

GeoDrilling International



Extreme drilling conditions

Whether it be extreme weather conditions or limited access, drillers can always be relied upon to rise to the challenge

Mining projects

Examining the role of drilling within the mining sector and how it continues to develop and evolve

Mineral exploration

In the search for new deposits of critical minerals, exploration drilling continues to play a key role in the process





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The future's bright, the future's electric

As I write this, I'm also preparing to attend bauma 2025, the world's largest construction industry trade show. The event, which will take place in Munich, Germany, in April, will feature 3500 exhibitors and doubtless feature many new innovations that will shape the industry for years.

How can I be so sure of these new developments? I can hear you ask. Well, it's pretty simple. In the run-up to the main show, bauma organises its 'Media Dialogue Days'. This two-day event brings together key exhibitors and industry journalists to discuss what will be displayed in April.

Many of the exhibitors I spoke to over the two days were reluctant to give too many details about the new technology and innovations they are bringing to bauma, as they want to make as significant an impact as possible with their latest product launch debuts; they were willing to divulge some information.

So, what did I learn? Well, the theme of electrification continues to gather at a pace, and I expect to see both a growing number of mains grid supply and battery options unveiled at bauma.

Other alternative power sources are also gaining traction, and I believe numerous hydrogen-powered pieces of the heavy plant will make their public debut.

The final ongoing trend is that of automation, which brings with it increased efficiency and safer sites, too, as staff are removed from the potential of heavy machinery.

However, just how groundbreaking any of these rumoured developments will be is yet to be seen...



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"The theme of electrification continues to gather at a pace"

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Drivetrains
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Germany
Bauma 2025 preview

COVER

LEURODRILL sets a new standard with C-Motors

In the Nordhavn project in Copenhagen, EURODRILL's new C-Motor C61 demonstrated up to 20% fuel savings and reduced CO₂ emissions. With an optimised design and lower costs, the C61 is pioneering for sustainable construction projects. EURODRILL's new C61 motor, an evolution of the EA61V, impresses with higher efficiency, a broader torque and speed range, and reliability.
<https://eurodrill.de/en/>

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Junttan launches Evolution series with DR5 rig

Junttan's new Evolution series of rigs represents the most significant investment in the company's history. It also introduces entirely new technology and design, which it states is set to redefine the piling industry.

The first new rig in the series, the Junttan DR5 drilling rig, represents class-leading single-pass drilling performance with technology designed for FDP and CFA applications.

"The Evolution series has been designed with a strong focus on customer needs, ensuring that its advanced technology and innovative features directly address the challenges our clients face," Tommi Lehtonen, Group CEO at Junttan, said.

"Our investment in the Evolution series is a testament to Junttan's commitment to pushing the boundaries of what's possible in the piling industry. The new DR5 represents



A wide range of options allows the Junttan DR5 to be customised to meet diverse customer requirements

a drilling rig that is more efficient, simpler to use, and easier to transport," Tomi Voutilainen, director of Engineering and Product Management at Junttan, said.

New mine water heat 'Living Laboratory' launched

The Mining Remediation Authority, formerly known as the Coal Authority, has announced the launch of the innovative Gateshead mine water heat 'Living Laboratory', a pioneering research initiative designed to expand the potential of mine water heat technology and advance the UK's journey towards net zero.

The Living Laboratory project marks a significant milestone in sustainable heat research, offering the only location in the world where thermal and hydrogeological behaviour can be studied between operational mine water heat schemes.

Located in the northeast of England, the Living Laboratory is situated in the vicinity of three mine water heat schemes. This includes Gateshead Energy Company's Mine Water Heat Network, the largest of its kind in Great Britain and one of the largest in Europe, and another privately funded pioneering scheme nearby at Lanchester Wines warehouses. This setup serves as a unique research environment to allow the study of thermal and hydrogeological behaviour between multiple mine water heat schemes within the Walker mining block in Tyne and Wear.

Supported by Gateshead Council, who allowed work to take place on their sites, the project involved drilling four boreholes and installing state-of-the-art monitoring equipment to gather crucial data.

The data generated will complement the research work underway at the mine water energy observatory developed in Glasgow by the British Geological Survey (BGS). This is part of the UK Geoenergy Observatories project, which comprises two at-scale facilities for research and innovation into shallow geothermal and underground thermal energy storage.

GSI expands capabilities with cased drilling services

GeoStabilization International (GSI), a leading North American geohazard mitigation team, has expanded its services to include a new fleet of cased drilling equipment. With this expanded fleet and its team of dedicated in-house engineers, the company states it is furthering its commitment to providing value-added geotechnical solutions for earth retention, foundations, and ground improvement.

"At GeoStabilization International, we constantly aim to be leading players in the industries we serve.

That means extensive market research, listening to the needs of our customers, and leveraging our in-house engineering capabilities and established industry relationships to advance new solutions," Rouse Slape, market development manager, GeoStabilization International, said.

"Expanding our fleet of equipment and services in cased drilling allows us to provide more of the cost-effective designs our engineers are known for, to more customers. The larger fleet increases our ability to meet our

customers' needs for cased micropiles, tiebacks and compaction grouting."

Cased drilling is a technique that involves installing cased micropiles as the hole is drilled, section by section. The method of drilling aids in stabilising unstable foundations and mitigates hazards that can occur when drilling in soft, shallow sections. Cased drilling is also used when ground conditions make drilling difficult, such as through fractured rock or loose formations.

Vermeer's AutoTension enhances efficiency on intersect bores

Vermeer is enhancing the capabilities of the D220x500 S3 and D550 horizontal directional drills (HDDs) with the optional AutoTension feature that simplifies the connection of two drill rigs working on intersect bores.

After completing a pilot bore, a drill outfitted with AutoTension allows HDDs on both sides of the bore to work together to increase the efficiency of reamer passes and the process of adding or removing drill rods to the tail string. When activated, AutoTension maintains a steady tension force on the drill string, helping to streamline large diameter and long-distance bores.

"The HDD industry is witnessing a growing trend of employing a drill rig on each side of a large diameter or long bore," explained Marv Klein, application specialist for Vermeer. "With Vermeer AutoTension on the D220x500 S3 and D550, crews on the entry and exit side of the bore can work together while reaming and swabbing a borehole. This leads to more efficient and accurate

reamer passes without the need for a mechanical locking swivel or breakout tongs for rod handling. Also, AutoTension helps optimise fluid management on the job because the need to transport fluids using vacs or pumps from one side to the other is reduced because crews can pull ream and pump fluids from either side."

The AutoTension feature, engaged from the control station, maintains a desired tension on the tail string throughout the drilling process. It allows for temporary disengagement when necessary, such as during rod additions or removals, without halting operations. This flexibility extends to directional changes, enabling the driving machine to switch between pushing and pulling without requiring action from the operator in the other drill.

The AutoTension feature also includes a lack of operator presence safety system. When the AutoTension operator leaves the seat, certain controls are locked out and an audible alert sounds at the AutoTension machine.



A drill outfitted with AutoTension allows HDDs on both sides of the bore to work together

This innovative feature offers several key benefits to HDD crews. It optimises reamer penetration through consistent tension application and improves positioning and control of the reamer within the borehole. Moreover, AutoTension helps maintain the intended bore path and reduces potential complications during the drilling process.

Contractors can match different Vermeer HDDs with the D220x500 S3 or D550 using AutoTension. Also, contractors who already own a D220x500 S3 or D550 can add this feature to their units.

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Van Oord starts Baltic Power wind farm project

Van Oord's heavy lift installation vessel Svanen has installed the first monopile at the Baltic Power offshore wind farm, located 23km north of the Polish coast.

The Baltic Power wind farm features a new generation of wind turbines with a generating capacity of 15MW. After a recent upgrade, including an extension of its gantry crane by 25m, the Svanen is ready to install the foundations for this new generation of wind turbines.

Baltic Power is Van Oord's first offshore wind project in Poland. Developers ORLEN and Northland Power contracted Van Oord for the transport and installation of 78 foundations, consisting of a monopile fitted with a transition piece. With a production

capacity of up to 1.2GW, the Baltic Power offshore wind farm is expected to ultimately supply renewable energy to more than 1.5 million households in Poland. The wind farm is expected to be completed in 2026.

The Svanen has recently undergone a major upgrade. Among other improvements, the gantry crane was extended by 25m, making it one of the largest heavy lift installation vessels worldwide.

As wind farm technology evolves to meet the growing global demand for renewable energy, turbines and their foundations are becoming increasingly larger. Thanks to this upgrade, Van Oord is well-equipped to handle this increase in scale.



Van Oord's recently upgraded heavy lift installation vessel Svanen at work at the Baltic Power offshore wind farm

Rig mobilised for Vulcan's Phase One lithium project

Vulcan Energy has started work on its integrated Phase One renewable energy and lithium project, with the mobilisation by its in-house geothermal well execution company, Vercana, of its V20 drilling rig to the Phase One Schleidberg well site near Landau, Germany.

The company's Phase One Lionheart Project targets the production of around 24,000tpa lithium hydroxide monohydrate for electric vehicle batteries, as well as renewable heating and power production, from hot, lithium-rich brines in the Upper Rhine Valley Brine Field. Increasing brine production from deep wells to augment Vulcan's existing brine production is a key part of Phase One.

The V20 is a 2500hp drill rig with 550t of hook load capacity, and is equipped with 7500psi fluid pressure system. Following assembly, routine commissioning procedures and technical testing will be carried out for the safe operation of V20 and associated equipment. Vercana's other electric

drilling rig, V10, will be mobilised to Vulcan's newly planned Trappelberg well site after Vulcan's Phase One financing closes.

Managing director and CEO, Cris Moreno, said: "The mobilisation of the V20 drilling rig is not only an important milestone for our Phase One Lionheart Project, but in Vulcan's mission to establish a sustainable, European-based lithium supply chain.

"With two fully refurbished, state-of-the-art rigs and a hugely experienced team, Vercana is well positioned to safely deliver new geothermal and lithium production and injection wells for many years to come in Central Europe, delivering both baseload renewable heating and lithium production for electric vehicle batteries.

"As lithium demand continues to grow, reducing Europe's dependence on imported raw materials is critical. By developing a fully integrated, sustainable lithium supply chain, Vulcan will be a key contributor to Europe's energy and mobility transition."

Daldrup & Söhne's €3M of contracts

Daldrup & Söhne has been awarded a general contractor order by the Geological Service NRW, based in Krefeld.

A research well is to be sunk in Krefeld-Girmesgath to a maximum depth of around 1000m. The aim is to investigate the geothermal potential of Carboniferous limestones.

The contract is part of the 'Geothermal Energy Master Plan' enacted by the state of North Rhine-Westphalia last year.

Additionally, Daldrup & Söhne is drilling an exploratory well (GeoLab-1) in the municipality of Grasellenbach, Hesse, for a consortium of research institutions

led by the Karlsruhe Institute of Technology (KIT).

According to the client, the results of this exploratory drilling will provide evidence of the area's suitability for the construction and operation of an underground laboratory.

The scheduled order value for both projects is around €3.0 million in total.

FPS calls for action on BSR delays

The Federation of Piling Specialists (FPS) is calling on the UK's government to address delays caused by the BSR approval process on project commencement

Delays caused by the Building Safety Regulator (BSR) approval process on project commencement, which extend far beyond the anticipated 12-week timeline, are placing severe strain on the geotechnical and wider construction sectors, particularly affecting high-rise, commercial, and residential developments.

Since the introduction of the new regulatory framework in April 2024, only a limited number of projects have received approval, leaving FPS members frustrated by prolonged delays in design finalisation and a lack of incoming work. The situation is particularly acute in London and other urban areas, where projects over seven storeys are stalled, creating a ripple effect across the geotechnical, demolition, and construction supply chains.

While the FPS fully supports the principles of the Building Safety Act and the role of the BSR in ensuring improved safety and accountability, the current approval process is proving unsustainable. Many FPS members are now being forced to consider reducing staff numbers and scaling back investment – actions that threaten to erode core teams and

exacerbate existing skills shortages once projects eventually gain approval.

FPS chair, Malcolm O'Sullivan, said: "While we recognise the importance of the BSR's role in improving building safety, the reality is that approval times of six months or more are simply not viable. These delays are undermining investment, recruitment, and the wider stability of the sector.

"More critically, they are jeopardising the government's ability to deliver its target of 1.5 million new homes over the next five years. Without urgent reform, these ambitions will remain out of reach."

FPS CALL TO ACTION

The FPS urges the government and the BSR to address these critical issues by:

- Providing clear, consistent guidance to ensure a streamlined approval process.
- Allocating sufficient resources to accelerate approvals and avoid unnecessary bottlenecks.
- Engaging more closely with industry stakeholders to develop practical solutions. ▼

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The right rig for challenging drill rig work

When it is necessary to employ a crane to lift a drill rig into a tunnelling pit, the rig in question must be something special to meet the challenging demands of such an extreme environment. The multifunctional capabilities of the 7822DT rig from Geoprobe make it the ideal choice for such difficult situations

“There’s only one right rig for the job, and that’s our 7822DT”

With a “safety-first” attitude, Allstar Drilling & Probing accepts challenging drill rig work many might turn down. “We focus on being safe first and then using our skills to make production,” Joe Neri, president, said. “We’ve completed more than 2000 Exxon projects safely, and we’re working for them on a daily basis since 2009.”

But being safe does not necessarily mean playing it safe when it comes to calls for unique drill rig work. “We would rather have a challenging job,” Neri said. “We do cool things most people would shy away from.”

So, when he got the call to lower a rig into a 75ft round, 45ft deep pit, he did not hesitate in accepting the job. “I received the call, did a site visit, and within 48 hours had secured the contract.

