR Lite

The **first mobile rotating SAR** for short to mid-range monitoring, expanded the coverage to fit **multi-pit operations** and complex geometries

5 km



ArcSAR Performance

Best-in class technology adaptable to **any monitoring scenario**. Total coverage with a single equipment

800 m

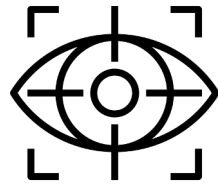


HYDRA-X

Small and portable radar for **focused close-range monitoring**

RockSpot & GEOCLOUD

Filling the gap in slope and tailing dams monitoring



RockSpot is an innovative radar system able to **locate, track and notify on rockfalls and mudflows in real time.**



RockSpot **never sleeps and provides continuous monitoring night and day.**



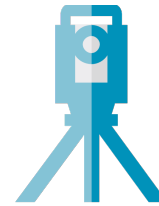
The user-friendly software platform **GeoCloud, provides all information and customizable notification options** on each individual rockfall event.

Geodetic Sensors

Total Stations / Multi Stations
GNSS Receivers



HxGN MineMonitoring



Total Stations

- Most **accurate** and **reliable** imaging monitoring total station



Multi Stations

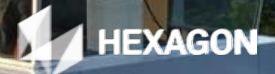
- The world's first **self-learning MultiStation** automatically adjusts to any environment, regardless of the challenges



GNSS Receivers

- **Powerful** GNSS technology for unmatched **accuracy**.

Leica
Geosystems



Total Stations and Multi Stations



Leica TM60

0.5" accuracy and 3 km range using Automatic Aiming (ATR)
Designed to withstand the roughest use in the most severe environments 24/7 (IP65)
Integrated 5MP camera using the telescope as lens → surveyors view



Leica MS60

The world's first self-learning MultiStation (IP65)
1.0" accuracy and 1.5 km range using Automatic Aiming (ATR)
Powerful scanning tool

GNSS Receivers



Leica GMX910

- Dedicated smart antenna for monitoring applications
- 555 GNSS channels



Leica GM30

- Full feature onboard software RefWorx (RTK, VADASE, logging&push)
- ME7 measurement engine
- 555 GNSS channels



Leica AR10

- Integrated robust UV resistant radome
- Ideal for Monitoring and RTK Networks
 - saving budget

Wisen Sensor Network

Wireless sensor connectivity

Autonomous wireless radio mesh

Mesh network: **Cable free automatic data transfer**

- Every node is a sensor & repeater
- Data relays between sensors beyond sight
- Multiple data paths for redundancy
- 900Mhz frequency, ideal for rugged mining environments

Master control unit: **SmartGateway**

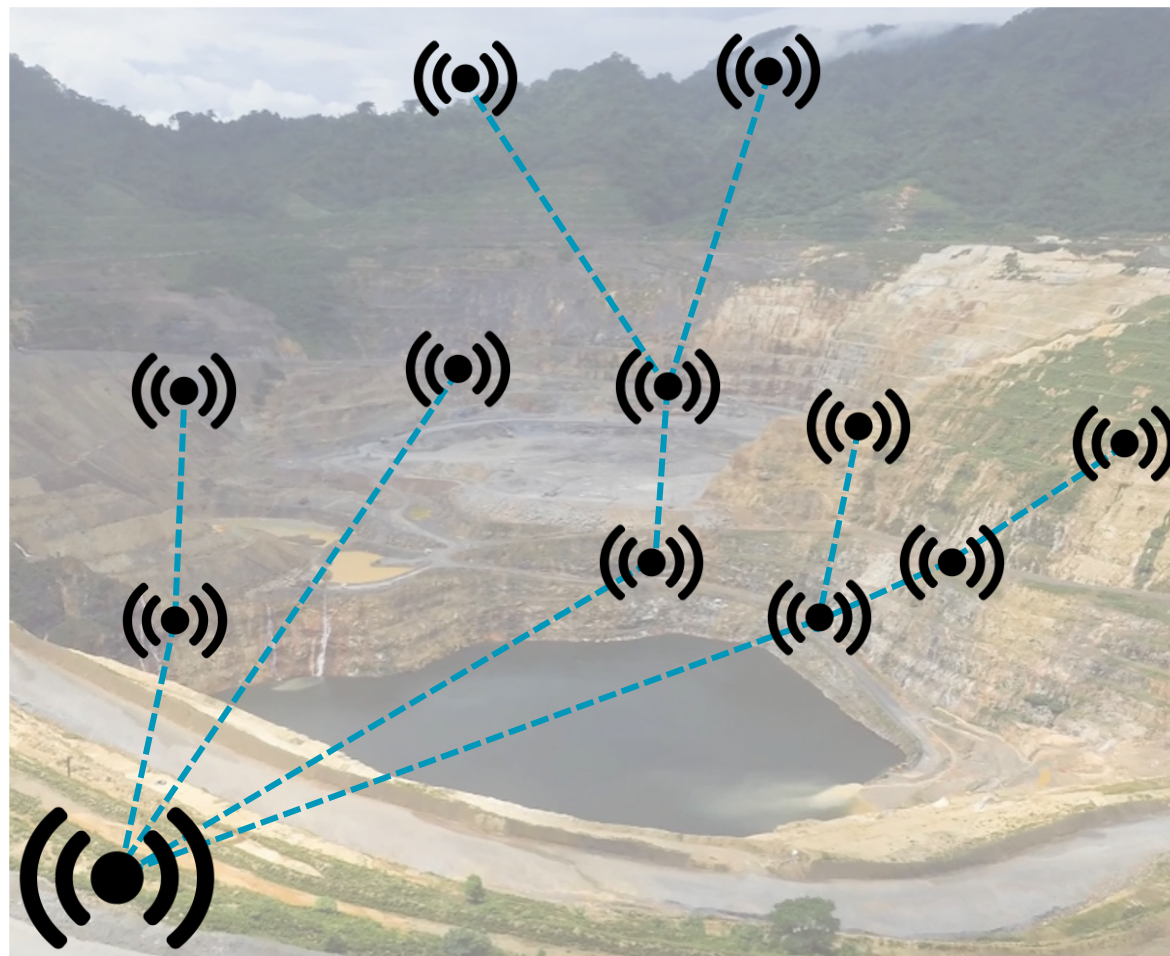
- Hub for collection of sensor readings
- Data storage & WAN connection
- Local wireless mesh controller

Slave units: **Wireless sensor nodes**

- Sensors: Tilt, Distance, Direction, Camera
- Interface connection: VW, Digital, Analog devices

Telemetry: **4G/ wifi/ Lan**

- Data is accessed and visualised in the cloud
- Any sim card will work
- Can be connected to wifi and Lan
- Up to 10km between nodes LOS, or 500m without Line of Sight
- Nodes do not need to see the gateway as data can be hopped
- All data can be exported via http, ftp, sftp





