Proactively manage ground stability risks in challenging geotechnical environments.

Elexon Mining has developed Geo4Sight; a wireless subsurface monitoring system for challenging geotechnical environments where the use of cabled monitoring systems is impossible, impractical or unreliable. Geo4Sight is initially offered as two distinct solutions:

**Geo4Sight Tilt: Real-time, wireless subsurface movement monitoring.**

Detect and manage ground movement to reduce the likelihood of failure, or reduce the impact of a failure, in challenging environments where traditional cable-based systems don't perform.

**Geo4Sight Pressure: Real-time, wireless pore pressure monitoring.**

Gives you greater insight into hydrological conditions in challenging environments where regular cabled systems fail or have serious limitations.

Elexon’s systems provide invaluable data that empowers mining companies to make well-founded decisions to improve safety, efficiency and resource conversion.

**Geotechnical Engineers - the unsung heroes**

Geotechnical engineers are challenged daily managing the geotechnical risks in mining. Aside from the uncertainties presented by nature, mining projects are constantly pushing into new territories. Bigger, deeper, more complex geotechnical conditions combined with growing production expectations and time constraints. Fitting in with production in a timely manner and enabling safe operation is critical. A small improvement may reap significant benefits; a few weeks of extra production or a few degrees steeper slopes, but may also have serious consequences.
Manage geotechnical risks

Typical geotechnical risks include:

- slope failures;
- waste dump failures;
- tailings dam failures;
- rock fall;
- drive collapses; and
- pillar instability.

These events can cause serious harm or fatalities as well as deliver significant economic damage.

Effective geotechnical risk management requires the right information at the right time. Predicting and understanding how the ground reacts to changes induced by mining is critical to making the right call for maintaining safe and efficient operations.

Early detection of potential failures allows mine operators to take corrective or preventative action and reduce the likelihood or reduce the impact of failures.

In-ground geotechnical monitoring

In the arsenal of the geotechnical engineer, in-ground monitoring is a critical tool for effectively managing geotechnical risks.

In-ground monitoring instruments can potentially detect critical changes in the ground, where most failures begin, long before surface monitoring methods indicate there is a problem.

The environment for in-ground monitoring is rough and rugged, especially for systems that rely on cables for power and data transmission.

Moving ground damages cables, rendering expensive installations useless and ineffective. Mine operators cannot risk a situation where the information that geotechnical engineers rely upon is not available when it is most needed - when a failure needs to be avoided or mitigated.

Redrilling and installing new monitoring systems after installed equipment has been damaged may be costly or even impossible because access to the area of interest may be impossible.

Elexon Mining’s solution

Elexon Mining has developed the Geo4Sight platform; a wireless system for subsurface monitoring in challenging geotechnical environments where the use of cabled monitoring systems is impossible, or where cables are at high risk of being damaged by moving ground.

Geo4Sight uses a wireless mesh network consisting of rugged battery-powered Nodes to communicate sensor data from deep in the ground to surface. Geo4Sight Nodes are installed into drill holes at regular intervals to enable data communication along the chain of Geo4Sight nodes. The Geo4Sight platform was conceived to integrate a range of sensors. Tilt and pore pressure sensing are the first solutions that are available.
Wireless in-ground movement monitoring

Identifying when, where and how the ground moves is critical to identifying failures at an early stage or even before the material yields and loses its strength. The earlier ground movement is detected, the better the chance of reducing the likelihood of a failure occurring or limiting its impact.

Geo4Sight Tilt nodes measure their tilt in space, including its magnetic orientation. Similar to inclinometer systems, taking measurements along the hole at regular intervals enables identification of movement in the ground around the hole.

Geo4Sight Tilt provides the following advantages over traditional systems:

- Work in three axes and include magnetic orientation of tilt;
- The currently achieved tilt sensor’s sensitivity equates to a movement of 0.3mm over 1 meter or a change in angle of 0.02 degrees;
- Can be queried at real-time;
- Remote operation without human interaction;
- Can be installed in long holes (100s of metres);
- Can be installed at any angle, up-, down- or horizontal holes;
- Even after ground moving up to several metres, the system still operates;
- Monitoring can continue after cut-backs without the need for drilling and installing further instruments.
Wireless Pore Pressure Monitoring

Pore pressure has a significant impact on stability of slopes in rock and soil. Moreover, in the case of large open pits, it is usually the only property that be easily varied (after Geoff Beale et al, 2013).

In the case of tailings dams, changes in pore pressure can contribute to failures with critical consequences. Given the impact of changes in pore pressure on ground stability, monitoring pore pressure is an important aspect of managing associated risks for the mine.

The complexity of installing multiple cable-based pore pressure sensors in a single hole limits the number of sensors. Cable based instruments may be rendered inoperable by ground movement. Geo4Sight Pressure reduces the complexity of installing many sensors in a single hole. Geo4Sight Pressure Nodes also measure tilt and can be combined with Geo4Sight Tilt nodes in the same hole combining inclinometer and pore pressure monitoring in a single wireless system.

The pressure sensor’s accuracies are as follows:

- $< 30$ bar the pressure sensing accuracy is 0.125% of full scale for ranges up to 30 bar and can stand an overpressure of at least 300%.
- $> 30$ bar the accuracy is 0.2% of full scale and can stand an overpressure of at least 200%.