“I saw the urgency of the situation, and as an owner,

third-generation well driller, and operator of heavy equipment, I’m more involved in determining projects accepted,” Neri said.

INTO THE PIT

“Having to be lowered into a pit by a 100ft crane, the 7822DT from Geoprobe seemed like the right rig to achieve all the different kinds of sampling. I could do mud rotary and direct push, whereas a full-size rig wouldn’t give me all those methods.”

The Two Rivers Water Reclamation Project in Monmouth Beach, New Jersey, valued at more than \$100 million, scoped to dig a 100ft hole down 40ft, had halted until the construction crew could learn more about the soil conditions. The contractors had hit soils that were not clay as expected, and there were concerns about sand seams.

“I loaded up the 7822DT for mud rotary, solid stem auger,

geotechnical samples, and dual tube samples to pull soil cores,” Neri said. “I wasn’t sure what I would come up against while down in the pit, so I came prepared. I used it all to collect split spoon samples and macro core samples to get soil descriptions. I got them blow counts to calculate N-value for lithology.”

While in the pit, the drill team used solid stem augers with split spoon sampling and the 3.25 dual tube system. The team drilled to 45-65ft below grade. The 7822DT rig provided them the versatility to run those different drilling methods, especially at a time when it was not possible to mobilise another rig.

MEETING THE CHALLENGE

“When we go to a site that’s challenging and show up with a rig that can do multiple methods in the same day, it’s cost-effective for the client,” Neri said. “A job that might need mud or augers or direct push, there’s only one right rig for the job, and that’s our 7822DT.”

The client’s project was at a standstill until the soil information could be gathered, so time was of the essence.

“It was a total of 72 hours from contract to completion. At the conclusion of the project, they invited me over into the trailer to acknowledge that they were thrilled with our ability to get them the soil information required to continue working,” Neri said. “I’ve been running Geoprobe since early 2000 and couldn’t be happier with the opportunities and capabilities it’s brought us.” ♥

Having its Geoprobe 7822DT rig lowered into a 75ft round, 45ft deep pit to undertake geotechnical drilling was just another job for Allstar Drilling & Probing



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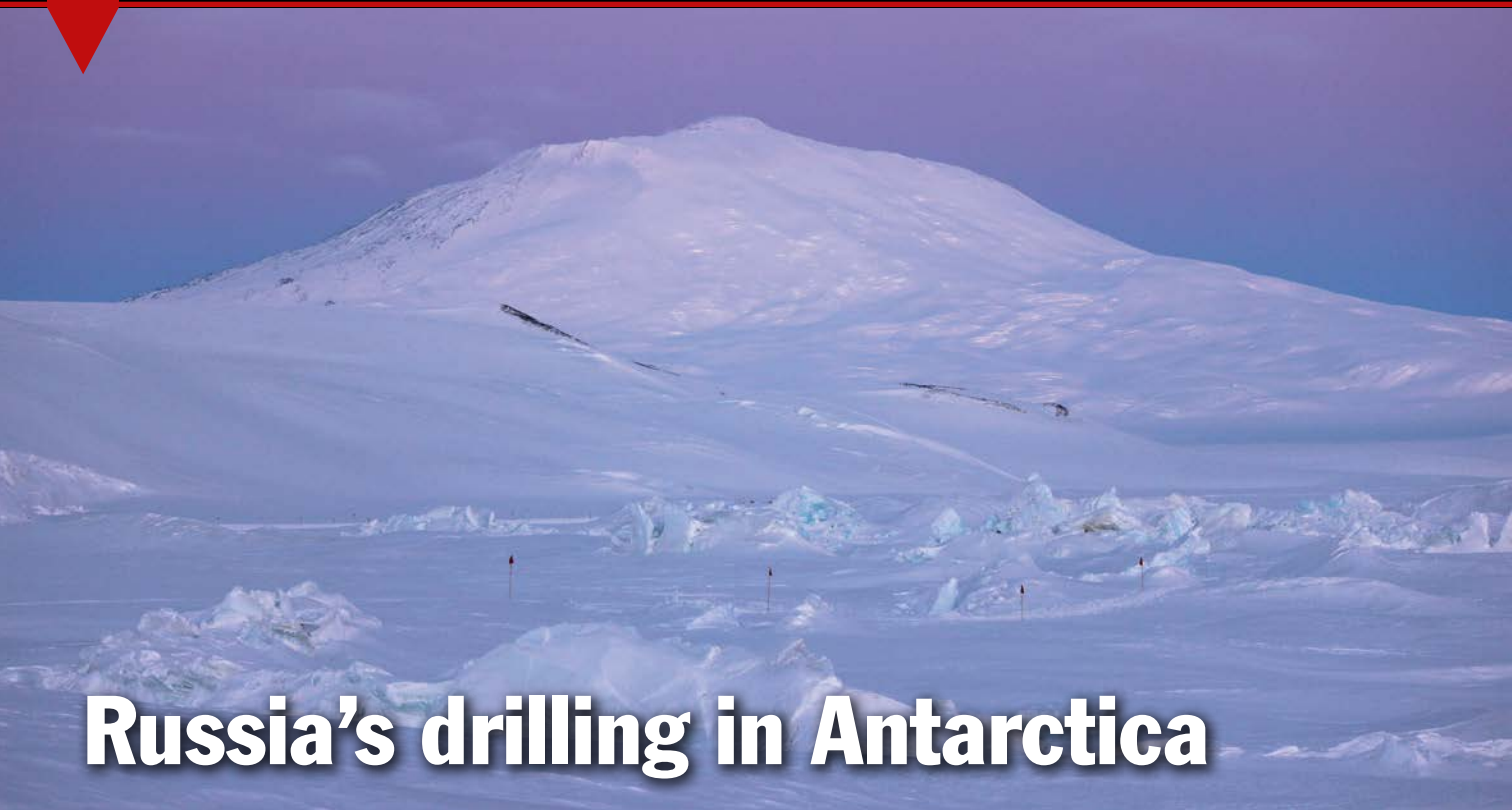
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Russia's drilling in Antarctica

Eugene Gerden reports on Russia's plans to accelerate its geotechnical drilling activities in the Antarctica region in years to come amid the ever-growing geopolitical importance of the region for most global powers

Above: Scientists at the Russian Arctic and Antarctic Research Institute plan to drill at least two new ultra-deep wells in Antarctica

Scientists at the Russian Arctic and Antarctic Research Institute (AANII), one of Russia's leading research institutions in the Antarctic region, plan to drill at least two new ultra-deep wells in Antarctica to conduct large-scale scientific research of the region in a view to understanding the causes of global warming and the reasons of the ongoing climate change in Antarctica.

One of the proposed wells will be drilled at Lake Vostok – the largest subglacial reservoir on the planet, which is hidden under a thickness of about 4km in the central part of Antarctica. The new well will be drilled to replace the old one, which was drilled in 1990 and is still being exploited. The new well's diameter is expected to be about 25cm. Unlike the previous one, it will not only reach the lake's surface but also allow scientists to study the water layer with the help of underwater devices. Scientists also plan to deliver the necessary equipment to the bottom of the reservoir to select and extract samples of sedimentary rocks to the surface.

ISOLATION

As Vladimir Lipenkov, a leading researcher and head of the laboratory of climate and environmental changes of the Russian Academy of Sciences (and one of the participants of the project) said, the Lake has been isolated from the outside world for millions of years, while its study is important for both Russian and global science, as it will allow to understand the reasons of global warming.

"It probably contains important information about the prehistoric past of the Earth, including sediment samples," Lipenkov explained. "If it is possible to obtain them, we will be able to learn more about the geology of Antarctica, about changes in its climate and glaciation over the past three to five million years. Also, an in-depth study of the reservoir will make it possible to identify microorganisms that are supposed to live in it and its surroundings."

Lipenkov also explained that to date, only one confirmed trace of a living creature has been found

in samples of the lake's water, which is frozen at the bottom of the glacier. This is a fragment of the DNA molecule of a thermophilic bacterium. However, such organisms live at temperatures of about 50C or more. Therefore, according to scientists, the microbe was introduced into the water environment from cracks in the earth's crust under the bottom of the lake, where there may be some hydrothermal activity based on the geothermal gradient.

EXTREME CONDITIONS

According to Lipenkov, the conditions for drilling on the site are considered extreme. These challenges include huge pressures, low temperatures, a lack of light, and long-term isolation (for millions of years) from the surface biosphere. In addition, according to him, a small amount of organic matter and an increased concentration of oxygen (of the order of 1g/l) in the reservoir is fatal to most terrestrial creatures.

Lipenkov continued: "Microorganisms that can adapt to such

conditions will be truly unique. In fact, in the lake, we will be able to observe extreme conditions in which life can still exist and evolve."

According to scientists, drilling an access well to Lake Vostok will require the introduction of several inventive preparatory solutions and steps. For this purpose, there are plans to develop a new large-diameter drilling system using new injection fluids. Also, there are plans to use a new generation of various measuring and sampling devices equipped with elements of robotics and AI algorithms.

In addition, scientists plan to focus on the design of technology for environmentally friendly "opening" of the lake and maintenance of the necessary amount of technical fluids and lake water in the well during the pulling and running operations, as well as drilling itself.

According to Alexander Rodin, the executive director of the National Centre for Environmental Monitoring and Ecology of the Moscow Institute of Physics and Technology, research into the Vostok has been going on since Soviet times, and it is important that after the crisis during the 1990s, Russia returned to Antarctica.

He also added that the planned wells, among other things, will allow autonomous unmanned underwater vehicles to be immersed in the lake, contributing to better project scientific results.

DRILLING ON DOME B

In the meantime, during the project's second stage, the scientists propose to drill a second well in the area of Dome B, which is the top of the glacier on one of the Antarctic ridges (ice divides). According to experts, the ice masses on the Dome itself are the most stable and have a horizontal flow speed close to zero.

According to scientists, the thickness of the glacier on Dome B is less than in the vicinity of the

East. Therefore, drilling wells at a depth of 2.6–2.8km will be sufficient here. During the mission, experts will pick up rock samples from the continent's surface. Such samples are of great value since the thick cover makes conventional direct geological study of Central Antarctica almost impossible.

According to scientists' calculations, in such natural formations, layers of sediments, which have accumulated over hundreds and thousands of millions of years, survive in good condition. The conduction of geotechnical drilling activities based on these sediments, according to them, will help to reconstruct changes in the gaseous composition of the Earth's atmosphere and unveil the history of the planet's climate.

Thanks to drilling and research at the Vostok station, scientists have constructed climatic series for the last 420,000 years. However, similar work on Dome B will allow them to study the period, which is three times longer.

Earlier, during drilling at the Vostok at a depth of about 3.5km, ice with an age of 1.2 million years had already been found. Thus, according to scientists, when drilling on Dome B, specialists can expect to obtain materials to reconstruct the history of the Earth's climate for 1.3–1.5 million years and determine the causes of the so-called Middle Pleistocene transition, during which approximately one million years ago, the Earth's climate system was radically changed.

INTERNATIONAL ACTIVITY

According to experts at the Russian *Izvestia* business paper, in addition to Russia, other countries are also planning to accelerate their drilling activities in the Antarctic region in years to come. According to their data, all ice divides in the region are divided between scientific projects implemented by several countries, with the Dome B project being assigned to Russia.

According to experts, the Dome B project could be considered the most promising for studying the paleoclimate and conducting other research, among other similar projects.

Still, other analysts believe Russian scientists may face several difficulties during the implementation of these projects.

UNIQUE TECHNOLOGIES

Professor Porozhsky at the Russian Ural State Mining University Konstantin, one of Russia's leading experts in the field of drilling, believes that while Russian scientists have unique technologies for ultra-deep drilling in extreme polar conditions, they will still have to overcome serious challenges during drilling at Dome B. These include the need to ensure thermal regimes in the bottom to avoid freezing water on the equipment and maintaining a pressure balance so that technical fluids and water do not mix. This, according to Porozhsky, is important and will help to avoid pollution of the lake. At the same time, according to scientists, the technologies tested in Antarctica can indeed be applied on other planets, as it will probably be easier to organise drilling there than to deliver the necessary tools off the earth for testing.

The project also involves the participation of scientists from Saint Petersburg Mining University, one of Russia's leading research institutions in the field of drilling, who will provide some of the latest technologies for drilling in the demanding conditions of Antarctica.

Scientists also believe the currently tested drilling solutions in Antarctica will be useful in the future when conducting research and the search for life on other planets with comparable conditions. For example, such technologies could be important for the conduction of any drilling activities under the polar caps of Mars or under a 30 km ice crust on Jupiter's satellite Europa. ▼

"We will be able to learn more about the geology of Antarctica"

When the going gets tough

Cone penetration testing (CPT) is a valuable tool in geotechnical engineering, offering real-time, continuous data on soil characteristics with minimal disturbance. However, the circumstances where it can be carried out can vary wildly, though that is no concern to Lankelma, which has developed a fleet of specialised CPT rigs to meet the demands of testing in extreme conditions

Lankelma, one of the world's leading cone penetration testing (CPT) companies, delivers ground investigations and engineering consultancy for construction projects around the world. It does so through the use of its extensive fleet of CPT equipment that can be mobilised anywhere in the world at short notice. The business tailors its services to suit different ground conditions and environments, including on the railway, restricted access sites, and nearshore investigations.

GDI had the opportunity to speak to Lankelma's managing director, Chris Dimelow, about how the business has developed its range of equipment to meet the increasingly extreme conditions in which it is required to perform CPT investigations.