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SOFTWARE SOLUTIONS

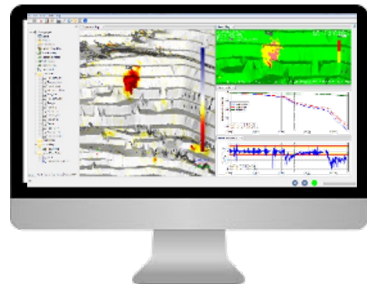


Multiple layers of safety and integration

GEOTECHNICAL MONITORING



CRITICAL MONITORING



HxGN GeoMonitoringHub

Guardian FPM360

Holistic complete view
of geotechnical sensors

Data comparison
and cross-check

Customized
reporting

Real Time Monitoring
Data processing
Alarming and analysis

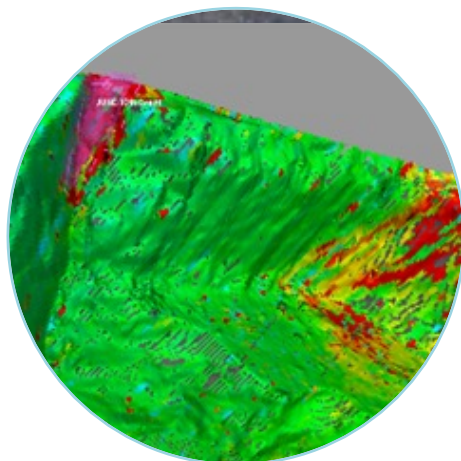


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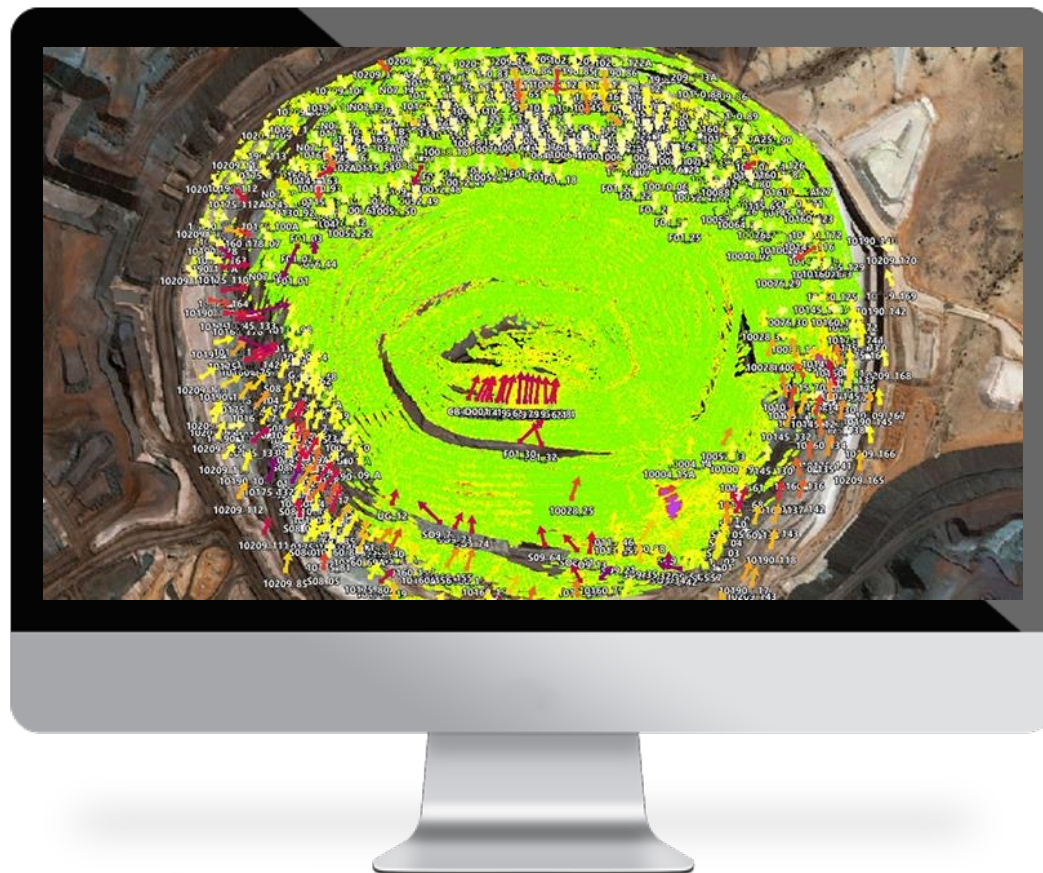
HxGN MineMonitoring Software Suites

Seamlessly collect data in Real Time from [Leica GeoMoS](#) and [IBIS Guardian](#), as well as [Third party](#) solutions.

