

APPLICATION FOCUS

Mine Monitoring



Mine Monitoring



Trusted Mine Monitoring

Since 1992, Geosense has been a trusted provider of advanced instrumentation and monitoring solutions that support geotechnical mine management systems.

Our technology enhances the safety, efficiency, and long-term success of mining operations across the globe—from **Mexico to Malaysia, Chile to South Africa, Australia, and throughout Europe.**

Mining operations carry inherent geotechnical risks. It is the responsibility of the principal employer and mine manager to ensure these risks are thoroughly addressed during the design, operation, and eventual closure of mines.

Geosense's customers, who install and monitor our sensors, play a critical role in meeting these responsibilities.

Our systems help installers and engineers increase mine safety through the deployment of

core geotechnical sensors, seamlessly connected to data loggers and wireless nodes.

These networks enable data transmission to central systems, forming the backbone of the developing '**Smart Mine's**—where key assets are digitised and continuously monitored.

With Geosense, mining professionals gain confidence in the stability of the ground around them. Our technology empowers fast, informed decision-making and supports the development of proactive, resilient mine safety strategies.

Instrumentation and monitoring play a vital role in all types of mining to:

- Ensure safety
- Control operations
- Verify the design
- Measure natural events
- Ensure compliance
- Control and reduce cost
- Increase knowledge for future operations

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EXPERIENCE IN TYPES OF MINES

Tailings Dams

Tailings dams are fundamentally different from traditional water dams. Rather than containing just water, they impound a mix of saturated tailings solids and water—making their design and operation more complex and inherently higher risk. Each tailings dam is unique, shaped by the geology, soil conditions, and operational practices of its specific mine site.

Failures in tailings dams can stem from several factors, including **structural overload, unexpected behaviour of the tailings material used in construction, or ineffective drainage systems** that lead to rising pore water pressure and a loss of shear strength. Critically, many failures can be traced to inadequate or outdated monitoring systems.

Geosense provides a comprehensive range of geotechnical sensors specifically suited to tailings dam applications. These include instruments to monitor **pore pressure, movement, deformation**, and other key indicators of dam integrity.

Combined with our **wireless data nodes** and real-time monitoring capabilities, our systems enable early detection of potential issues—allowing for faster, more informed responses to emerging risks.



Open-pit Mines

Open-pit mining operations face significant geotechnical challenges, with slope stability being a critical safety concern. The risk of ground failure increases with pit depth, exposing personnel and equipment to hazards such as rockfalls, slope collapses, and debris flow.

External factors—including heavy rainfall, groundwater infiltration, and high winds—can rapidly compromise pit walls and reduce visibility, further increasing operational risk.

Effective monitoring of **slope stability, ground movement, and groundwater conditions** is essential for maintaining safe working environments and ensuring the continuity of operations.

Real-time data allows mine operators to detect early signs of instability, respond quickly to changing conditions, and implement proactive measures to prevent incidents.

Geosense offers a wide range of robust instrumentation designed specifically for the challenges of open-pit mining. Our sensors, combined with wireless data transmission systems, provide continuous monitoring of critical geotechnical parameters—helping operators manage risk, improve decision-making, and keep personnel safe.



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Underground Mines

Underground mining presents unique and complex geotechnical challenges, where ground movement is one of the most critical threats to both safety and operational continuity. Risks such as rock falls, tunnel collapses, and structural instability can arise without warning—often intensified by stress redistribution and mining-induced ground deformation.

Maintaining the stability of underground openings and ground support systems requires constant awareness of how the rock mass is responding to excavation activities. This is especially important in large cavern mines, where unusual geometries and elevated stress conditions demand precise and continuous monitoring.

Geosense provides a suite of high-performance instruments tailored for underground mining environments, including:

- **Extensometers** for tracking deformation and convergence in rock strata
- **Inclinometers** to detect and measure lateral ground movement
- **Piezometers** to monitor groundwater pressure and potential seepage risks
- **Wireless monitoring systems** engineered to operate reliably below ground, delivering real-time data without the need for extensive cabling

Together, these tools enable mine operators and engineers to anticipate potential failures, evaluate support performance, and ensure a safer working environment deep below the surface.

TYPICAL MONITORING PARAMETERS

Stability of excavated slopes - settlement or lateral movement
Load in supporting anchors
Groundwater levels
Tunnel convergence
Tunnel lining behaviour

Geosense Mining projects

Below are some of the many hundreds of mining projects our sensors have been used on. Some have dedicated case studies which you can click through to find out more information.