A SPECIALIST FLEET

Dimelow began by outlining the extent of the dedicated rigs the company has at its disposal. "Alongside our standard CPT rigs, Lankelma has a variety of more specialist rigs that have either been designed and built by our own engineering teams or in collaboration with rig manufacturers, usually to help overcome specific challenges or the most common site conditions we come across.

"The innovation is something we are very proud of, from developing the world's first rail CPT rig nearly 20 years ago right through to more recent creations such as the modular CPT ramset."

Among the range of equipment available to the Lankelma team for any embankment or slope testing,

they have an array of excavator-mounted options that allow them to deploy the CPT from either a different level than the excavator or in some instances, to push at a predetermined angle.

"Several projects we undertake each year can have very specific restrictions that require us to either adapt or build a solution to overcome," Dimelow explained. "These have included cantilever options to test over the edge of a platform or quay wall. Frames to secure our standard land-based equipment to be used on floating platforms and modular systems that can be taken into very small environments and reconstructed above the testing position."

For work in more challenging or extreme conditions, Lankelma has two CPT crawlers that have

Years of experience has given the Lankelma team the knowledge needed to adapt any challenge no matter what the terrain



been specifically commissioned and/or adapted to work in the extreme cold environments of Northern Scandinavia. "Both UK23 and UK28 have worked in the Arctic in temperatures as low as -30," Dimelow explained.

In addition, both of those rigs can also convert to battery or mains power when temperatures make operating on diesel engines difficult. Alongside this feature, they have other design solutions to withstand extreme conditions encountered on-site.

Dimelow then talked about Lankelma's UK8, also known within the company as Bogskipper. "Our Bogskipper rig was converted from a quarry dumper. It was originally designed to overcome the difficult ground conditions associated with working on peat bogs. However, it has found more recent use working in intertidal environments where the ability to move quickly over soft ground is an important asset."

SPECIALIST ADAPTATIONS

Naturally, much of the equipment needed for working in such difficult conditions is not readily available, as Dimelow noted: "Though much of the equipment that Lankelma uses is off-the-peg, due to the challenges we face, we often have to manufacture specialist conversion equipment in-house.

"We have several CPT rigs that have been wholly or partially adapted by the in-house fabrication team. This includes adaptations to redistribute weight, allow for new and improved ram sets, and complete refits of rigs to provide pushing capabilities in environments otherwise not catered for."

With access to such specialised equipment, Lankelma can take on CPT projects that other companies might shy away from. "In the marine environment, our jack-up platforms have been stationed in the North Sea throughout winter and have to withstand 5m waves off the coast of Lincolnshire.

"In terms of weather, some of the most challenging condi-

tions that Lankelma has dealt with include Arctic conditions in Northern Scandinavia (below -30C), which meant 2m high snowdrifts and near constant darkness.

"Conversely, we have used heli portable equipment from an unmanned pumping platform off the coast of Cameroon. Pushing to 60m below seabed through 30m of water using our smallest ramset in temperatures closing in on 40 degrees."

RESTRICTED ACCESS

The Lankelma teams have to adapt to not only extremes of weather but also severely restricted access, as Dimelow said: "In more extreme access conditions, we've tested underground in a bore only 1.7m in diameter. Setting up an entire push system when you don't even have enough room to stand up comes with a whole set of unique problems. Some can be foreseen, and others come as a surprise, and solutions need to be found on the fly."

While Dimelow has acknowledged that being adaptable is key to success, that alone is not enough to overcome difficult conditions. "The key to success in challenging conditions is principally an excellent technical and management team who plan the logistical, safety and operational constraints and then a crew of experienced field staff capable of overcoming difficult working conditions compounded by the isolation of often working in areas which are difficult to resupply or communicate with.

"Experience and determination among crew members is vital in order to complete the works, coupled with good support from the project's and engineering team to manage morale and arrange any resupply of equipment."

A PROACTIVE APPROACH

That reliance on teamwork throughout the company when it comes to tackling difficult jobs and the lessons learnt from each

new challenge continues to pay dividends around the new jobs Lankelma can take on. As Dimelow said: "Experience of working in a range of challenging environments has led to a more proactive approach to planning and coordination for this type of CPT works and promotes an atmosphere of adaptability and versatility.

"We actively engage the field teams in the planning stage of the project. This helps the office team understand some of the more nuanced issues associated with working in extreme environments. It also allows the field staff to be involved in the decision-making and demonstrates that their well-being and working conditions are taken seriously."

Dimelow also noted that as well as personnel development equipment improvements play an important part too and discussed how the adoption of specially engineered equipment continues to provide solutions to challenges encountered in extreme testing environments. "The use of such equipment is invaluable in extreme weather, and new developments are regularly applied after each project."

COMMUNICATION

However, meeting the challenges of drilling in extreme conditions is an ever-changing venture, and Dimelow is always looking for ways to improve the efficiency of operations on that topic; he noted that "communication with the client and local entities is always necessary when running projects in extreme conditions".

A high level of communication ensures regular and accurate updates about the changing conditions are available, which provides important information for the planning and implementation of projects in extreme conditions. "It always allows for a more smooth-running project, and in cases where this sort of communication is unavailable or impractical, additional issues are often encountered," Dimelow concluded. ▼

"Several projects we undertake each year can have very specific restrictions"

"Experience and determination among crew members is vital"

Drilling in the eye of the storm

Gordon Ross, Igne's site investigation managing director for Scotland, provides an insight into how a team of drillers from Igne were able to navigate the dual challenges of Scotland's extreme weather and terrain to achieve a successful ground investigation outcome

Scotland's remote landscapes add another layer of complexity to site investigation projects



Scotland's breathtaking landscapes are shaped by nature's extremes, from rugged coastlines to towering mountains. However, these same forces create a formidable challenge for ground investigation teams drilling boreholes in some of the UK's most unpredictable and demanding weather conditions.

From torrential rain and heavy snowfall to howling gales and freezing temperatures, the elements can test even the most seasoned drilling crews. Site investigation success in such conditions requires strategic planning, specialist equipment, and an in-depth understanding of Scotland's unique geological and meteorological landscapes.

EXPERT INSIGHT

Gordon Ross, Igne's site investigation managing director for Scotland, provides a firsthand account of the challenges his teams encounter while drilling in Scotland's extreme landscapes and ever-changing weather conditions. From battling heavy snowfall in remote Highlands to mitigating risks posed by gale-force winds, Ross' insights shed light on the complexities of operating in one of the UK's most demanding environments.

Here he also highlights the importance of a proactive

approach to risk management, ensuring both safety and project success in the face of nature's unpredictability.

EVER-CHANGING WEATHER

Scotland's weather is notorious for its rapid and dramatic shifts. A calm morning can swiftly turn into an afternoon of high winds and driving rain, significantly impacting drilling operations. To ensure safety and maintain the integrity of the investigation, our crews must be prepared to adapt.

On a recent project in the far north of Scotland, drilling operations were suspended ahead of an approaching storm. The decision to pause operations was not taken lightly but was necessary to prevent accidents and preserve the quality of recovered samples. Such proactive risk management is essential when working in extreme environments.

THE RIGHT TECHNIQUES

When working in volatile conditions, choosing the right equipment can also make a huge difference. Sonic and rotary drilling techniques are particularly well-suited to the variety of ground conditions found in Scotland.

The use of LS250 Sonic and Fraste PL-G rotary rigs allows for high-quality core and sample recovery across diverse geological

formations, including softer Caithness Flagstones and harder metamorphic and igneous rocks such as psammite, gneiss, and granite.

Sonic drilling offers distinct advantages in harsh conditions. It enables rapid penetration of challenging formations, while Geobor-S wireline and conventional T2-101 water flush systems provide flexibility to adapt to changing lithologies.

These techniques allow for efficient and precise sampling, even in remote and extreme environments.

OVERCOMING CHALLENGES

Scotland's remote landscapes add another layer of complexity to site investigation projects. On a large-scale project spanning the Highlands, strategic compound locations were chosen to minimise mobilisation distances while reducing disruption to local communities.

Well-equipped welfare and parking facilities were established, accommodating engineers, consultants, and site visitors while ensuring operations could proceed efficiently.

To maintain productivity in extreme weather, logging facilities were set up inside temperature-controlled containers. This simple but effective measure allowed geotechnical data collection to continue uninterrupted, protecting both personnel and samples from harsh external conditions.

SPECIALIST EQUIPMENT

Mobility across difficult terrain is another crucial consideration in extreme weather. In boggy, remote areas, traditional trackway methods can be costly and inefficient. Instead, low ground pressure (LGP) rigs and Morooka

"Extreme weather and remote locations can present significant communication challenges"

support vehicles were deployed to minimise land damage and enable safe access to working locations.

This adaptive approach proved to be both cost-effective and time-efficient, demonstrating the importance of selecting the right equipment for the job.

SAFETY FIRST

Ensuring personnel safety in extreme weather conditions requires constant vigilance. The unpredictable nature of Scotland's climate means that teams must be prepared to halt operations when conditions become too hazardous.

During a recently completed large substation project, drilling was suspended multiple times due to heavy rain, snow, and high winds. Prioritising safety not only protects workers but also safeguards the integrity of samples, ensuring high-quality data for analysis.

Comprehensive risk management strategies are essential in such environments. Regular weather monitoring, real-time decision-making, and contingency planning are critical components of a robust health and safety protocol.

Providing high-quality personal protective equipment (PPE) ensures that workers remain safe and comfortable despite the challenging conditions.

COMMUNICATION

Extreme weather and remote locations can present significant communication challenges. Maintaining reliable contact between team members, clients, and stakeholders is essential for coordinating operations and managing risks. Satellite phones, walkie-talkies, and multi-network mobile solutions help overcome connectivity issues, ensuring that teams remain informed and responsive even in the most isolated environments.

CONCLUSION

Drilling ground investigation boreholes in Scotland's extreme weather conditions is not for the faint-hearted. However, with careful planning, specialised equipment, and a proactive approach to risk

management, even the most formidable challenges can be overcome.

By employing advanced drilling techniques, strategically locating compound areas, using specialised rigs, prioritising safety, and maintaining effective communication, ground investigation teams can successfully navigate the complexities of Scotland's ever-changing climate.

In the face of nature's extremes, adaptability, expertise, and resilience are the keys to success. As the industry continues to push the boundaries of what's possible in site investigation, Scotland remains a proving ground where skill and innovation come together to meet the demands of both the elements and engineering excellence. ♥



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Extreme conditions – drilling through ice and time

As interest in ice drilling for scientific research and resource exploration grows, Signe Hansen interviewed lead driller Matthias Hühner, who recently returned from the Beyond EPICA project in Antarctica, and explored the challenges of drilling in extreme Arctic environments



Drilling and collecting core samples at the Little Dome C camp in Antarctica presents an extreme set of challenges

Photo: PNRA_IPEV

From the end of 2024 to February 2025, 16 scientists and logistics staff worked in Antarctic summer conditions, with average temperatures of -35°C during the fourth campaign of the Beyond EPICA – Oldest Ice project.

Situated at the remote Little Dome C camp, at an altitude of 3200m above sea level, the aim of the project was to extract a 2750m deep ice core from the Antarctic ice sheet to obtain critical details about Earth's climate and atmospheric history, extending beyond 800,000 years ago.

The Beyond EPICA – Oldest Ice project, funded by the European Commission, follows the EPICA (European Project for Ice Coring in Antarctica) project, which finished in 2005 and provided award-winning research on natural climate variability and mechanisms of rapid climatic changes during the last glacial epoch.

On the team was Matthias Hühner, from the Alfred-Wegener-Institute (AWI), who has participated in the project since the first

campaign in 21/22. With a Master of Science in Aerospace Engineering, Hühner has worked for AWI as an engineer developing the ice core drill and related equipment for the project since 2015. He has participated in Beyond EPICA as lead drill engineer for the last two years. In this role, he has been responsible for organising and developing everything related to the drill, from the mechanical/electrical components to the logistics of getting it to the Little Dome C camp.

I asked Hühner, who had the opportunity to learn some of the skills of deep ice coring during three summers in Greenland (EastGRIP) and two shorter expeditions to Antarctica, what the biggest challenge on a project like the Beyond EPICA project is.

"This logistics chain is one of the biggest challenges, not only because it is remote and difficult to reach, but also because it requires a lot of international coordination," he said.

"Most of the drilling equipment has to be shipped from Europe

three years in advance. It arrives by ship via Australia to the Dumont-d'Urville station on the coast. From there, it is transported overland (traverse) to Concordia Station and later to LDC. Smaller equipment and personnel can be transported by plane via New Zealand to Mario-Zucchelli station and Concordia. During the season, there are only very limited opportunities to obtain missing or broken parts."

200 DAYS AT MINUS 35C

As the name indicates, the Beyond EPICA project aimed to go beyond the results of the EPICA project to unveil, for the first time, critical details about Earth's climate and atmospheric history, extending beyond 800,000 years ago and showing a continuous record of the history of our climate as far back as 1.2 million years. To do so, the Beyond EPICA team carried out a total of more than 200 days of successful drilling and ice core processing operations across four field seasons in the extreme environment of the central Antarctic plateau, where temperatures average minus 35°C.

In the harsh milieu, the monotony and the scale of the project caused a major challenge for drillers. "As for the drilling itself, it can sometimes be a challenge to keep the drillers focused on the job. This is especially true when everything is running smoothly, and a certain routine has been established," Hühner explained. "Maintaining focus is necessary because we have very limited automation and monitoring in the drilling system. This is a result of the patchwork of equipment and

"Most of the drilling equipment has to be shipped from Europe three years in advance"

the harsh environment. We try to mitigate this problem by having several operators at the controls (four-eyes principle), changing positions regularly and taking as many breaks as possible between shifts."