API



IBIS Guardian FPM 360



API



Leica
Geosystems

GeoMoS



HxGN GeoMonitoring

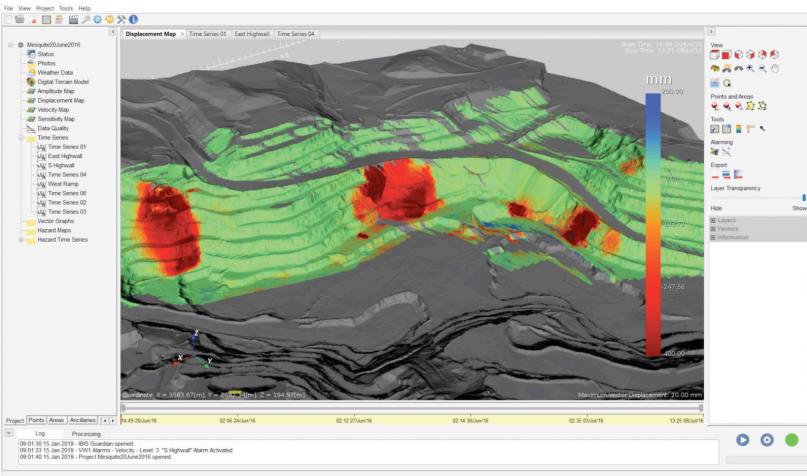
Hub



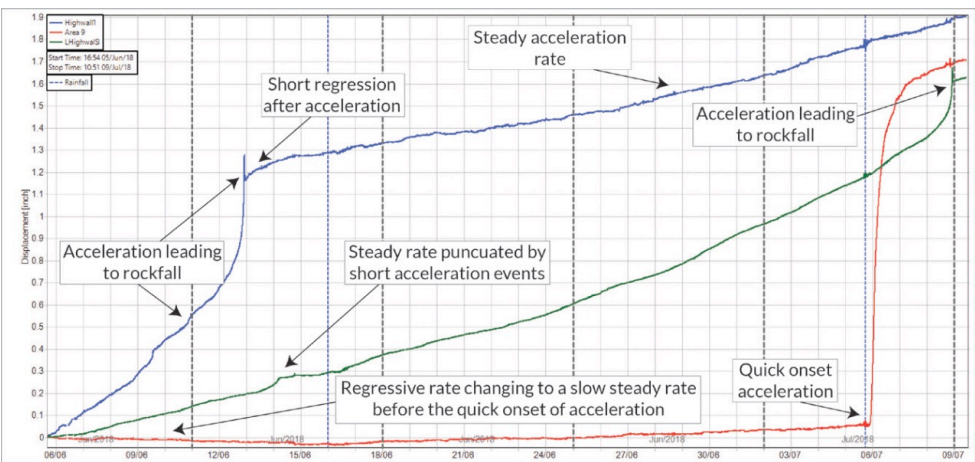
IBIS Guardian FPM360

Key Features

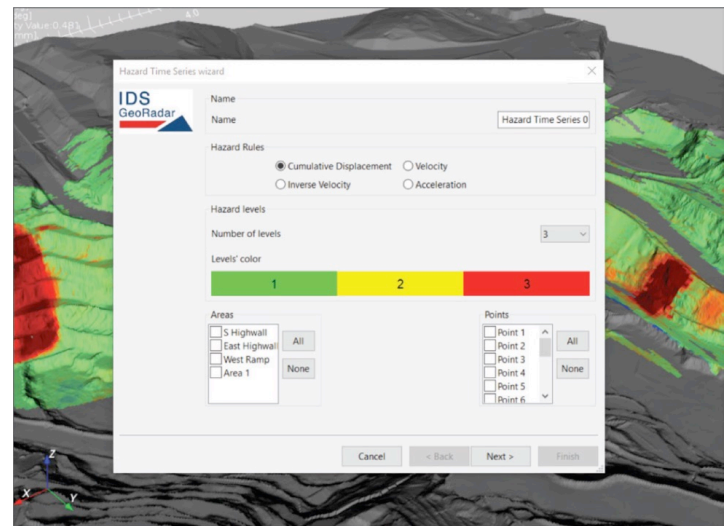
1 DATA PROCESSING AND MAP VISUALIZATION



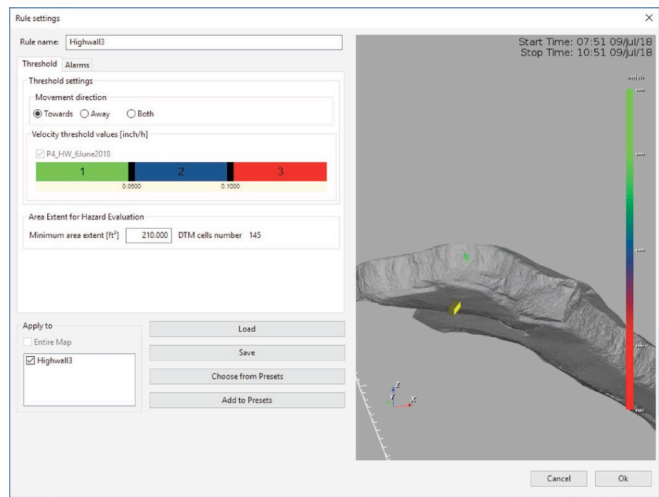
2 DATA ANALYSES AND INTERPRETATIONS



3 HAZARD MAP AND/OR TIME SERIES CREATION



4 USER DEFINED THRESHOLDS AND NOTIFICATION METHODS

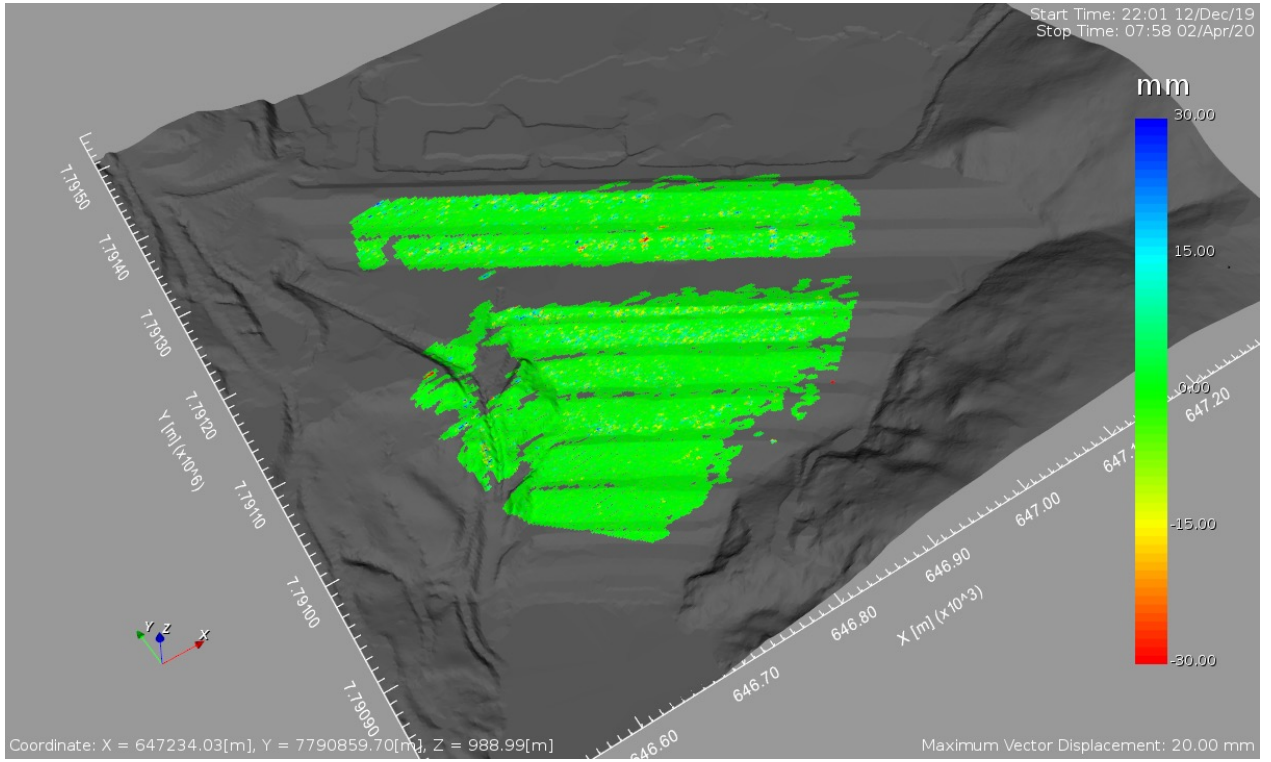
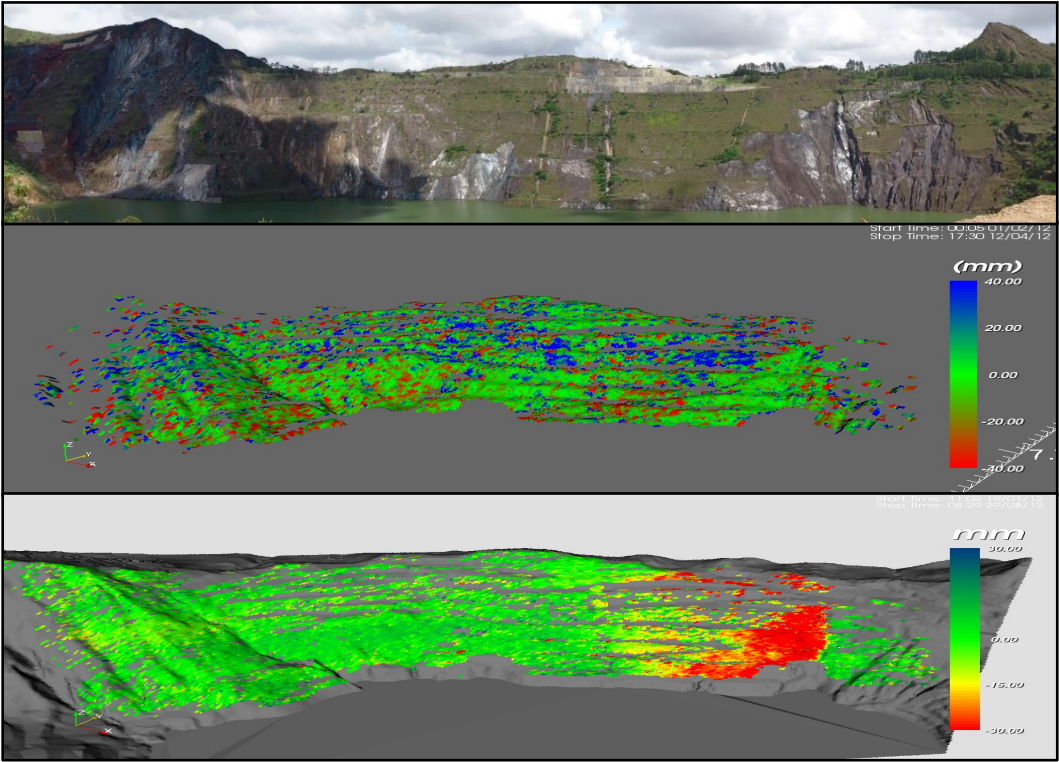