GEONSENSE MINING PROJECTS

Boulby Mine Shaft Re-lining, UK
Vale Teluk Rubiah, Malaysia
Krumovgrad Gold Mine, Bulgaria
Tara Zinc Mine, Ireland
El Soldado - Chile
Woodsmith Mine - UK
Letseng Diamond Mine - South Africa
La Hacienda Mine - Mexico
Malmberget - Sweden
Zhaimere Mine, Kazakhstan
Mega Sabeka Storage, South Africa
MBCC Jabal Sayid - Saudi Arabia
LKAB Malmberget - Sweden
FQML Cobre Las Cruces - Spain



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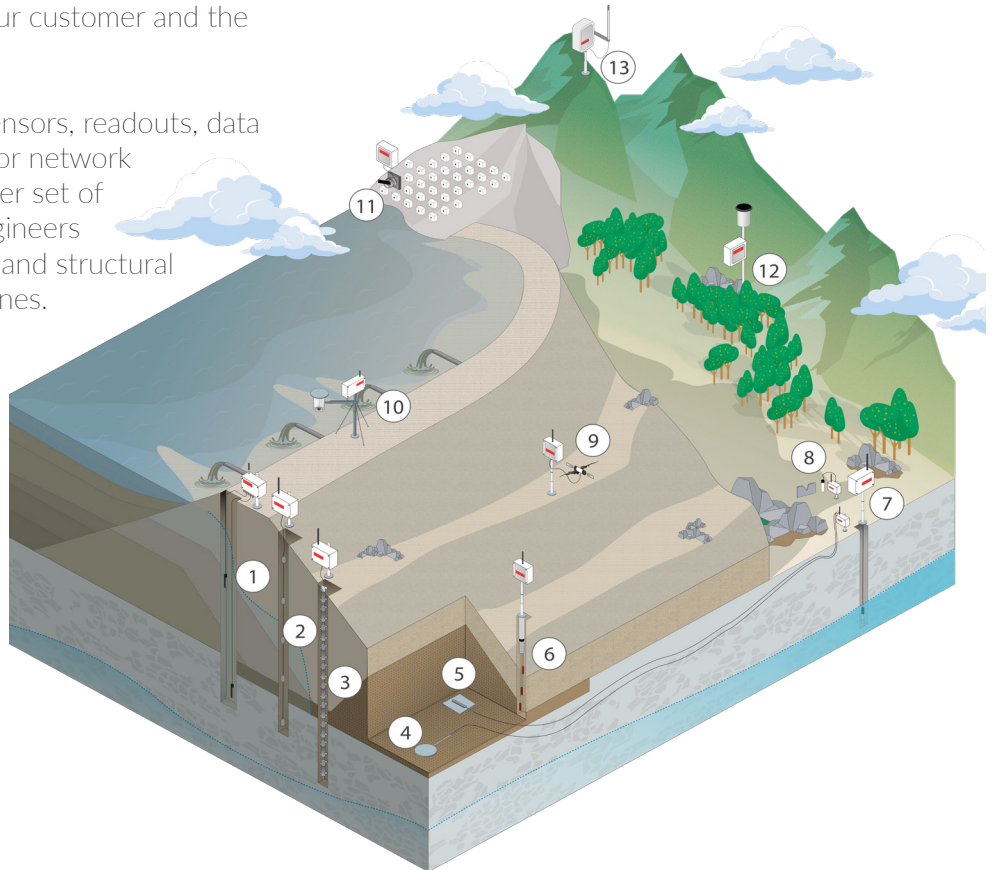


Partnering for comprehensive solutions

We believe in cooperation and working with partners to get the data our customer and the mine operator need.

Our Geosense range of sensors, readouts, data loggers, and wireless sensor network solutions are part of a larger set of tools for Geotechnical Engineers in setting up geotechnical and structural monitoring systems for mines.

As a dedicated manufacturer, we respect the workflows of our clients or their partners when installing sensors and managing the wider monitoring systems in projects.



	LOCATION	MONITORING PARAMETER	INSTRUMENT	WIRELESS UNITS
①	Embankment/Foundation	Pore Water Pressure, Phreatic Surface	VW Piezometer	VW 5-Channel
②	Embankment	Temperature	VW Thermistor String	VW 5-Channel
③	Embankment	Horizontal Displacement	In-Place Inclinometer	Digital
④	Foundation Interface	Earth Pressure	Total Pressure Cell	VW 1-Channel
⑤	Foundation Interface	Settlement	VW Liquid Settlement Cell	VW 1-Channel
⑥	Embankment	Vertical Deformation	Multi-Point Borehole Extensometer	VW 5-Channel
⑦	Sub-Surface	Water Quality	Water Quality Probe	Digital
⑧	Embankment/Foundation	Seepage	Weir Monitor V-Notch Weir	VW 1-Channel
⑨	Embankment	Surface Displacement	VW Crack Gauge	VW 5-Channel
⑩	Reservoir Level	Water Level	VW Piezometer (Vented)	VW 1-Channel
⑪	Abutments	Load In Anchorage	VW/Strain Gauge Load Cell	VW 5-Channel, Piconode
⑫	Environment	Rainfall	Rain Gauge	Piconode
⑬	Central Data Acquisition	All	All Sensors	Gateway