One shift at the site required at least three drillers to handle all the surface equipment (fluid management, ice core, drill cuttings) and prepare the drill on the surface between the runs. With two shifts (six drillers), the team could work from 08:00 until around midnight. In addition to the drillers, four members kept the camp and the workshop running, and six scientists handled and analysed the ice.

FINDING THE RIGHT SPOT

The logistics challenge applied to the cargo and the 16-person crew who participated in the project. While participants spend eight to nine weeks at the Little Dome C drill camp, the time it takes to get there and return back means most spend around 12 weeks in the field. This year, team members met in Christchurch, New Zealand, on the 12th of November, and while Hühner left with a few others on the 1st of February, others were still in Antarctica or on a ship/plane back to Europe when he shared his experiences with me.

Despite the project's challenges, the team successfully drilled a 2800m long ice core, reaching the bedrock beneath the Antarctic ice sheet.

"This season, we have been fortunate to have only minor problems with the ice core drilling itself, but we did lose a few pieces in the hole close to the end of the season when we switched to a rock drilling setup. It took us about a week to get all the pieces back to the surface. It always feels good to leave the hole clean for the next season," Hühner said.

The extracted ice preserves an unprecedented record of Earth's climate history, continuous information on atmospheric temperatures and pristine samples of old air with greenhouse gases

spanning over 1.2-million-year-old ice and probably beyond.

"From preliminary analyses recorded at Little Dome C, we have a strong indication that the uppermost 2480m contain a climate record that goes back to 1.2 million years in a high-resolution record where up to 13,000 years are compressed into 1m of ice," Julien Westhoff, chief scientist in the field, postdoc at Copenhagen University, reported.

The principal investigator in the field, Frank Wilhelms, joint professor at Göttingen University and the Alfred Wegener Institute, added: "The right location was identified using cutting-edge radio echo sounding technologies and ice flow modelling. Impressively, we found the record that goes from 0.8 to 1.2 million years ago, exactly where it was predicted to be, in the depth range between 2426 and 2490m, extending our previous 20-year-old EPICA ice core record."

Beneath the ice preserving over 1.2 million years of climate history, the bottom 210m of the core, located just above the bedrock, contains ancient ice that is highly deformed, potentially mixed, or refrozen, with its uncertain origins. Through advanced analysis, researchers hope to test existing theories on the dynamics of refrozen ice beneath the Antarctic ice sheet and gain new insights into East Antarctica's glaciation history.

"We have marked a historical moment for climate and environmental science," commented Carlo Barbante, professor at the Ca' Foscari University of Venice, a senior associate member of the Institute of Polar Sciences of the National Research Council of Italy (Cnr-Isp) and coordinator of Beyond EPICA. "This is the longest continuous record of our past climate from an ice core, and it can reveal the interlink between the carbon cycle and temperature of our planet."

KEEPING IT COOL

By analysing the ice core from Beyond EPICA, scientists hope

to unlock new insights into the Mid-Pleistocene Transition – a crucial period between 900,000 and 1.2 million years ago when glacial cycles extended from 41,000-year to 100,000-year intervals. The factors driving this shift remain one of climate science's most complex mysteries, one which the project aims to resolve. To do so, however, first, the team must solve another logistics challenge, namely transporting the ice cores back to appropriate facilities for analysis.

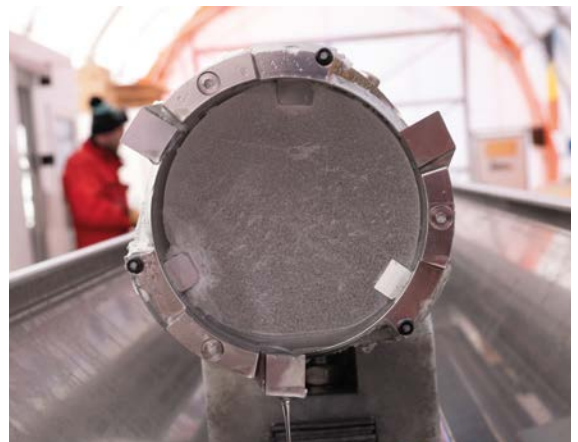
"The precious ice cores extracted during this campaign will be transported back to Europe on board the icebreaker Laura Bassi, maintaining the -50C cold chain, a significant challenge for the logistics of the project", explained Gianluca Bianchi Fasani, senior researcher at ENEA-UTA (National Agency for New Technologies, Energy, and Sustainable Economic Development – Antarctica Technical Unit) and head of ENEA logistics for Beyond EPICA. "To reach this goal, a strategy was developed involving the design of specialised cold containers and precise scheduling of the National Antarctic Research Programme (PNRA) air and naval assets."

The samples are expected to arrive in Europe in early April. As soon as they do, the project will focus on analysing the ice samples to uncover the Earth's climate and atmospheric history over the past 1.2 million years and probably beyond. ♥

"We have marked a historical moment for climate and environmental science"

Once the core samples have been collected from the Antarctic ice, the next logistical challenge is transporting them to Europe for analysis

Photo: PNRA_IPEV



Powering Portugal's marble industry

Solubema Quarry faces harsh operational challenges in Portugal's Alentejo region. Extreme temperatures and pervasive dust are met with Atlas Copco's E-Air H250 VSD portable air compressors, prioritising efficiency, reliability and mobility in marble extraction

Situated in Vila Viçosa, at the heart of the Alentejo region, Solubema Quarry is Portugal's largest marble quarry and a key supplier of premium stone to global markets. Operating in an unforgiving environment where summer temperatures soar to 45C and winter chills dip as low as -4C, the quarry contends with relentless dust from its daily operations.

In these tough conditions, maintaining efficiency and productivity is a significant challenge. To overcome these hurdles, Solubema Quarry has deployed five Atlas Copco E-Air H250 VSD portable air compressors designed to excel in the toughest environments.

Tiago Gonçalves, operations manager at Solubema Quarry, explained the quarry's unique demands: "The environment here tests every piece of equipment. The extreme heat, the cold, and the constant dust require machinery that can handle any challenge it is faced

with. With Atlas Copco's E-Air portable compressors, we've found a solution that is both reliable and efficient, even in these hard conditions."

TRANSFORMATIVE RESULTS

The E-Air H250 VSD portable air compressors have become essential to the daily operations at Solubema Quarry. The electric units power critical equipment, including stone-cutting machines, drilling rigs, and pneumatic hammers, ensuring a consistent and reliable supply of compressed air.

The electric drive eliminates the need for an internal combustion engine, ensuring a consistent supply of emission-free air.

Because the units produce no local emissions, they can safely operate near the marble stone and site operators without causing any harm. This feature aligns perfectly with the company's commitment to enhancing working conditions and reducing emissions.

The portable compressors' Variable Speed Drive (VSD) technology optimises energy use, adapting to the specific demands of each application. By replacing older, less efficient diesel units, the electric mobile compressors have significantly reduced the quarry's operational costs while maintaining high productivity.

"Atlas Copco's E-Air units have delivered transformative results. Their efficiency has lowered our energy usage, while their robustness has reduced the time and cost associated with maintenance," Gonçalves said.

A SUPPORTIVE PARTNERSHIP

Beyond the performance of the equipment itself, Solubema Quarry has benefited from Atlas Copco's extensive customer service. With a robust global support network and quick access to spare parts, the quarry has experienced minimal downtime, ensuring operations continue without disruption.

Gonçalves emphasised the importance of this collaboration: "Atlas Copco's team is always available to support us, and their equipment consistently performs at the highest level. This partnership has been instrumental in helping us meet our productivity goals."

SETTING THE STANDARD

In a region where environmental conditions are as demanding as the work itself, Solubema Quarry continues to push the boundaries of operational efficiency. With Atlas Copco's electric E-Air H250 VSD portable air compressors at the heart of its operations, the quarry demonstrates how reliable machines can transform the toughest conditions into opportunities for growth and success. ▼

Atlas Copco's portable E-Air H250 VSD compressors are used to power critical equipment at the Solubema Quarry in Portugal's Alentejo region



Borehole geophysical logging in extreme conditions

Drilling in extreme conditions can be just the start of the challenge on a jobsite. Once a borehole has been drilled if it then needs to be logged the contractor doing that work has their own set of unique challenges to overcome as outlined by the team at Robertson Geo

Robertson Geo Services (RGS) is the services division of Robertson Geo, a manufacturer of a comprehensive range of geophysical borehole logging equipment, sold worldwide. RGS provides a global logging service across diverse environments for geotechnical, mining, water and renewables business sectors. RGS Engineers are all highly trained in both technical and safety matters and can solve the often unique problems in any environment that each borehole brings.

EQUIPMENT

Geophysical borehole logging is conducted on the full spectrum of boreholes, from shallow geotechnical boreholes to deep mining exploration boreholes. Usually starting once the drilling has reached target depth, equipment is set up at the borehole, and anything from a single probe to a full suite of 10 or more probes will be inserted into the borehole to measure geophysical properties.

The surface equipment, comprising a winch, data acquisition unit and a sheave or tripod-mounted pulley are set up at the borehole to convey the probes and record the resulting digital data. The range of probes available includes televiwers for borehole wall imaging, callipers to assess borehole condition, sonic probes to determine velocities, resistivity probes and many more.

LAND-BASED CHALLENGES

Land-based logging is usually conducted from customised logging vehicles, often 4x4s, capable of transporting all the equipment and probes needed for the job. The environments

encountered range from sub-zero arctic conditions to sweltering equatorial jungles, with everything in between including deserts, forests, mountainous regions, peat bogs and frequently just muddy fields.

The first challenge is to gain access within line of sight of the borehole, to ensure operations can be conducted safely. Challenges routinely include lack of space around the borehole which may compromise set up, difficult driving conditions, working on slopes or at heights or in confined spaces.

Working in poor weather is a normal part of the job, with work only stopping with the possibility of lightning or the most extreme winds. Appropriate PPE, adherence to strict safety protocols, close cooperation with the drill crew and equipment designed to work in harsh conditions mitigate these problems.

Where vehicular access to the borehole is not possible, even with the best 4x4 vehicles, portable operations are necessary. Equipment may need to be hand carried to the borehole or preferably loaded onto specialist all-terrain vehicles. At the borehole, work will proceed largely exposed to the elements. Temporary shelters may be used, but all equipment needs to be water-resistant to cope.

OFFSHORE CHALLENGES

Offshore operations constitute a large part of RGS's work, mostly at offshore wind farm sites (OWF), working from jack-up platforms or, more commonly, heave-compensated drill ships. With experience gained from more than 65 OWF projects across 55 wind farms globally,



RGS is now well-equipped to meet the challenges. Mobilisation needs to be carefully planned so that equipment and engineers arrive in time against a backdrop of changing schedules or even changes to ports of embarkation.

One challenge that must be prepared for and met is that attributable downtime is all but eliminated. Spare probes, spare acquisition electronics and a full set of winch spares must be brought as the option to run to port in the event of a failure is economically unviable. A marine version of the 2000m Winch, with marine-resistant materials and modular, replaceable parts, was developed.

Operations onboard continue 24/7, stopped only by excessive sea swell over prescribed safety limits. Drill deck operations must be closely coordinated with the drilling crew as the winch must be secured on the rooster box at each borehole. Space is limited and time for maintenance is minimal, for as soon as logging is complete, the vessel immediately prepares to move to the next borehole. ►

The conditions at the Coire Glas Pumped Hydro Storage project were some of the most challenging the Robertson Geo team has ever encountered

► UNDERGROUND OPERATIONS

Underground working brings its own set of unique challenges, non-more so than a recent major infrastructure project.

Robertson Geo Services was contracted by STRABAG UK Ltd to collect a comprehensive set of geotechnical data for the Coire Glas Pumped Hydro Storage (PHS) project being developed by SSE Renewables at Loch Lochy, Scotland. PHS schemes are now acknowledged to be a major future contributor to the solution for variable renewable energy sources.

Deploying a suite of geophysical probes in an exploratory tunnel over 1km long some 700m below ground level, in boreholes oriented near horizontal and vertical (up and down), was particularly challenging, requiring the development of new equipment and techniques.

“The first challenge is to gain access within line of sight of the borehole”

THE GI PROJECT

The Coire Glas PHS project is scheduled to be operational by 2031, making it the first large-scale PHS scheme to be built in the UK for 40 years. When completed the project will deliver a power output of up to 1500MW with a storage capacity of 30GWh, enough storage to power over 3 million homes for 24 hours.

The project is being led by developer SSE Renewables. Construction company STRABAG UK, with its vast experience in engineering and tunnelling, was contracted to carry out the exploratory works, with Züblin conducting the drilling programme. The exploratory works were designed by SSE Renewables' consultants, Stantec and COWI.

The exploratory works that the STRABAG UK team is undertaking for Coire Glas is one of the most extensive ground investigations of its time, collecting and analysing a huge volume of geotechnical data before construction begins. The comprehensive scope of the ground investigation is not least required due to the site's proximity to the

Great Glen fault line, visible from outer space. The geotechnical data will observe ground conditions to inform on the potential risks and challenges posed to a successful delivery of the project.

ENVIRONMENTAL CHALLENGES

Robertson Geo Services' remit was to collect geophysical data in a range of underground boreholes, using a large suite of probes.

An exploratory tunnel was constructed, over 1km in length, in which three galleries were constructed from which a series of long near horizontal and angled boreholes were drilled. For these boreholes, a comprehensive suite of probes was run. In addition, many short “televiewer” boreholes were also drilled and logged for borehole imaging and in situ deformability and stress testing, with some of the boreholes being drilled upwards.