Guardian Slow Movement

Monitoring applications

Open-pit mine operations

Tailing dams





HxGN MineMonitoring

SERVICES AND SUPPORT



Mine Monitoring Services



**AFTER SALES
SUPPORT**



**24/7 ASSISTED MONITORING
SERVICES**



**ADVANCED
SERVICES**



Worldwide Support Network





HxGN MineMonitoring

After Sales Support

Efficient, seamless and more reliable

- Extended warranty **up to 7 years** from purchase
- **24/7 Support** with Ticket tracking
- On-site **Maintenance visit**
- **Software** maintenance and upgrades
- Professional **Training & User Certification**



Assisted Monitoring Services

24/7 control rooms

Hexagon Monitoring room and operation flow chart



Assisted Monitoring Services

Highly specialized staff – born and raised in mining



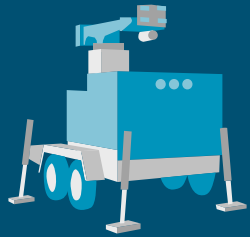
Qualified and trained staff dedicated to your needs

- Our 24/7 monitoring centers have dedicated **highly specialized staff** to **analyze** monitoring data and **notify** Customer geotechnical team.
- More than 50 staff and growing in Hexagon Monitoring Centers dedicated entirely to Assisted Monitoring Services
- Geotechnicians, Geotechnical Engineers and Senior Geotechnical Engineers for all threat and response levels.



HxGN Mine Monitoring for VALE

Partners in safety



37 #
Radars



66 #
TPS

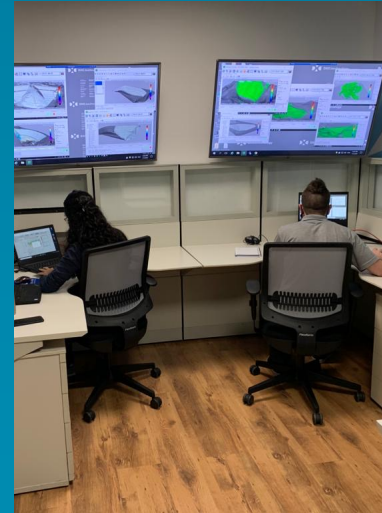
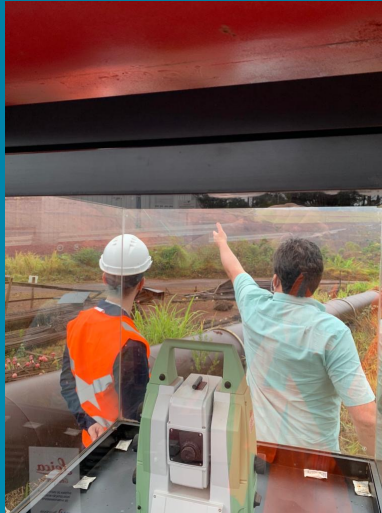


35 #
**Qualified staff
in 8 24/7
Monitoring
Rooms**



17 #
**Pits & Dams
monitored**

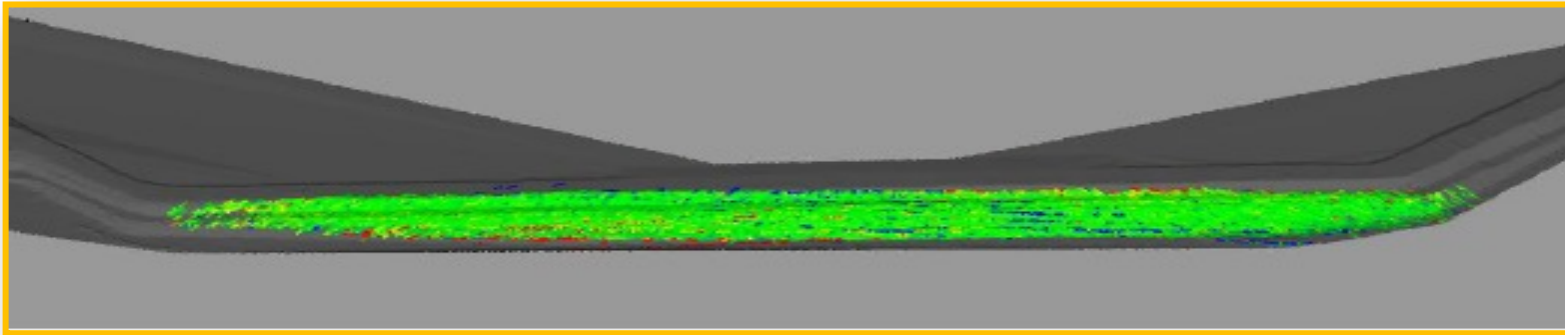
HxGN MineMonitoring for Partners in safety