Tailings dam infographic by Worldsensing

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Case Study

PROJECT: BOLIDEN AITIK TAILINGS STORAGE FACILITY, SWEDEN

**CLIENT: BOLIDEN MINERALS AB
CONSULTANT: KLOHN CRIPPEN BERGER (KCB)**

I&M SPECIALIST: RUSPECO

OVERVIEW

Aitik Tailings Storage Facility (TSF) is located about 15km southeast of Gällivare, Sweden.

Mining began in 1968, and Aitik has grown into one of Europe's largest copper mines, with a permitted capacity of 45 million tonnes per year. It operates as an open-pit mine, where ore is processed on-site into a mineral concentrate.

This is transported by rail to the Rönnskär smelters, while waste rock and tailings are deposited locally.



Boliden has committed to the **Global Industry Standard on Tailings Management (GISTM)**, a global benchmark for safe, responsible tailings management, aiming for zero harm and launched a remediation program at the mine.

Between 2020 and 2024, over 45 million tonnes of rockfill were placed to buttress key embankments. The works included the installation of



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shear keys and toe berms to enhance long-term dam stability.

Crucially, Boliden also transitioned the dam construction method from Upstream to Downstream configuration— improving safety without interrupting ongoing operations.

MONITORING

The Aitik Tailings Storage Facility (TSF) is divided into multiple embankments, including dams A–B, C–D, E–F, G–H, and I–J. HS, VR and V2.

A monitoring program supports ongoing risk mitigation across the site. Key monitoring objectives include:

- **Tracking pore pressure in dams and foundations**
- **Detecting seepage and internal erosion**
- **Measuring embankment deformation and lateral movement**

Three different types of Geosense Piezometer were used to monitor pore water pressures in critical zones in the Tailings Dam and Foundations.

They were part of the **Trigger Action Response Plan (TARP)** for a near-real-time response for the higher-risk areas like dam E–F, where pore pressure increases may indicate instability.

Standard VW-3000 & 3400 Drive-in version Piezometers were used plus Piezometers to automate legacy sensors.

For the embankment areas, Geosense In-place Inclinerometers (IPI) were installed in Quick-joint casing to measure any lateral displacement in the ground. An additional Geosense Portable Inclinerometer system is also in use for spot measurements on some parts of the mine site.

The instrumentation is all compatible and connected to a series of Worldsensing gateways and loggers, enabling automated data collection and reducing the need for cabling across the vast site.

Visualization and analysis are performed in real-time using Bentley VDV software, ensuring continued GISTM compliance.

PRODUCTS USED

- VW3000 [Piezometers](#)
- VW3400 [Drive in Piezometers](#)
- Quick Joint [Inclinometer casing](#)
- In-place [inclinometer \(IPI\)](#)
- Portable [inclinometer](#)
- Worldsensing [Gateways](#)
- Worldsensing [Dataloggers](#)
- Bentley Visualisation Software

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“Geosense are a top partner for helping us deliver comprehensive solutions for mining monitoring, with excellent in-house service backing up high quality products, delivering the data our customers need.”

José Ramón García-Pelayo,
Founder & Business
Development Director, Ruspeco

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Typical Instruments



VW Piezometer

Piezometers measure pressure to monitor pore water pressure, the phreatic water level. They can be used within a tailings dam embankment and reservoir water level. Pore water pressure monitoring is used to assess the stability of the embankment and high pore pressures can be a precursor to slope instability. Geosense have corrosion resistant Piezometer especially for use with tailings.



Thermistor String

This consists of a cylinder of high strength steel with 3 to 5 vibrating wire strain sensors mounted parallel to the longitudinal axis and arranged equidistant around the circumference to measure compression of the cylinder under load. They are manufactured with a centre hole to accommodate anchors, rock bolts and tendons.



In-Place Inclinerometer

In-Place Inclinerometers (IPI) measure inclination. When placed within a tailings dam embankment they monitor horizontal displacements which if excessive can lead to instability and failure.



In-Place Inclinerometer-Extensometer

The IPI-X is an Automatic Magnetic Extensometer combined with an In-Place Inclinerometer which can be used typically to measure vertical and horizontal displacement in embankments, dam foundations, deep foundations and around tunnels and diaphragm walls.