The exploratory tunnel allowed vehicular access within close proximity of the galleries, whereafter, the equipment was removed from the vehicle and set up at the boreholes. A 2000m winch, enclosed in a safety cage was used to deploy the probes. Additional equipment included a “push” system for the long, angled boreholes where the probes would not descend under gravity alone and a further “push” system for the short upward-facing vertical boreholes.

The project site was nine hours travel time from the RGS base in North Wales, requiring the logging crew to stay locally in a popular tourist area. Work continued 24/7 with two teams of two engineers alternating on back-to-back 12-hour shifts.

Logistics underground could be challenging with equipment needing to be moved around underground while many other tasks were occurring simultaneously.

The work was physically demanding at times especially when using the “push” systems or moving equipment around.

The tunnel environment itself was good, being relatively spacious, well-lit and well-ventilated with good water drainage, especially important at the work locations. A comprehensive safety and welfare system was already in place for the project including the use of a tally system to monitor personnel numbers underground, the provision of WiFi connectivity throughout the tunnel and an underground refuge chamber.

Other underground challenges that had to be managed were the sometimes noisy work environment and avoiding the inevitable dripping of water on sensitive equipment such as laptops. Vehicles entering the tunnel had to have fire suppression systems fitted and the round trip travel time from accommodation to site could be up to 90 minutes per day.

PROBLEMS AND SOLUTIONS

The most challenging aspect of the logging operation was the development and deployment of the “push” systems. RGS already had considerable experience both underground and of using “push” systems, albeit on horizontal boreholes up to about 40m in length. Therefore, the challenge of pushing, near to horizontal, to around 280m while underground was not underestimated.

Robertson Geo's engineering department designed a push-pull connecting system that allowed the probes to be pushed.

Working closely with the drillers, Züblin, a reel of hollow plastic pipe on a drum was used for pushing but was only capable of reaching around 100m when friction halted progress. Substituting the plastic pipe for small-diameter aluminium push rods enabled the probes to be pushed to the target length, once the connector had been suitably modified. The design of the connector included a swivel to minimise the chances of the logging cable becoming tangled around the push rods. The system worked successfully, allowing the push rods to be extracted before

logging commenced, which was much preferable to trying to withdraw the push system as logging was taking place. This allowed for smooth logging and excellent depth registration.

A second challenge was to minimise shadowing on the televiwer images in the horizontal boreholes while using the push system. Shadowing on televiwer images occurs when the probes are not fully centralised in the borehole. The standard arrangement of centralisers is designed so that, upon retrieval, the centralisers are free to contract avoiding the possibility of the probe getting stuck. However, when "pushing" the probe into the borehole, the centralisers are free to expand, and if the springs are too strong, they could prevent the progress of the probe. Therefore, there is a trade-off between minimising shadowing while still being able to push the probe. Both six-band

and four-band centralisers were tested onsite and the resulting images were compared for shadow effect. The four-band centralisers, with stronger springs than the six-band, provided better centralisation while also avoiding the risk of getting the probes stuck.

A further challenge was to design a push system for the upward-facing (raise) boreholes, which were up to 22m in length. A manual arrangement using customised tubular push rods was engineered which worked successfully. It could, however, be physically challenging as the push rods needed to be extracted at logging time working against the winch to maintain smoothness and good depth control, requiring support from the STRABAG/Züblin team.

CONCLUSIONS

The geophysical logging campaign formed a vital component

of the overall ground investigation, providing calibrated data, not attainable by other means, at centimetre resolution in the boreholes. The boreholes drilled into the igneous/metamorphic rock were both smooth and stable, ideal conditions for logging, resulting in a very high-quality dataset. The televiwer data was of premium quality, important for delineating faults and fractures that affect groundwater movement.

The logging crews collaborated with STRABAG and Züblin throughout, allowing any problems to be resolved in a timely manner, safely and efficiently. The ability to call on the RG engineering department resources for the design and build of the push-pull connector was a distinct advantage in overcoming the main challenge of the angled and raise drilled boreholes. ♥

"Logistics underground could be challenging"

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Accepting the castle access challenge

The need to create a second barrier-free access point for tourists entering a historical castle was the challenge accepted by German special foundation engineering contractor Geo-Bohrtechnik. In order to counter the issues of working in such an exceptional location in combination with steep terrain and extreme dust generation, the company turned to Hütte for an exceptional drill rig



The need for a new elevator extension at a German castle; just another challenging job for German special foundation engineering contractor Geo-Bohrtechnik

Steep terrain, limited access and excess dust were among the difficulties that needed to be overcome while installing bored piles with a Hütte HBR 203 drill rig

The private builders of Hohenzollern Castle, Georg Friedrich Prince of Prussia and Karl Friedrich Prince of Hohenzollern, are planning the construction of a new elevator extension at the Castle that will create a second barrier-free access point for tourists entering the castle. To establish the foundation for the elevator platform, German special foundation engineering contractor Geo-Bohrtechnik was contracted to install 17 420mm diameter bored piles. The problem was the extreme conditions that would need to be overcome.

THE CHALLENGE

Due to the location and design of Hohenzollern Castle, the space available for the new elevator is very limited. The construction site can only be accessed via a narrow, winding road, making it inaccessible for large equipment. In addition, the drilling platform

is very restricted, and the terrain surrounding the castle is extremely steep. Then there is the final challenge of the fact that the load-bearing White Jurassic limestone was overlain by non-load-bearing layers.

The solution developed for this project was drilling 17 bored piles

at depths of up to 11m and installing them into the existing White Jurassic limestone to form the foundation of the elevator platform. Additionally, nine 150mm diameter GEWI tension piles were drilled to 8m at an angle beneath the castle to further anchor the elevator platform.

THE SOLUTION

Geo-Bohrtechnik's small drilling rig, a Hütte HBR 203, was ideally suited for the task as the compact machine was able to travel the entire way from the valley floor to the construction site on rubber tracks.

The boreholes were drilled using a cased auger drilling method with a diameter of 42 mm, and in the White Jurassic limestone, Geo-Bohrtechnik used a down-the-hole hammer with a large compressor. The GEWI tension piles were installed using an excavator-mounted drilling unit with a down-the-hole hammer. ▼



Reducing costs and CO₂ emissions

The new EURODRILL C61 motor concept shines in action on a Danish jobsite as it demonstrates the company's commitment to innovation

The C61 motor concept, an evolution of the EA61V presented at Bauma 2022, once again demonstrates EURODRILL's commitment to innovation. In real-world construction applications, this patented motor concept stands out for its increased efficiency, broader torque and speed range, and high reliability.

The selection of the Nordhavn urban development project in Copenhagen as a test site for the new energy-efficient C61 drive concept was particularly well suited. Denmark has long been regarded as a global leader in sustainability, and Nordhavn is a flagship project in this regard. The district, which is transforming from a former port area into a climate-neutral residential and commercial zone, was the first in the world to receive the DNGB Gold certification for sustainability.

CHALLENGING CONDITIONS

True to the principle that ambitious goals often come with challenging conditions, construction companies working on the project face daily struggles with high groundwater levels and extremely hard chalk and flint layers.

To ensure optimal transportation links, construction of the Nordhavn Tunnel has been underway since the summer of 2024. As part of a joint venture, long-standing EURODRILL partner Grundbau Nord is drilling over 1000 anchors in the tunnel entrance areas, which are being constructed using an open-cut method.

Difficult ground conditions posed challenges at the start of the project, pushing conventional drilling systems to their limits. Beyond the shortened lifespan of conventional geroler motors, the drilling rigs faced significant thermal stress on their hydraulic systems.

"Grundbau Nord approached us in the fall regarding these challenges. At that time, we were in the final phase of developing the C61, which promised to solve all the reported issues," Andreas Pikowski, EURODRILL's sales director, said.

COLLABORATION

An agreement was quickly reached to collaborate on testing the innovative motor concept in real-world conditions. The C61 was integrated into the EURODRILL drive system for on-site deployment. This new motor carries forward all the advantages of the EA61V, which has been successfully used on numerous construction sites since its launch in 2022. Compared to its predecessor, the C61 features an optimised design and is 130mm shorter. Additionally, the additional cost of the system has been reduced by approximately 80% compared to the previous model.

Since early December, the anchor drilling rig has been operating with EURODRILL's latest drive technology. The focus is not only on documenting direct experiences with the C61 motors but also on comparing them with previously installed motors and other drilling units with different drive technologies.

After just a few weeks, the results have been overwhelmingly positive. Drilling performance has slightly improved, while fuel consumption per anchor has been reduced by up to 20%. This not only translates into significant cost savings but has also led to several tons of CO₂ emissions being avoided during the short test phase. The efficiency gains are also evident in the thermal performance of the hydraulic system – critical oil temperatures were never reached at any point.

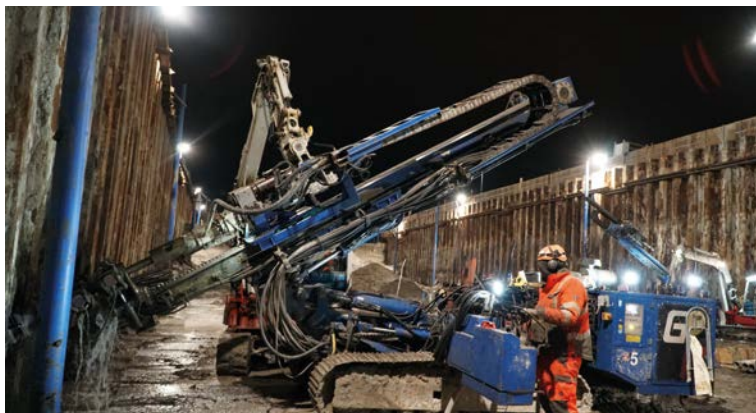
The test run in Copenhagen has proven that EURODRILL has found a solution to the current challenges in motor technology for drilling drives.

RETURN ON INVESTMENT

Given the performance benefits and cost efficiency, the C61 is expected to be integrated not only into new drilling systems but also as a retrofit solution for existing equipment, delivering a rapid return on investment.

"We are delighted to offer this motor technology not only for large drilling rigs but also for anchor drilling rigs. We are proud to showcase at Bauma 2025 that this proven technology has become the new standard in our anchor drilling rigs," Ralf Sönnecken, managing director of EURODRILL, said. ♥

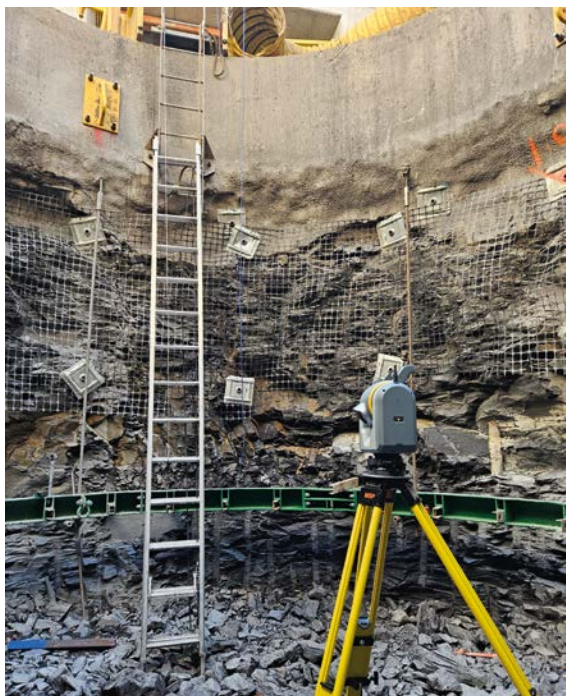
"We are delighted to offer this motor technology"



EURODRILL's C61 drive concept has been proven a success after its use on a challenging jobsite in Denmark

Facing the challenges of vertical shaft mine construction

Brett Grocock, owner and authorised mine surveyor, Element Geospatial (formerly Mine Survey Plus), addresses how mine owners can address the challenges of vertical shaft mine construction through the use of surveying technology and innovative techniques



Surveying is a crucial part of vertical shaft mine construction

Over time, mine operators must assess the future value of mineral resources far below the Earth's surface as ore accessed in shallow pit mines is depleted. While decline, ramp, or incline shafts are suitable for mining surface deposits, vertical shafts can be more economical for transportation of people and ore, utility corridors and ventilation at greater depths and allow miners to extract otherwise inaccessible minerals. As existing mines expand and deeper ore-bodies are discovered, adding vertical shafts is often preferred, if not necessary.

The deepest mines today reach 4km (2.5 miles) underground and are becoming increasingly automated, which improves safety and sustainability within the mining operation.

Specialised engineering skills and equipment are required to construct these underground mines; only a handful of companies possess the necessary expertise. Element Geospatial (formerly Mine Survey Plus), a Perth-based company, is a stand-out in the industry in the niche area of surveying, having worked in more than 90 mines in 14 different countries. In particular, Element Geospatial is well-versed in managing the challenging environment of surveying vertical shaft projects.

Surveying is a crucial part of vertical shaft mine construction to ensure work is proceeding according to design with high accuracy and precision. The biggest challenge is collecting as-built measurements with speed and accuracy under adverse conditions. Element Geospatial provides information that reduces rework and avoids wasting materials by quickly identifying discrepancies and accurately estimating concrete volumes for the shaft liner.

Element Geospatial invests heavily in the latest technology available, such as scanning total stations and global navigation satellite system (GNSS) receivers, to ensure the highest levels of safety and performance at its mining projects around the world. Advanced engineering and surveying solutions and 3D analysis now provide detailed information throughout construction to expedite the workflow.