Examples of current applications

Proactive monitoring of tailing embankments

Monitoring a tailing dam with IBIS FM in Chile

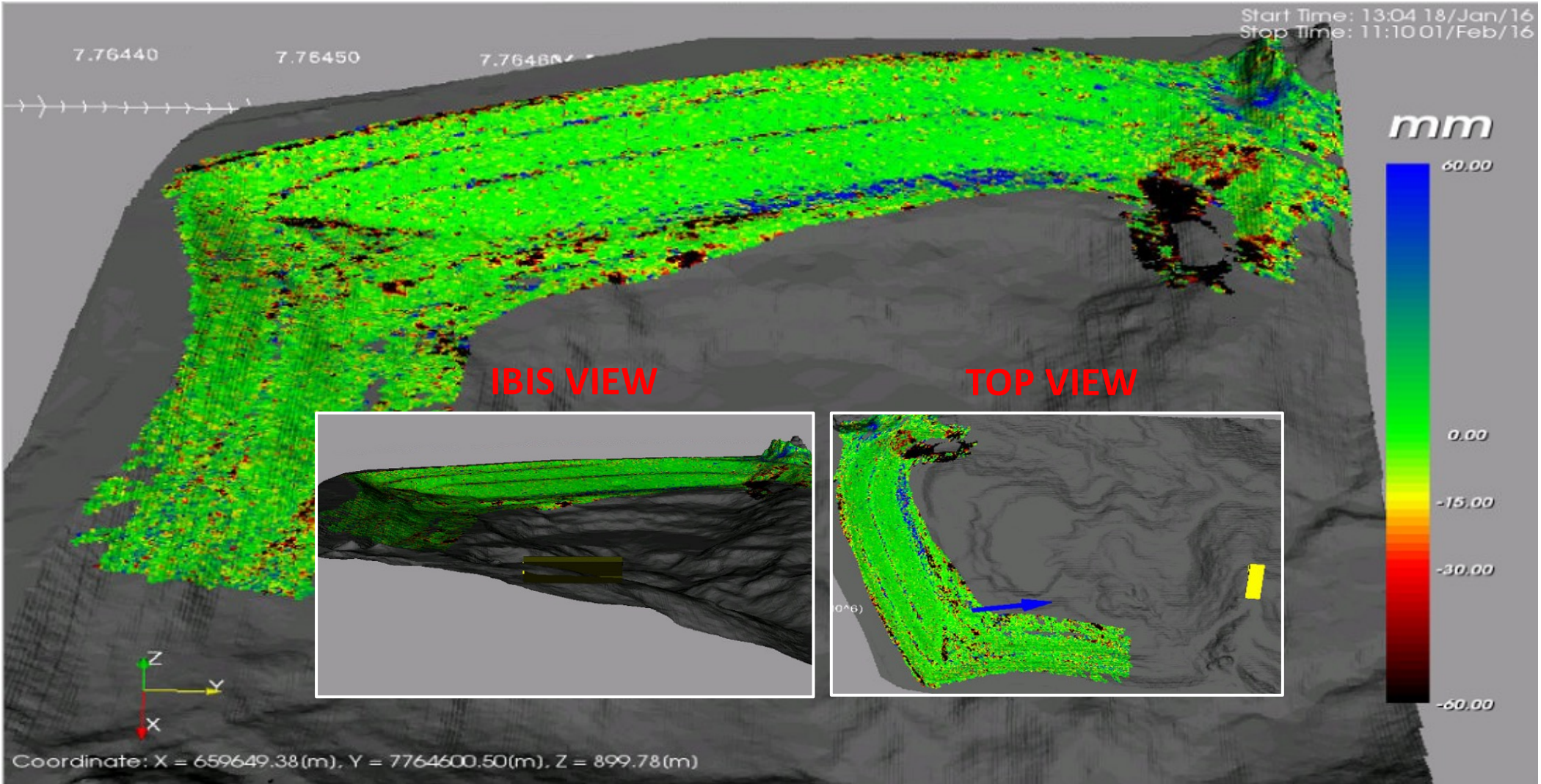


IBIS-FM, in this case together with the Eagle Vision camera, permanently monitor the tailings dam from a distance of 1.9 km providing information in real-time 24/7 on the stability of the dam.

Tailing dam monitoring with IBIS-FM in Brazil

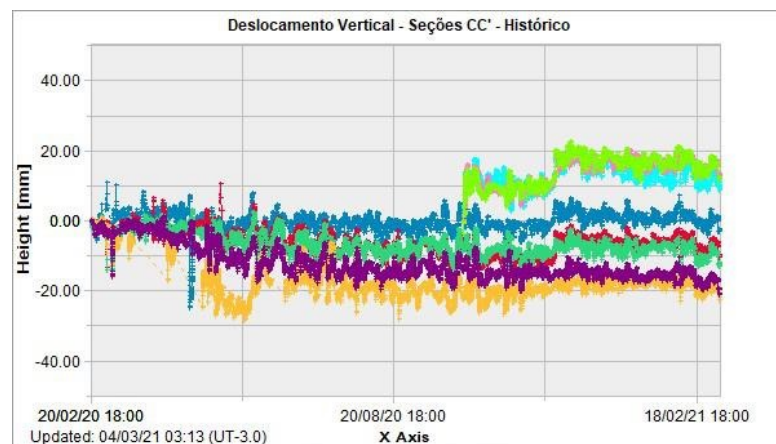
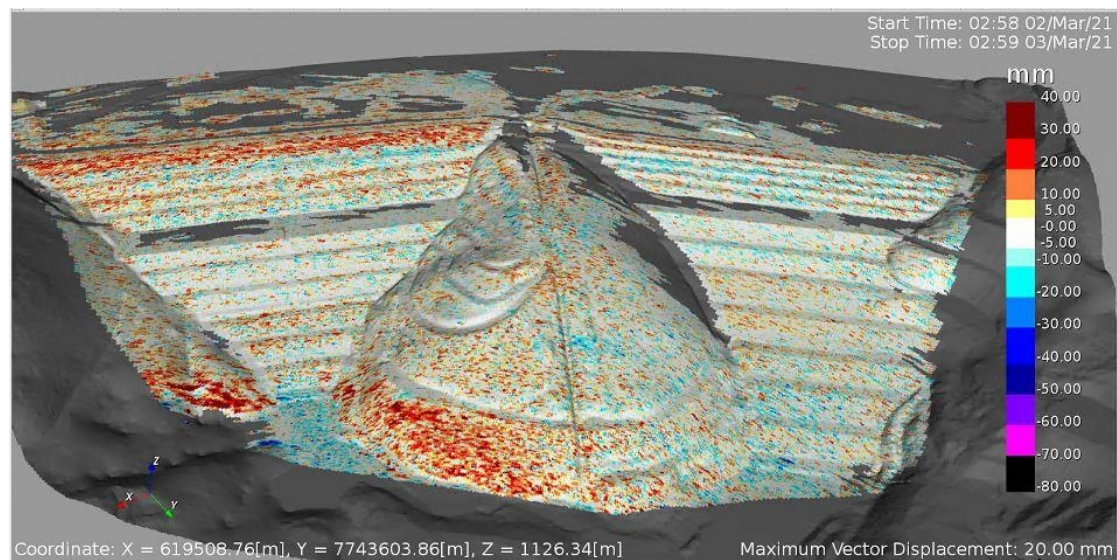