In-Place Extensometer

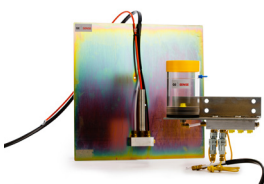
The In-Place Extensometer (IPX) offers automated monitoring of standard magnetic extensometer installations. The system is designed for a simple, adaptable installation with a single cable connection at the top of the borehole.



Total Pressure Cell

Vibrating wire Total Earth Pressure Cells are used to measure stress acting on a plane surface.

When installed at the foundation interface and combined with a piezometer the effective stress of the soil can be calculated and thus it's stability.



VW Liquid Settlement Cell

Vibrating wire Liquid Settlement System measures displacement vertical displacement.

When installed at the interface settlement or heave of the dam foundation can be monitored.

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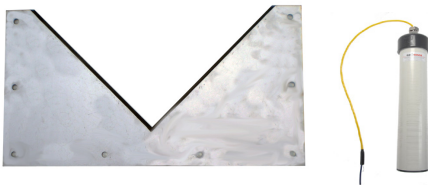
Typical Instruments



Multi-point Borehole Extensometer

Vibrating wire Multi-point Borehole Rod Extensometers measure vertical displacement.

They are used to measure vertical deformations at various depths within a tailings dam body which allows for settlement predictions and monitoring during and post construction.



Weir Monitor & V-Notch Weir

The V-notch & vibrating wire Weir Monitor are used to measure flow. Seepage flow is a critical component of monitoring as increases in flow indicate that either the phreatic surface has become too high or that internal erosion and potential piping is occurring which could lead to failure.



VW Crack Gauge

Vibrating Wire Crack Meters measure displacement. When installed on embankment berms they can detect surface movements which could be the pre-cursor of internal erosion and possible piping.



Anchor Load Cell

Vibrating Wire and Strain Gauge Anchor Load Cells measure load on ground anchors.

Where abutments need to be stabilised ground anchors can be used which should be monitored to confirm their integrity and any change in load due to ground failure.



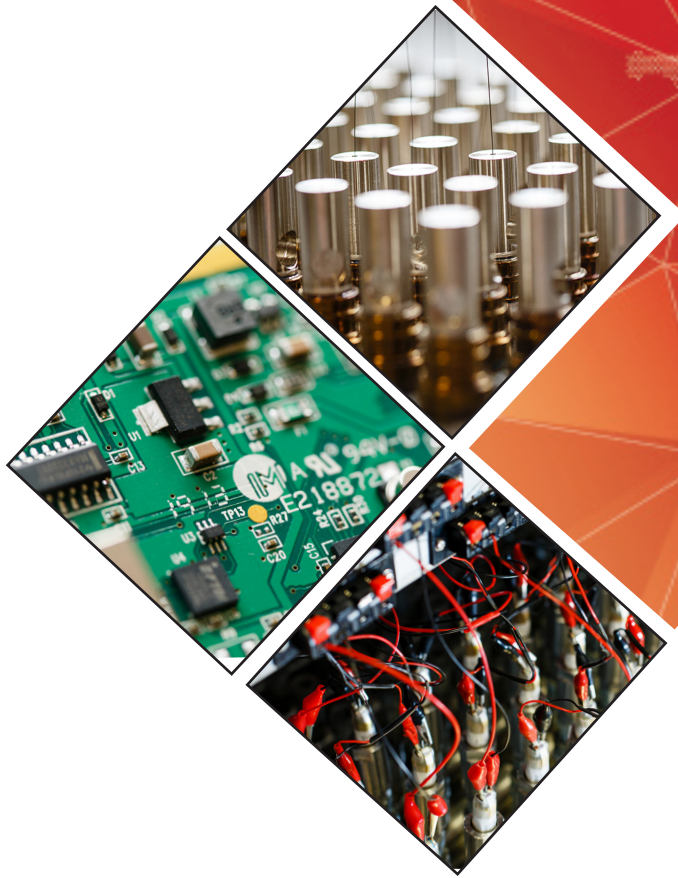
Weather Station

A weather station can be configured to meet your exact needs, from simple wind measurements to stations that monitor not only meteorological sensors but also other parameters such as soil moisture content, water levels or air quality.



Gateway & Nodes

The Gateway is the central hub for gathering the raw data from all sensors via the wireless Nodes from where it is transferred via the Internet to various third party data visualisation software including sensemetrics and Geo-Axiom.



HEAD OFFICE

Nova House
Rougham Industrial Estate
Rougham, Bury St Edmunds
Suffolk IP30 9ND
England

+44 (0)1359 270457
sales@geosense.com
support@geosense.com

NORTH AMERICA OFFICE

15 West 38th Street
Suite 632
New York
NY 10018

+1 518-920-3483
sales@geosense.com
support@geosense.com

www.geosense.com