UNIQUE ENVIRONMENT

Vertical shaft surveying presents unique challenges compared to above-ground surveying,

frequently presenting testing and difficult and uncomfortable conditions due to the following characteristics:

- **Groundwater:** Equipment must be rugged and water-proof to withstand exposure to salty groundwater in the shaft.
- **Airflow:** Constant airflow in the shaft acts like a wind tunnel, affecting plumb lines and total stations.
- **Long hours:** Surveyors must be available 24/7 to avoid delaying construction work; they work 12-hour day or night shifts. In remote areas, workers are flown in and out on a weekly or bi-weekly rotating basis.
- **Time pressure:** Surveyors must quickly verify measurements after blasting to identify overbreaks/underbreaks before the next concrete pour. Processing data in real-time allows surveyors to communicate results within minutes of returning to the surface. For example, surveyors may have only 90 minutes to survey a 6m high and 5.5m diameter vertical shaft, process the data and calculate the volume of concrete needed to validate proper thickness and design.
- **Sightlines:** In a 5.5m diameter shaft, the setup is in the centre of the stage, and sight lines are very short, which is less than ideal for geometric calculations such as a resection.
- **Obstacles:** Plumb lines snag on forms, tapes rip off walls, steady brackets are hit, shutters are damaged, etc., making surveying more difficult.

- Accuracy: Tolerances for shaft construction are extremely tight, reflecting the critical nature of the infrastructure being built. The correct amount of rock/soil must be excavated, and the concrete has to be a certain thickness so that prefabricated horizontal steel buntons will fit.

SPEED AND ACCURACY

After consulting with Ultimate Positioning Group, Trimble's Australian distributor, Element Geospatial, purchased its first Trimble SX12 scanning total station to use on the Havieron decline project in Western Australia in 2021. The SX12 scanning total station combined a high-accuracy robotic total station and a 3D laser scanner in one instrument. A small green laser spot (3mm diameter electronic distance measurement (EDM) laser spot at 50m) was especially helpful for underground applications like staking out lines, and the robotic technology withstood the harsh conditions found in a shaft construction site, such as dust and moisture.

The value of the scanning/total station technology was so beneficial that Element Geospatial purchased a second SX12 scanning total station to use on an underground mine project in Australia. This expansion effort involved the construction of two 1460m shafts in a raised bore. The shafts were constructed for ore hauling with guides, buntons, and brackets to secure water, air, and utility pipes. Working from the top down, surveying and installation of the concrete liner was scheduled to take 18 months plus the time to erect the steel structure and fit out the shaft.

Element Geospatial is also employing the SX12 scanning total station at an Australian coal mine that requires twin ventilation shafts descending 500m. This drill and blast project proceeds in 6m increments, with the surveyors checking the as-builts in between blasting and pouring concrete.

ADAPTING WORKFLOW

In recent years, laser scanning technology has become an increasingly important part of the workflow. Thorough documentation of the shaft walls serves multiple purposes:

- Overbreak and underbreak analysis: Scans reveal areas where too much or too little rock has been removed during blasting and excavation.
- Volume calculations: Creating a model from the scan data, surveyors can accurately calculate the volume and thickness of concrete needed for each pour.
- As-built documentation: Scans provide a detailed record of the shaft's actual geometry, which is crucial for future planning and maintenance.

As the shaft progresses, the as-built measurements are verified against the design after each blast phase and before the next row of forms are filled with concrete. To collect the necessary data, the surveyor is lowered into the shaft on a work stage suspended from a hydraulic arm to perform the next setup. The arm keeps the cage off the wall and holds the cage relatively stable so that movement does not skew the results.

Element Geospatial defines shaft control using already established primary survey control marks at the top of the shaft, co-located with plumb lines and plumb line prisms installed at the surface. Surveyors then use a remotely controlled winch to drop the plumb line suspended on a wire from the surface, ►

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“Surveyors can enhance their performance by applying new scanning technology”

▶ with a 20kg weight at the bottom to keep it from moving. Small brackets are installed every 50 – 60m to guide the wire through a narrow opening, which helps minimise sway over hundreds of metres and improves the accuracy of the plumb line system. The surveyor resects off prisms as in a conventional survey, but the prisms move slightly due to airflow in the shaft, and extra rounds are required to obtain an accurate horizontal position with the SX12 scanning total station. Element Geospatial uses Trimble Access field software on a Trimble TSC7 controller to collect the total station readings to ensure an accurate and adequate resection is performed.

RAPID DATA PROCESSING

Element Geospatial uses Trimble Business Center (TBC) software for rapid data processing and was instrumental in developing its vertical shaft capabilities. Its feedback was incorporated into the product design process, ensuring that real-world perspective was applied to these specialised capabilities.

Once the shaft is scanned, the surveyor ascends to the surface,

loads the scan into TBC and removes noise, such as ladders or steel cables, with the surface inspection transparency tool in Trimble Access. A heat map is generated to show deviations from the design. After creating a solid cylinder model, the operator calculates the volume of the ring of concrete, prints a report, and delivers the information.

Accurate volume calculations are increasingly important as contractors seek to reduce concrete waste to minimise the project’s carbon footprint and be properly compensated for work completed. The 4.1 billion metric tons of cement, a key ingredient of concrete, manufactured worldwide in 2023 is estimated to contribute 8% of the world’s carbon dioxide emissions.

The combination of field data collection using the Trimble SX12 and subsequent processing in TBC enables a quick turnaround of critical information, meeting the demands of tight construction schedules. Operators can automate the as-built data collection process and provide near real-time feedback to the excavator operators, which is typically one of the most time-

consuming tasks in shaft construction.

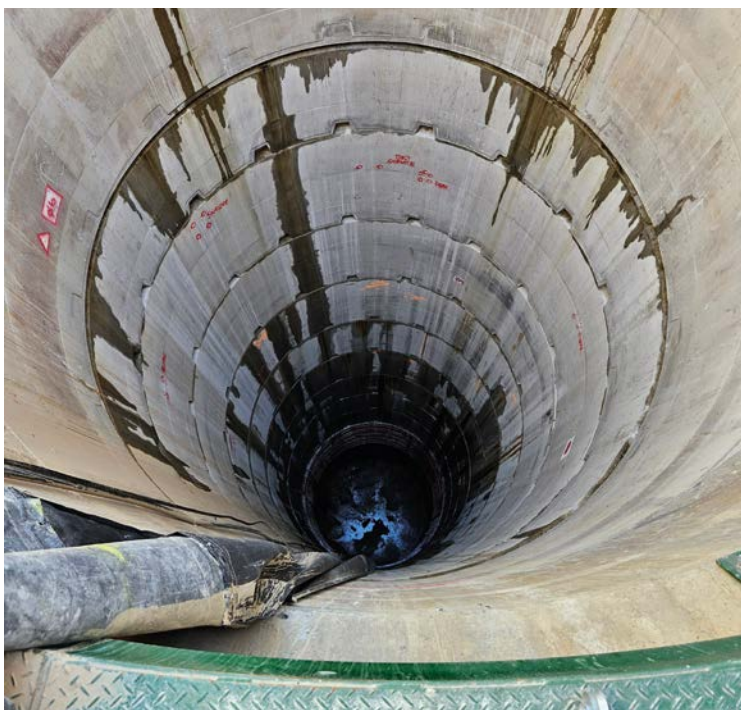
“We’re under a lot of time pressure, so the equipment has to work well all the time,” James Gianatti, senior surveyor at Element Geospatial, said. “We do a 10-minute scan, colourise it and load the scan into TBC to quickly analyse whether too much or not enough material has been blasted off the walls.”

By eliminating trips to the office, processing the files on PCs, producing a hard copy report and then passing the information back to supervisors and operators, infield scanning, registration and processing significantly expedite the surveyor’s work.

MAKING A JOB EASIER

Surveying a vertical mine shaft poses significant challenges while requiring a high level of accuracy. Element Geospatial welcomes any technology that both expedites the process and enhances results. Incorporating the Trimble SX12 scanner and TBC and Trimble Access field software into their workflow delivers noticeable benefits. Comparing scan data against the design profiles to verify conformance while in the field has proven to be a time saver on several vertical shaft projects in the past few years. The 3D scan provides an added layer of visual communication and immediate feedback on any course correction that may be needed. Better accuracy translates into less rework and helps the team meet ambitious construction schedules.

When the pressure is on to complete construction projects quickly and efficiently, surveyors can enhance their performance by applying new scanning technology that produces more accurate information under adverse conditions. Vertical shaft surveying is just one of many types of challenging projects that benefit from highly skilled surveyors and modern survey technology to achieve improved workflows and complete jobs successfully. ▼



Accurate shaft surveying is necessary to calculate the volume for the ring of concrete lining the shaft

Dewatering pumps: The backbone of mining operations

Slater Blanchard, Southwest sales manager at Tsurumi Pump, provides an insight into the importance of dewatering pumps for the mining industry and what buyers should consider when looking to acquire pumps for the dewatering of mine sites

Dewatering pumps play a crucial role in the mining industry, helping to regulate water levels and ensure safe and effective material extraction. These pumps have progressed significantly over the years in both technology and design, with a focus on durability and innovation to withstand the tough conditions of mining operations.

The mining industry encompasses a wide variety of activities, each with its unique dewatering challenges. Dewatering pumps are essential in managing high-head abrasive and corrosive materials in demanding environments. Their reliable and continuous operation is essential for preventing flooding and maintaining the stability of mining sites.

SELECTION CRITERIA

Water accumulation at mining sites can result from groundwater intrusion or the mining process itself. Electric dewatering pumps are utilised in both underground and surface mining. For this reason, it is critical to consider the following key factors when selecting the right dewatering pump for mining:

- **Durability:** Mining pumps must be exceptionally durable to withstand harsh conditions, including both acidic and caustic solutions with abrasive solids.
- **Efficiency:** Energy efficiency is critical in mining, particularly in remote locations with high energy costs. Advanced pump designs prioritise reduced energy consumption without compromising performance. High-efficiency motors, including variable frequency drives (VFDs), enable pumps

to operate at varying speeds, lowering energy usage during low-demand periods and extending equipment life.

- **Ease of Maintenance:** Remote mining locations require easy maintenance and repair of pumps to minimise downtime. Modular designs and readily available spare parts streamline maintenance, reducing reliance on specialised repair teams and ensuring uninterrupted operations.

Corrosion-resistant materials like stainless steel and specialised coatings extend the pump's lifespan in challenging mining conditions. Hardening techniques and ceramic coatings combat wear from abrasive particles, ensuring reliable operations over extended periods.

SENSOR INTEGRATION

The integration of sensors with technology allows for the real-time monitoring of pump performance. These intelligent systems can predict and prevent

unexpected failures and optimise operations based on specific application requirements. This results in improved energy efficiency and operational reliability. Modular designs simplify maintenance and repairs, while compact pump designs excel in space-constrained underground mining, minimising pump installation and maintenance disruption.

As the mining industry expands and evolves, technological advancements in dewatering pumps are imperative. Companies like Tsurumi Pump are leading the way with innovative products that exceed the rigorous demands of modern mining.

Staying informed about the latest advancements in dewatering technology is indispensable for mining professionals. Understanding mining site requirements and innovative pump designs empowers mining operators to make informed decisions that enhance safety, efficiency and profitability. ▼

“Allows for the real-time monitoring of pump performance”



Moving over to Tsurumi pumps for dewatering has resulted in significant cost savings for an Illinois miner

Inside the Matrix of underground mining safety

Ming Magazine's Beth McLoughlin talks Matrix Design Group to discover how safety systems can boost mine productivity

Underground mining can be high-risk

Over the decades, Matrix Design Group's experts have learned how technology can make mining safer and more productive. Its pioneering IntelliZone proximity detection system is used in 90% of US mines and is found worldwide.

The company, a wholly owned subsidiary of Alliance, has also won awards for its tech, including the Occupational Health Safety (OHS) New Product of the Year award in September 2024 for its Omni Pro Vision AI technology.

Such innovations are critical in an industry where errors and accidents can lead to fatalities. Matrix also calculates that the lost-time cost for a more severe "struck or injured by motor vehicle" incident is US\$69,035. More than 103 million days are lost each year due to work-related injuries in mining.

Underground mining presents unique challenges, including poor visibility, air quality, and other risks. However, emerging technologies are making a crucial difference.

Chris Adkins, Matrix's mining sales manager for the US, told *Mining Magazine*, GDI's sister title, that the evolution of safety equipment for underground mining began with systems that could detect heat underground.

"The heat point system meant you could detect hot places underground, but this meant you already had a fire," he said.

Tragic incidents in Adkins' home state of West Virginia, including the Sago Mine disaster in 2006, in which 12 coal miners in West Virginia died, and another was left in critical condition, and the Upper Big Branch Mine Disaster in 2010 in which



29 died, were powerful catalysts for change.

Subsequent developments included mine refuge chambers, sealed environments designed to keep miners safe in an emergency. But Adkins said it was advances in communications technology that made the biggest impact.

"The impact of developing a tracking system, so we know where people are underground, and can respond to emergencies and direct traffic to areas of the mine that need assistance, has been huge, and Matrix has been at the front end of that," he said.

Miners can now hit an emergency button on a device that they are wearing to alert others if there is an emergency.

"We have had situations where miners have had a cardiac arrest and have been able to press that button and get assistance straight away," Adkins said.

The other step change that wearable devices have made possible is the advent of proximity detection technology. Fatal

accidents were often a result of people standing in dangerous places.

Now, a wearable device will show if a miner wanders into a dangerous area, and the proximity detection system, such as Matrix's IntelliZone Proximity Detection System, can shut machinery down. It will no longer be operable until it is in a safe spot where no one can be harmed.

"This has led to a big reduction in fatalities in the mining industry," Adkins said, adding that tracking systems' data can boost productivity and safety.

"The data from the machines shows the bigger picture – from the continuous miner to the feeder, how long does it take? What route are they taking, and which section is more productive and why?"