Tailing dam monitoring with IBIS-FM in Brazil

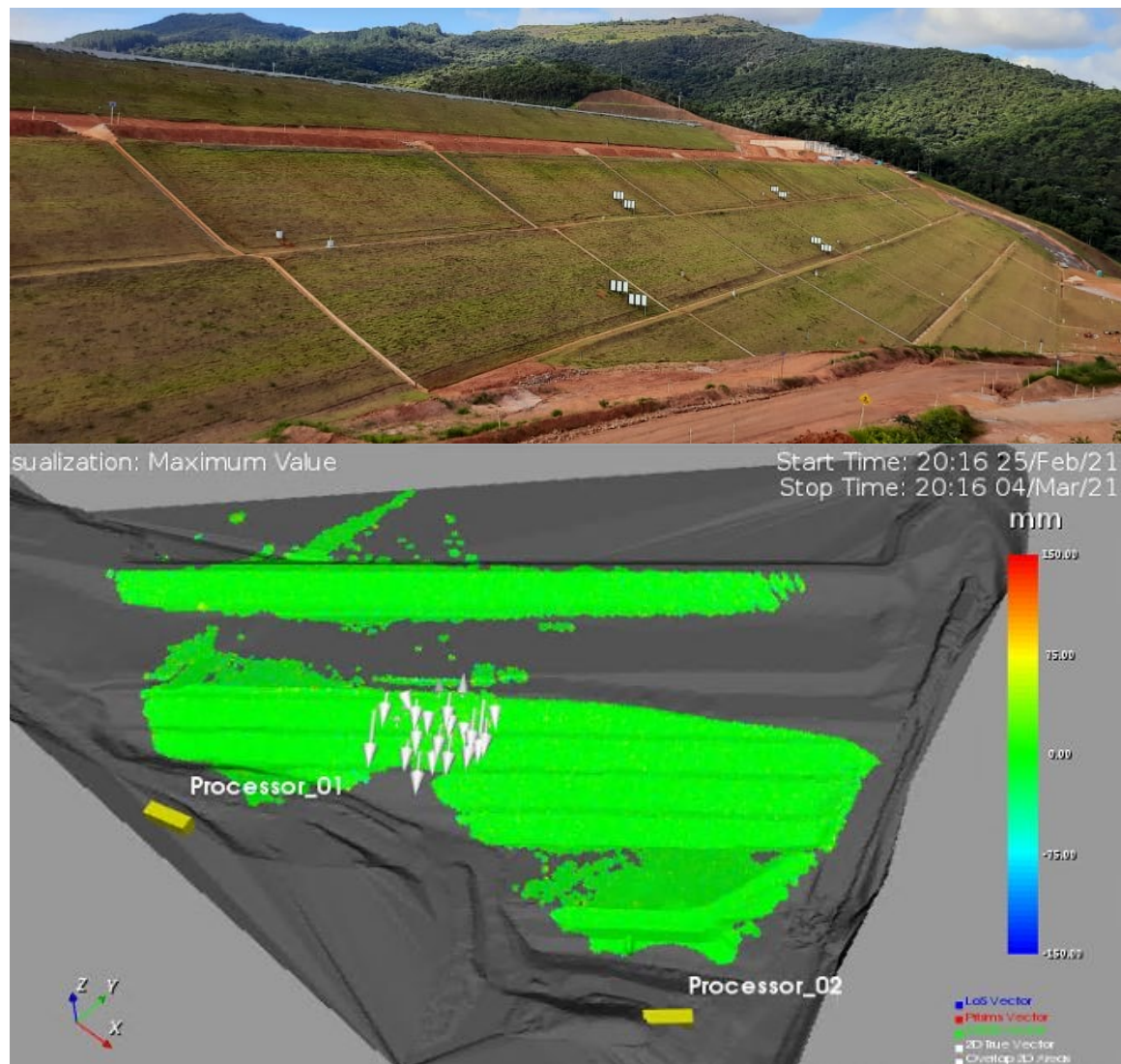


Scale +/- 60 mm

Tailing dam monitoring with IBIS-FM and TM50 in Brazil



Tailing dam monitoring with IBIS-FM and TM50 in Brazil

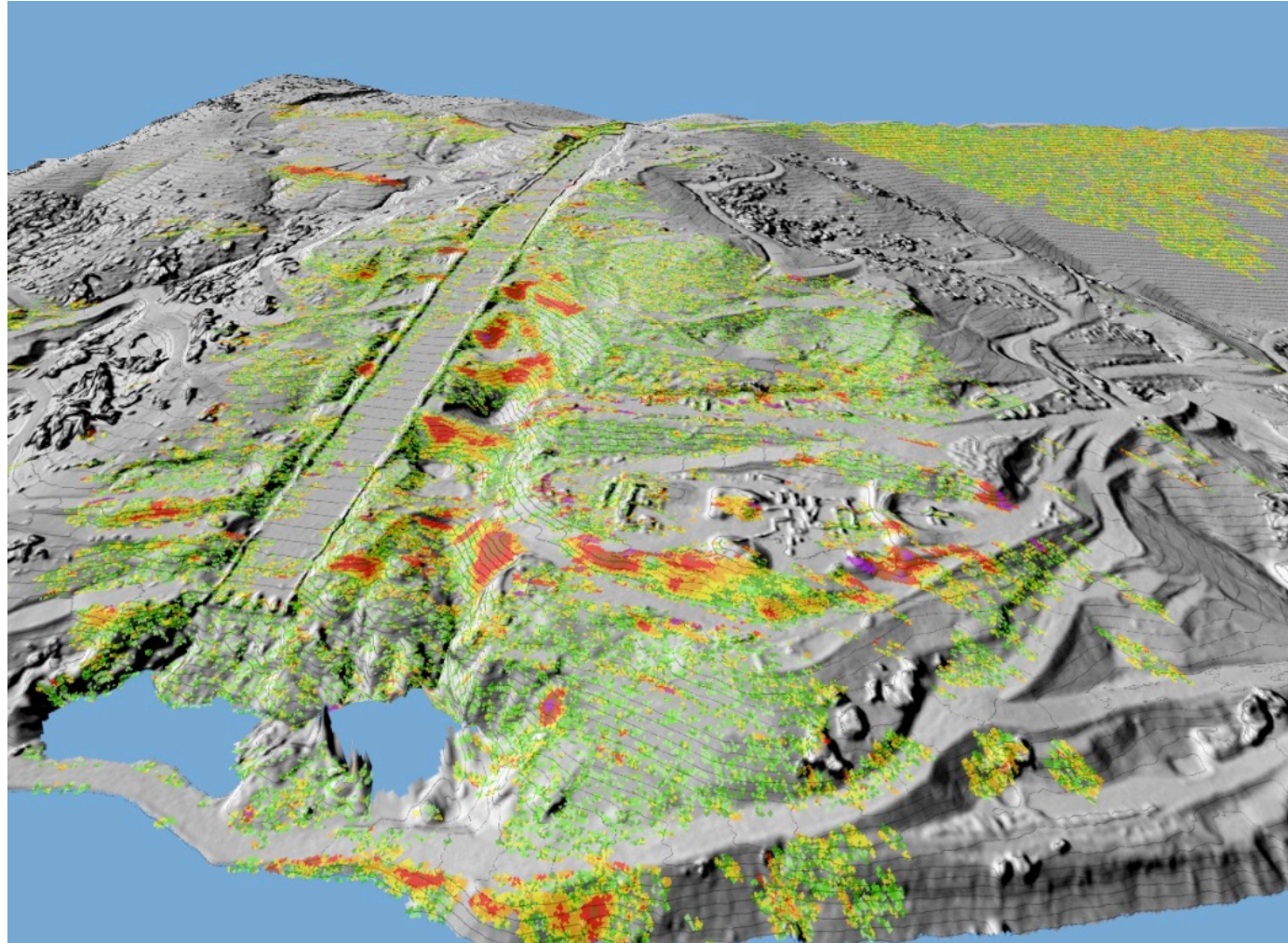




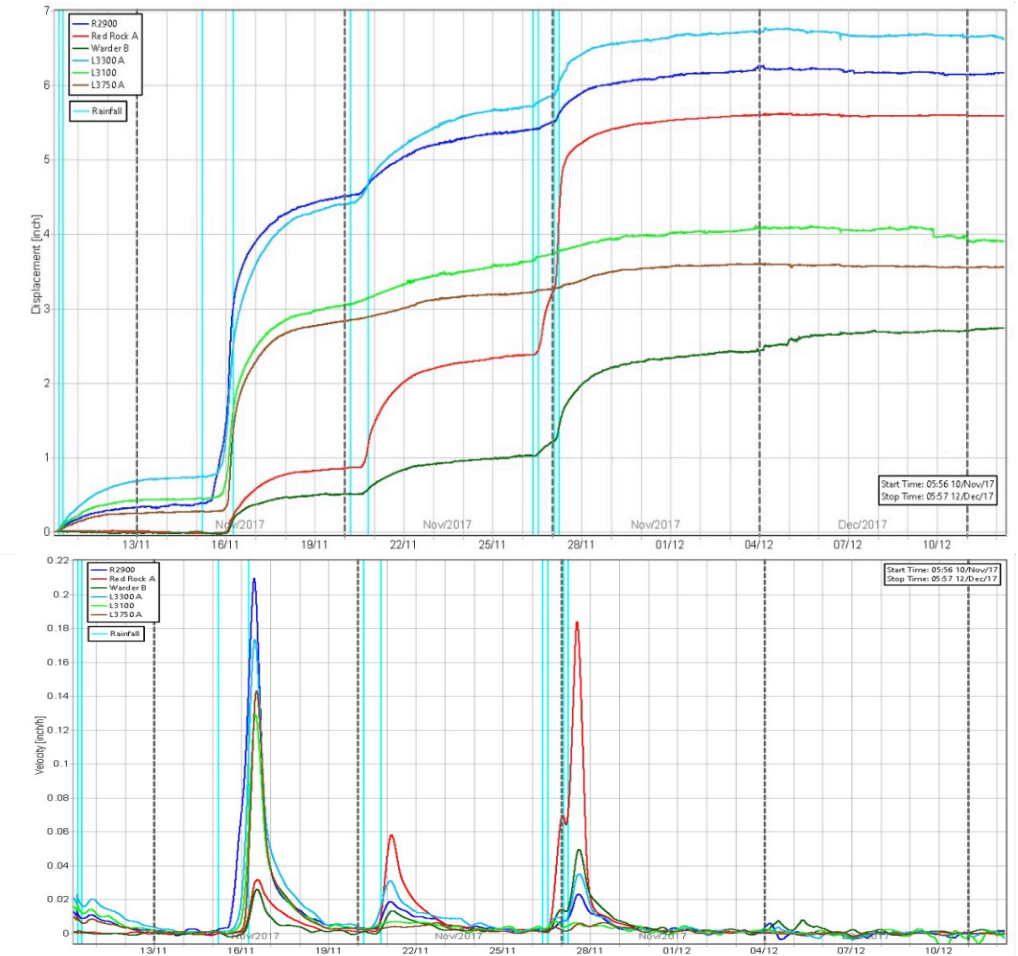
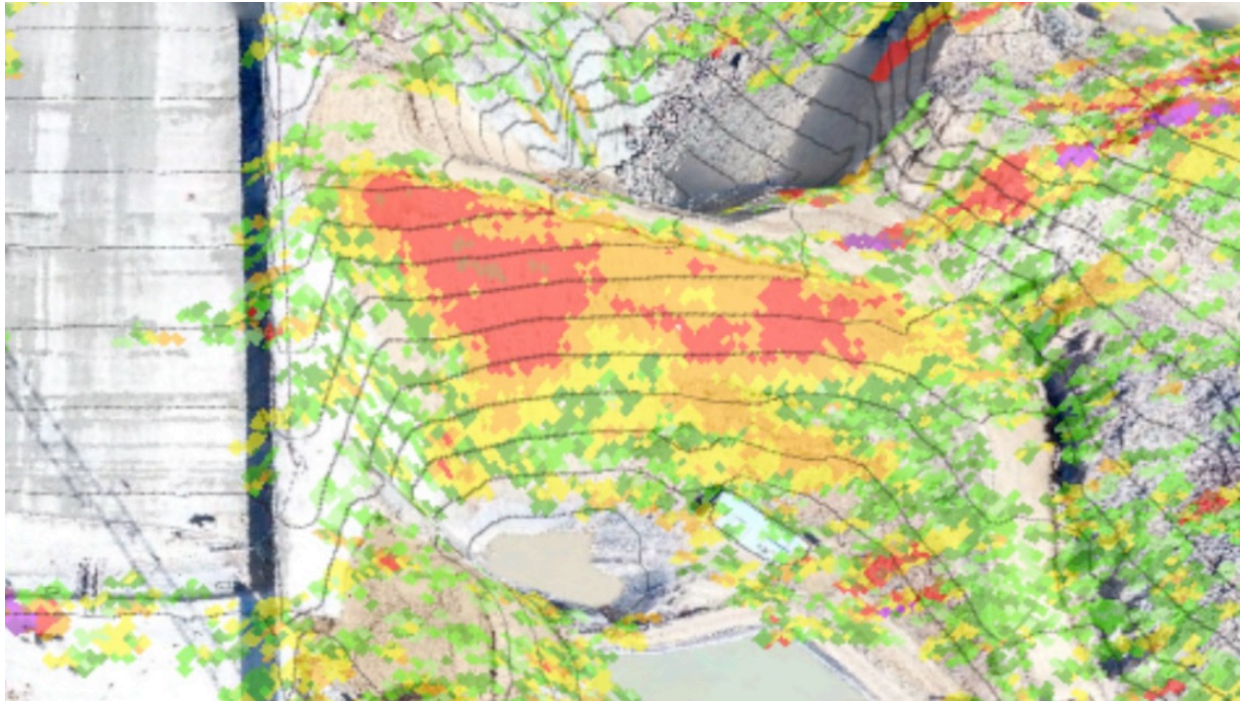
Monitoring a DAM Spillway with IBIS-FM in the US



Monitoring a DAM Spillway with IBIS-FM in the US



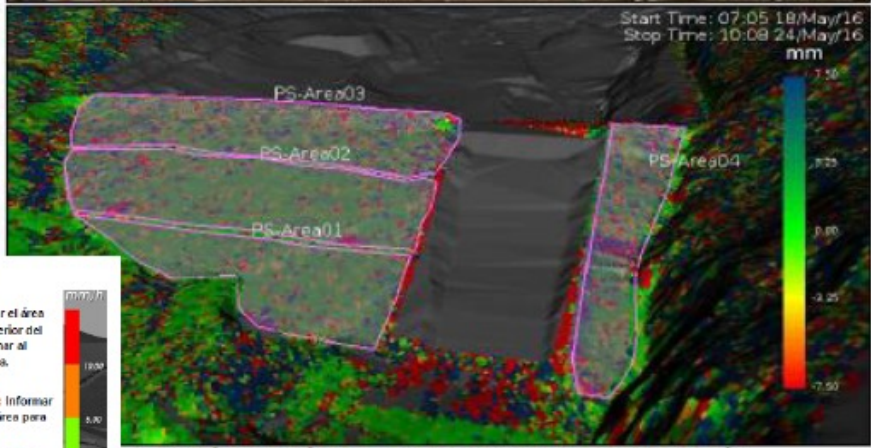
Monitoring a DAM Spillway with IBIS-FM in the US



Monitoring tailing dam with IBIS Rover and TM50 in Peru



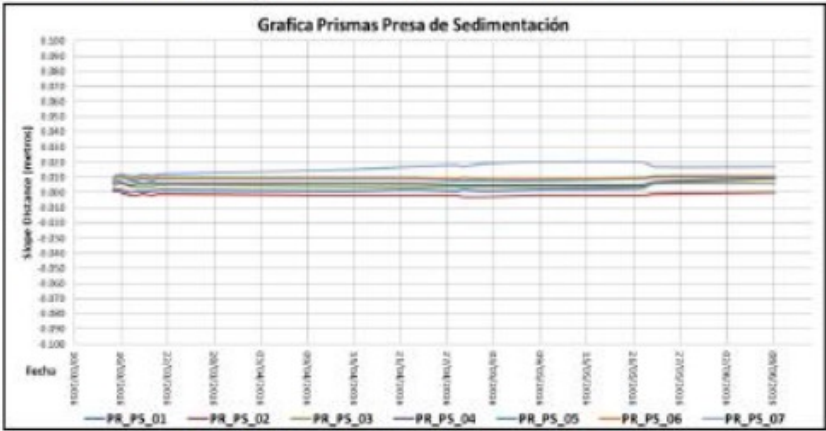