A mine owned by Matrix's parent company, Alliance in Gibson County, Indiana, is the most productive in the US, he said, "and it's got proximity detection systems on every piece of equipment underground."

"The data from the machines shows the bigger picture"

One of the benefits Matrix has of being part of Alliance is the ability to run every new product through testing and trials in Alliance mines. Matrix can take on board feedback and hone products before they reach the open market, taking into account nuances such as change management.

Changes have included refining alerts so they do not interfere with other systems or become a nuisance to operators.

"The concern has always been that proximity detection inhibits productivity on haulage," Brian Jones, mining sales and marketing for Matrix, told *Mining Magazine*. "But implementation says otherwise: [miners] have been able to implement products and run a safer operation while maintaining or exceeding production benchmarks they had previously set."

Even allowing for unique geological conditions, he said the evidence challenges the assumption in underground mining that this technology could slow production down.

Adkins added that once employees got used to the proximity detection system, they adjusted their behaviour even before hearing alerts.

"In one of the mines in West Virginia, the coal mine was 48in high," he said. "You are running shuttle cars back and forth, it's big equipment."

"[The miners] started getting into the habit of stepping back if they heard the machine coming, before they even got an alert, for two reasons.

"One, they didn't want to make the operator mad that they shut his machine down. Two, they realised it can make things better and safer, and people are getting to go home at the end of the day."

AUTOMATION ROADMAP

"We are at the point now where we think the right combination of technologies exists to put a

roadmap in place to get to automation," Jones said. "The ultimate safety resolution is to move people out of dangerous environments into other areas."

He said it will soon be feasible for room-and-pillar operations and potentially for drill and blast operations, along with other tasks on the mine site.

"I've seen automated systems in Australia for some time now," Jones added. "It is usually a combination of automation and somebody on the surface, though room-and-pillar operations is a challenge because of the ongoing evolution of that market."

Overcoming obstacles including the niche nature of coal and a lengthy approval process for new technologies will be key to that success.

Regulation, Jones said, can be "a double-edged sword", both driving change and in some cases slowing it down.

In the US, the Mine Safety and Health Administration is taking steps to speed up some processes, he said.

MONITORING METHANE

After receiving feedback from Alliance customers Matrix developed the M5, a machine-mounted methane monitor. The M5 can be used on continuous miners or similar excavating equipment operating in coal or gassy mines.

Methane is a lethal risk in underground coal mining. It is highly flammable, can cause explosions, and displaces oxygen in the air, leading to miners feeling sick and dizzy, potentially causing deaths.

"We were able to see what the weak spots of the existing technology were, including sensors getting wet and not working properly," said Adkins, speaking about what the Matrix team learned from Alliance customer feedback on their previous methane detection systems.

Matrix developed the M5 in partnership with Monitech Mine Monitoring Systems of South Africa to build a monitor that is water and vibration resistant, easy to calibrate and has "zero drift".

The process of developing products can vary. IntelliZone started development about 10 years ago, as the team sought to solve a problem it had observed in coal mining.

OmniPro was developed originally for the industrial forklift market. Now the award-winning collision avoidance system is used on all types and sizes of equipment, including underground equipment.

Jones said partnerships with experts from other sectors have often been key to innovation, particularly as Matrix develops its products' automation capabilities.

"We are developing a series of products in the next five or six years that will [further] enable automation," he said. This technology suite will include stand-alone offerings, such as OmniPro, and working with original equipment manufacturers (OEMs) to boost the productivity and safety of their machines through automation.

It will require interoperability between machinery built by different providers.

Going back to the underground environment, getting different machines to share data with each other can be far from straightforward.

"That isn't easy underground," Jones said. "You don't have GPS, and there are a lot of challenges. But the idea is to have those machines operate in a way that removes personnel from dangerous situations."

Matrix is developing a network that will allow miners to get data from underground to the surface daily, allowing operators to take proactive measures to improve safety and productivity in their environments. ▼

"More than 103 million days are lost each year due to work-related injuries in mining"

Mines and the local economy – excellence in the making

Hennie Colyn, MMM, strategic account executive (RKAM) at Schneider Electric, discusses the numerous benefits in the mining sector of marrying cultural, linguistic, economic, regulatory and environmental factors at a local level

Localisation is, by definition, a broad term used to describe a myriad of products, services and operations, all developed to meet the needs of a particular market or community. And while it sounds quite dry, it is anything but. The ability to marry cultural, linguistic, economic, regulatory and environmental factors is no mean feat, and the benefits are numerous.

In the mining, minerals and metals sector, localisation benefits both the mine (in question) and the local economy. It is symbiosis at its finest, as both parties stand to gain tremendously.

However, to understand localisation, it is almost important to drill down, if you will excuse the pun, what localisation truly means to mining and, equally importantly, how the sector can benefit local communities and the economy.

A WIN-WIN SCENARIO

For one, localisation initiatives prioritise the hiring of local talent, sourcing from local suppliers, and fostering community-led development. This creates jobs and stimulates economic growth by increasing domestic demand for goods and services.

Furthermore, for communities near mining operations, this translates to improved livelihoods and more robust local economies. In fact, countries across the globe boast local mining towns.

Equally, mines benefit from local supply chain stability and the subsequent risks associated with global disruptions, currency fluctuations, and logistical delays, making operations more resilient.

Additionally, by generating legitimate employment opportunities, localisation diminishes the appeal of illegal mining, addressing a significant socio-economic challenge in many mining regions.

Examining the bigger picture, localisation also enables organisations to meet their broader sustainable development goals. Through investment in infrastructure, education, and healthcare, mining companies enhance community welfare and long-term economic viability. These efforts echo global sustainability priorities, including poverty alleviation, education, and gender equality.

DIGITAL TECHNOLOGIES

For localisation to truly take effect, the mining, minerals and metals sector must also partner with technology companies. Indeed, across the globe, the sector is moving towards a digital posture, and localisation is part of this transition.

In short, the new era of digital mining allows mines to gain the most from local expertise and operations.

At the heart of mining operations lie its people, which is why their safety is paramount. Here, automated and remote-controlled equipment reduces risks in hazardous environments, allowing machines to shine while men stay safe.

Furthermore, real-time data systems enhance mineral exploration and processing, allowing companies to identify and extract valuable resources with precision.

Advanced technologies like precision mining and sensor-based systems that minimise waste also optimise resource utilisation, thus

reducing reliance on traditional energy sources while contributing to lower carbon emissions. This is particularly beneficial in countries that struggle with unstable grid infrastructure.

Real-time monitoring and data analytics also help mining companies identify inefficiencies and optimise operations, again saving on OPEX. Furthermore, the integration of geographic information systems and cellular technologies ensures streamlined operations in challenging terrains.

SKILLS DEVELOPMENT

Importantly, upskilling and reskilling local workers to operate advanced technologies ensure the long-term viability of digital innovations in mining. Similarly, it creates digitally savvy workforce, which allows for important skills development in:

- Proficiency in operating and maintaining automated and AI-driven systems.
- Data analytics capabilities for interpreting sensor and equipment data.
- Knowledge of sustainability practices to align with environmentally responsible mining initiatives.

Lastly, one would be remiss not to talk about the importance of AI and automation in local mining operations. AI-powered tools, such as predictive maintenance systems, autonomous vehicles, and drones, reduce operational costs, enhance safety, and optimise resource extraction.

By leveraging AI, companies can predict potential issues, reduce downtime, and streamline ore processing, further boosting productivity. ▼

“At the heart of mining operations lie its people”

Astral firms up Mandilla endowment ahead of resource upgrade

Joshua Smith, editor of *GDI's* sister title *Mining News Network* reports on Astral's pre-feasibility for a potential Western Australian mine which is due before the end of June

Perth-based gold exploration and base metals company Astral Resources has reported a string of high-grade gold results from infill work at its mainstay 1.3-million-oz Mandilla project near Kalgoorlie in Western Australia as it works to upgrade the project's mineral resource estimate.

Two diamond holes of a four-hole program at the Theia deposit returned results such as 28m at 2.63gpt from 149m, including 0.5m at 115.7gpt and 0.3m at 20.3gpt, and 8.9m at 1.04gpt from 86.3m.

CORRELATED RESULTS

The 'true width' of the mineralisation is unknown. However, Astral managing director Marc Ducler said the results correlated with the current MRE mineralisation wireframes, meaning they were likely to help convert some of the lower-confidence material to the higher-confidence 'indicated' category.

"When aggregated, the mineralised intersections have returned 172 gram-metres and 99 gram-metres ... respectively," Ducler said.

"Assay results for the final two diamond drill holes are expected to be received shortly. Based on observations from drill-hole logging, we are confident similar results will be achieved."

Meanwhile, extensional RC work at the Eos deposit struck 14m at 2.5gpt gold from 46m and 10m at 1.05gpt from 159m.

POTENTIAL EXPANSIONS

Astral said the south-to-south-west-dipping vein sets at Eos were similar in style to those at Theia and indicated potential



expansions to the undrilled north section of the deposit.

A July 2023 scoping study for Mandilla, including the Theia, Eos and Hestia deposits, outlined a standalone project comprising three open pits feeding a 2.5Mtpa processing facility to produce 80,000-100,000oz of gold a year.

Using a gold price of A\$2750/oz, Mandilla had an NPV of \$442 million. Gold prices are currently above \$4400/oz.

Astral is working on a pre-feasibility study for Mandilla, slated for completion before the end of the June quarter. It started the new year with circa A\$25 million in cash.

The company last week reiterated that it was "fully funded to a final investment decision, including the acceleration of exploration activities at Mandilla and Feysville and

completion of the Mandilla pre-feasibility and definitive feasibility studies".

FINANCIAL LEVERAGE

Astral has previously tipped the potential satellite feed that could come from the nearby 196,000oz Feysville project to "provide significant additional financial leverage" for its Mandilla PFS.

RC results from Feysville are expected in the coming weeks, with a diamond rig to start spinning in the area before the end of January and aircore drilling to follow.

Shares in Astral have recently been steady at around 14c on at the time of writing, capitalising the stock at A\$174 million. It has had a decent share price run of late, having traded at levels around 6-8c for most of last year. ▼

Astral Resources has reported high-grade gold results from its mainstay 1.3-million-oz Mandilla project near Kalgoorlie

"Fully funded to a final investment decision"

The Snowy 2.0 project

Described as one of the civil engineering wonders of the modern world, the Snowy Mountains Hydro-electric Scheme in Australia is undergoing an expansion programme, Snowy 2.0, but challenging ground conditions meant innovative solutions have had to be incorporated to allow tunnelling work to continue



Grouting work carried out with the aid of a Comacchio MC 22 rig allowed tunnelling to continue on the Snowy 2.0 project after a sink hole developed stopping the TBM

The Snowy Mountains Hydro-electric Scheme, originally built from 1949 through 1974, stands as a testament to Australia's engineering prowess, seamlessly blending renewable energy generation with intricate infrastructure. Located in the Snowy Mountains in the state of New South Wales, it is described as one of the civil engineering wonders of the modern world, consisting of eight power stations, 16 major dams, 80km of aqueducts and 145km of interconnected tunnels.

The expansion phase of the 4100MW Snowy Mountain hydroelectric scheme is currently underway with the Snowy 2.0 project. The project involves the construction of a 2000MW underground pumped-storage hydroelectric power plant that will link two existing water reservoirs, Tantangara and Talbingo. The project features 27km of tunnels – waterways, auxiliary and access tunnels – and an underground power station measuring 22m wide, 50m high, 250m long and located beneath around 800m of solid rock.

The hydroelectric power station will generate green energy as the water passes turbines in the tunnels, sending it to the grid. The reversible turbines are designed to push water back upwards, meaning the same water will be pumped back and forth all the time, allowing for hydroelectricity on demand.

This massive hydropower project is being built for project promoter Snowy Hydro by Future Generation (FGJV), a joint venture between Webuild, its American subsidiary Lane Construction and Australian firm Clough. It is the largest renewable energy project under development in Australia (and one of the biggest pumped-storage projects in the world), and it is critical to support the country's shift away from coal and other fossil fuels towards renewable sources for the production of electricity.

One of the longest and most technically difficult sections of the project, a 15km long segment of the "headrace" tunnel linking the upper Tantangara dam to the underground power station is being built using a 2000t, 143m long and 11m diameter open-faced tunnel boring machine (TBM).

THE CHALLENGE

Early during the tunnel excavation phase, unforeseen obstacles emerged, and the TBM had to be paused: as it advanced through low-strength rock, the machine faced a sinkhole caused by a faulted and fractured zone of completely weathered rock, combined with a buried gully with substantial subterranean water flow. This led to the TBM dipping steeply, with collapsing material above reeling into the open face of the machine, creating a

sinkhole to the surface. The machine became immobilised, unable to steer, and any movement risked further collapse, exacerbating the sinkhole.

To assess the situation, extensive geotechnical investigations were carried out on the headrace adit alignment, including horizontal boreholes alongside from adjacent to the adit launch, inclined boreholes from above, geophysical MASW seismic lines from above, forward investigation holes from the two drill rigs inside the TBM, thus helping finalise remediation plans.

WAGSTAFF PILING'S SOLUTION

Due to the poor and very poor rockmass conditions encountered in front of the TBM, several rounds of grouting were performed from the TBM during the excavation of the tunnel, around and in front of the shield, to improve the rock mass condition. However, for a more effective ground consolidation, a treatment campaign needed to be implemented from the surface to improve the disturbed zone of the ground matrix sufficiently and ensure the TBM can successfully restart excavating.

The contract for surface consolidation works was awarded to Wagstaff Piling, an Australian-owned and operated piling contractor with over 40 years of experience in technically advanced foundation engineering.