Ubicación de los prismas de monitoreo en Presa de Sedimentación



Ubicación de las áreas de monitoreo Presa de Sedimentación

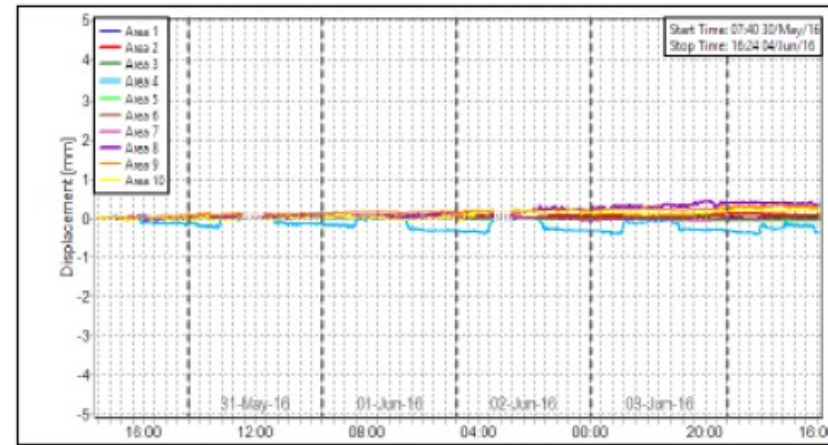
Rangos de Alarma

- Danger** (>10mm/Hr): Evacuar el área inestable la parte inferior y superior del sector e inmediatamente informar al supervisor e interesados del área para preparar la evacuación.
- Warning** (5.0mm/Hr<Wg<10.0mm/Hr): Informar al supervisor e interesados del área para preparar la evacuación.
- Watch** (2.5mm/Hr<Wg<5.0mm/Hr): Chequear mediante supervisión algún indicio de inestabilidad en el entorno del sector de interés.

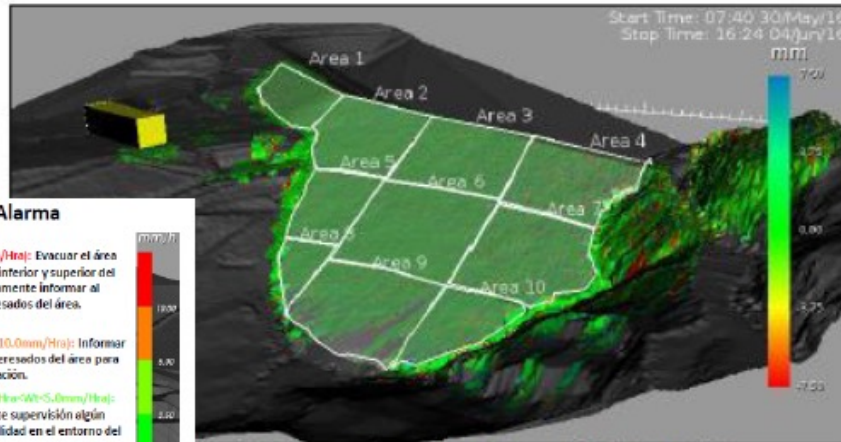


Grafica de Desplazamiento Acumulado VS. Tiempo

Monitoring tailing dam with IBIS Rover and TM50 in Peru



Grafica de Desplazamiento Acumulado VS. Tiempo



Rangos de Alarma

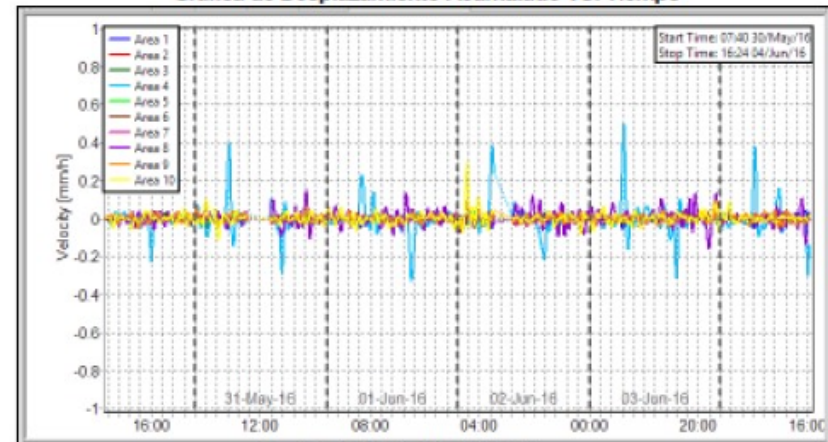
Danger ($>10\text{mm/Hr}$): Evacuar el área inestable la parte inferior y superior del sector e inmediatamente informar al supervisor e interesados del área.

Warning ($5.0\text{mm/Hr} < \text{Wp} < 10.0\text{mm/Hr}$): Informar al supervisor e interesados del área para preparar la evacuación.

Watch ($2.5\text{mm/Hr} < \text{Wp} < 5.0\text{mm/Hr}$): Chequear mediante supervisión algún indicio de inestabilidad en el entorno del sector de interés.

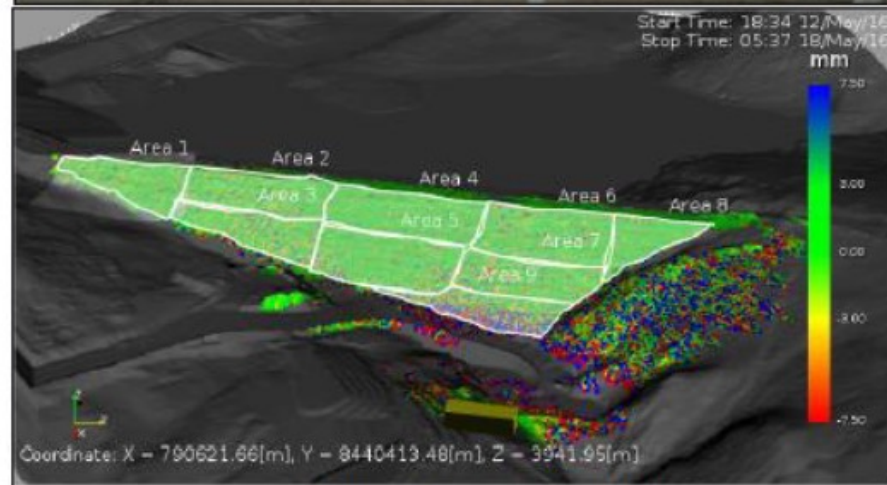
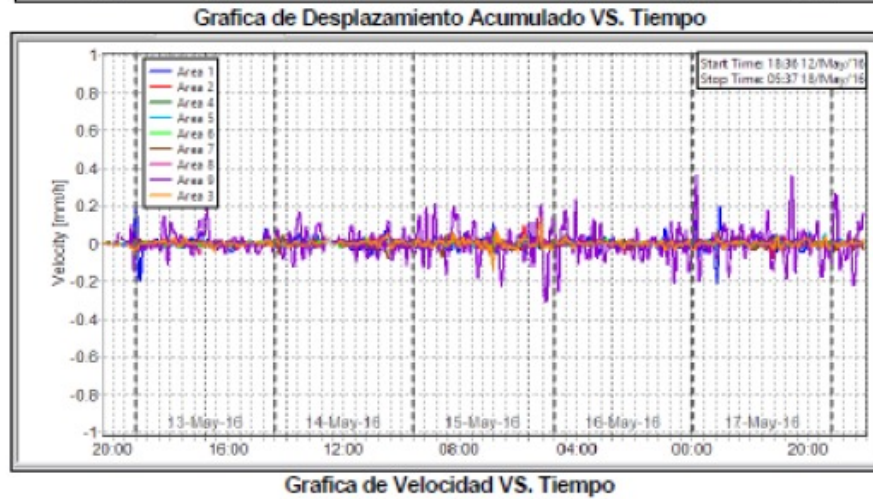
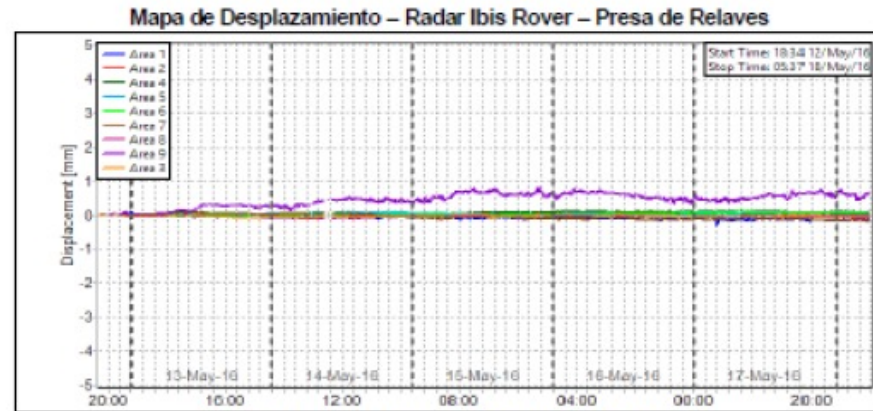


ión de las áreas de monitoreo Presa de Sedimentación



Grafica de Velocidad VS. Tiempo

Monitoring tailing dam with IBIS Rover and TM50 in Peru



Ubicación de las áreas de monitoreo Presa de Relaves



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