"Due to the challenging conditions, we decided to adopt a special grouting method, using Part A and Part B grout combinations for control of grout mobility, viscosity, and gel set times," Russell Denny, special projects manager at Wagstaff Piling, explained. "Part A typically comprises cement,

bentonite, and water, and Part B comprises activator sodium silicate diluted in a bentonite and water slurry. The ability to vary the activator dose in real time allows the injected grout to be changed between high and low mobility very quickly. Grout properties can, therefore, be adjusted to suit unpredictable and/or variable downhole conditions. Textbook terms 'compaction' grouting, at the low mobility end of the range, and 'permeation' grouting at the high mobility end of the range. Real time oscillation between high and low mobility is the key to solving difficult problems with flowing groundwater, artesian pressures, voids, cavities, karstic conditions, and the like. This technique is predominantly a 'single-shot' technique, although a 'double-shot' process can be used if required."

A CAPABLE COMACCHIO RIG

Wagstaff Piling could rely on a Comacchio MC 22 duplex drilling rig, that was designed according to the client's specifications through the collaboration of the longstanding Australian dealer Drilltechniques.

"The MC 22 rig's features include advanced mast articulation capabilities, allowing it to perform the multiple inclinations required for the project," explained Christopher Logan, Director of Sales and Operations at Drilltechniques. "Moreover, we spec'd out the machine to include a heavy-duty double-head system, comprising a 2400daNm lower head and 900daNm upper head, combined to a triple clamp with the patented Comacchio casing extractor".

Drilling was performed with a down-the-hole hammer using 152mm diameter outer casing rotating left and inner rods rotating to the right with interchangeable drill bits. The drill holes extended from 45m to 60m at varying sub-horizontal angles in a canopy above and around the TBM's cutting head under the sink hole, and in front of the cutting face to reach the sound rock head

forwards of the TBM location. Following air flush drilling to the toe level, the inner drill rods with the DTH were extracted leaving the outer casing in place.

Mixing of all grout components, testing of grout parameters and pressure grouting would then be conducted via the end of the casing, as the casing was slowly withdrawn.

The seamless handling of casings and drill rods was made possible through the Comacchio excavator-mounted CPH grab.

GROUTING CHALLENGES

Maintaining precise borehole inclinations was critical to ensure effective grout penetration and consolidation of the fractured rock mass. However, this was only one of the challenges the drill crew had to face during the eight months of continuous operation.

Winter conditions posed significant operational challenges, particularly related to freezing slurry lines and temperature-induced variations in grout viscosity and set times. The slurry plant was designed with a recycling capability to prevent freezing and maintain continuous operation.

As the project progressed, a 24-hour shift system was adopted to expedite the process and align with TBM excavation schedules, which required precise coordination with the client and its TBM activities.

Due to the project's location in the heart of the Kosciuszko National Park, strict environmental control measures were enforced to minimise the impact of drilling and grouting operations. The use of an internal diverter mounted on the Comacchio MC 22 and the implementation of comprehensive measures for waste containment and disposal ensured that all environmental requirements were met.

"A series of 152mm diameter holes in the improvement zone would be drilled and grouted, with the variation of the grouting properties analysed, including delivery pressures, flow rates

and volumes," Denny explained. "A general target sequence was developed involving primary holes followed by secondary infill holes. However, as early works commenced the sequence was soon re-developed in response to the observations of the early grouting performance. Primary holes generally provided a baseline of the performance, and later holes indicated considerable ground improvement. Comparison of flows, back pressure, volumes, and connectivity to the TBM itself led to necessary viscosity adjustments and hole sequencing adjustments."

A total of 128 boreholes were executed, with approximately 6000m drilled and over 2000cu.m of grout injected.

SUCCESSFUL STABILISATION

Detailed monitoring of the surface area was carried out through a lidar survey to verify the effectiveness of the consolidations over time, highlighting the progressive reduction of the connection between the underground excavation of the TBM and the subsidence effect on the sinkhole on the surface until its stabilisation.

Ongoing injection eventually led to sufficient improvement in front of the TBM to allow thrust on the face to reinstate the ability to steer the machine. A sufficient stabilised canopy had been provided above the machine to drive ahead without unstable ground reeling into the machine. Now with stability at the face, the machine could be converted to closed face slurry mode. Once in slurry mode, the TBM could progress into the unstable interface zone, and drive into stable rock, where normal operation was possible.

Once complete, the Snowy 2.0 hydropower project will increase the scheme's generating capacity to 6.3 from 4.1GW, and will also serve as a battery, storing up to 350GWh for use at peak times, thus providing stability to the power grid when other renewable sources like wind or solar are failing to meet demand. ♥

"Due to the challenging conditions, we decided to adopt a special grouting method"

"Ongoing injection eventually led to sufficient improvement in front of the TBM"

Exploration time machine

How easy would it be for explorers to find deposits if they could go all the way back to when they were created? David Upton explores an approach heading down that path

Imagine reaching into your exploration toolkit for a digital twin of the Earth's surface – mountains, erosion, basins, oceans and even the rise and fall of great systems of oxygen and carbon. Then imagine using the digital twin to find basins with a perfect combination of factors for creating giant sediment-hosted copper deposits and tracking their movement across the Earth's surface to the present day. It would be a remarkable development in mineral exploration.

Now imagine that just such a thing could become a reality in only five years thanks to a world-first project led by University of Adelaide Mawson chair of Geology Professor Alan Collins. The project, Plate Tectonics, Critical Metals and Habitable

Earth project was recently made possible by an AUS\$3.4 million grant from the Australian Research Council Laureate Program. The University of Adelaide also committed AUS\$1 million to the project.

NOT JUST ABOUT ROCKS

Collins is a visionary scientist who has been working towards the launch of the project for 20 years. He was among the first to argue that plate tectonics is not just about rocks. Plate tectonics drives the chemistry of the oceans and the atmosphere, the global climate and the evolution of life itself. The profound impact of global tectonics has gained much more attention recently, with several scientific papers published since 2018 that tie it to the concentrations of carbon in the atmosphere and nutrients such as nitrogen and phosphate in the oceans.

Collins is also among a growing number of scientists who postulate the absence of plate tectonics on other planets, such as Mars and Venus, is why they do not support life, despite having volcanic activity and evidence of plenty of water in the past.

The University of Adelaide's digital twin project promises incredible advances in our understanding of all kinds of Earth systems, not just economic mineral systems. The digital twin will span the Earth's history from 1800 million years to 500 million years ago, taking it up to the Cambrian period when a great diversity of life emerged. Collins said unravelling how the deep Earth controlled the chemical and environmental evolution of the Earth's surface over such a long period of geological time was incredibly challenging.

"In some ways, the project is ridiculously ambitious," he said.

"But we can see all the steps ahead of us and have just about all the people with the right abilities and the technologies to pull it off. The ambition is to try to bring it all together over this five-year cycle and make this an area of research that leaves a legacy for the University of Adelaide well after the project is finished."

Building a digital twin will require a multinational, multi-disciplinary team. The project will be a collaboration with the University of Sydney's EarthByte Group, Curtin University, University of Leeds and a number of other colleges in Australia and overseas. Activity is due to begin in earnest this year after the recruitment of three post-doctoral researchers and up to six doctoral students.

The first step in creating the digital twin is already well underway with the publication in September of world's first continuous, full-plate tectonic reconstruction back to 1800 million years ago. This major work was led by Xianzhi Cao of the Ocean University of China and supported by researchers from the Collins' Earth and Tectonics Group, the University of Wollongong, the University of Sydney, and Curtin University.

PLATE RECONSTRUCTION

The initial focus of the digital twin project will be field work in Arabia, east Africa, India and Brazil to collect data to strengthen the plate reconstruction.

"What we've done with the plate reconstruction is definitely not the final word on what the world looked like over this time – it's only the first attempt," Collins said. "But it's a step change in the way we can test hypotheses for how our planet came to be habitable, with the

The ambitious project to build a digital twin of the Earth's surface dating back as far as 1800 million years ago is led by Alan Collins



diversity in ecosystems and life and chemistry that it has.”

Collins said three recent innovations made it possible to create a deep-time digital twin of the Earth’s surface. The first of these was the development of workflows and software to generate deep time plate reconstructions from thousands of scientific papers and paleo-magnetics.

“The second key innovation is the development of software to dynamically model the interaction of what we call the solid Earth with all the systems at the surface – how high are the mountains, how fast was the erosion, how much and what type of sediments were filling the oceans,” Collins said. “These are very complex interactions that are critical for developing our digital Earth model.”

The third major innovation lies in recent advances in geochronology that make it possible to rapidly and inexpensively determine the ages of shales, carbonates and other sedimentary rocks.

TRADITIONAL GEOCHRONOLOGY

Traditionally, nearly all geochronology has been directed at finding the crystallisation age of which igneous rocks cooled from magma, largely based on the radiogenic decay of a uranium isotope to a lead isotope. More recently geochronology techniques have become more widely used for finding the age of mineralisation in igneous and sedimentary rocks, including the timing at which it was reheated or added to by metamorphic events. However, a big piece of puzzle was still missing – the ability to determine the age at which sediments were deposited.

While a technique using an isotopic pair of rubidium and strontium had been available for many years, it was very slow and expensive. It worked only after the rubidium and strontium isotopes in a rock sample were painstakingly separated before the dating technique was applied. The rubidium and

strontium isotopes have the same atomic mass, which means a mass spectrometer could not identify one from the other.

Knowing the significance of this gap in geochronology, Collins was part of a team involving Sarah Gilbert, Juraj Farkas and Morgan Blades, who steered the development of a new form of rubidium-strontium dating by one of their then PhD students, Darwinaji Subarkah, supported by funding from MinEx CRC.

REACTION CELL TECHNOLOGY

The technique combines a “reaction cell” with a well-known technology known as laser ablation-inductively coupled plasma mass spectrometry. The reaction cell technology, which oxidises one of the ionic species of interest and not the other, was pioneered in 2016 by Thomas Zack at the University of Gothenburg in Sweden. He is now an affiliate with the University of Adelaide’s School of Physics, Chemistry and Earth Sciences.

“Thomas did the proof of concept and we have been developing it and applying it,” Collins said. “So, we are confident that at the moment, we are at the forefront of the application of this technique, and we aim to stay there.

“We can now very quickly, and therefore cheaply, get an awful lot more data for things. For example, within a day, we can conduct about 600 different analyses, which means you could easily sample every 5m of shale in a core, and in a week, you will have ages you will know whether it’s something to do with mineralisation or the depositional age of those shales. And you will only have spent a couple of thousand dollars.”

The reaction cell LA-ICP-MS machine is owned and operated by Adelaide Microscopy, which is part of the University of Adelaide.

MINERAL EXPLORATION

Collins said the digital model would be valuable for mineral

exploration because it covered a time when many global scale critical metal deposits were formed, including Mount Isa, Broken Hill, McArthur River and the African Copper Belt. “There are numerous theories about how plate tectonics shaped great mineral deposits,” he said. “These include the idea that copper enrichment in the African Copper Belt was due to an increase in atmospheric oxygen, which followed global glaciations eroding huge amounts of life-essential nutrients into the oceans.

“The digital twin will test that hypothesis and allow us to better understand the controls, timing and distribution of increased oxygen through the Proterozoic in Australia and around the world.

“Our research will also provide 1300 million years of earth history of where plate boundaries were active. This will allow explorers to pinpoint and track volcanic arcs that may have created Andean-like, giant porphyry copper-gold mineral systems.

“Arcs and their subduction zones also refertilise the mantle, which is a process that played a key role in the formation of the supergiant Olympic Dam deposit.”

More broadly, the digital twin will be fascinating for anyone with an interest in the tectonic forces that shaped Earth.

Collins said there was a huge amount of public interest in tectonics, with a video file of a tectonic reconstruction he released in 2021 recording almost four million views.

“An important part of the project is communicating our results, particularly with students, and feeding the natural curiosity of the public,” he said. “We need to encourage the next generation of researchers and explorers who ‘get’ the significance of plate tectonics in understanding our world and finding metals for the energy transition.” ▼

“We are at the forefront of the application of this technique”

The new technologies driving mineral exploration

Dr Dave Lawie, chief geoscientist, IMDEX, provides *GDI* with an insight into the latest technologies being developing to aid in the exploration of new mineral deposits around the world

By using the latest technology, geologists can now analyse rock chemistry, alteration, and structure in near real-time

The search for the next big mineral discovery is no longer just about luck and good geology. In a dynamic industry, modern mineral exploration is being shaped by innovative technology, AI, and real-time decision-making.

Today's explorers are harnessing some of the most sophisticated tools available.

Companies that adapt, innovate, and embrace new

exploration methods will be the ones to uncover the next world-class deposits.

With the increasing demand for critical minerals – including lithium, copper, and rare earths – the best exploration technology is no longer a luxury; it is a necessity. The future of mineral exploration will be defined by those who embrace real-time analytics, AI-driven insights, and innovative geochemical tools.

ARE WE LISTENING?

The rocks will speak – but are we listening? The answer lies in leveraging the latest advancements to decode the signals. IMDEX explored these issues in its Xploration Technology Symposium held in Canada in January 2025.

Exploration success is messy, uncertain, and often hinges on a mix of technological breakthroughs and sheer perseverance.



And innovation is non-linear, it is about swings, roundabouts, and human connections.

A major theme of the symposium, which is in its 10th year, was the shift toward real-time mineralogy.

Dr Cassidy Harraden from the Mineral Deposit Research Unit at the University of British Columbia highlighted the potential of Laser-Induced Breakdown Spectroscopy (LIBS), a field-portable technology that allows explorers to analyse mineral chemistry in minutes rather than weeks. This means geologists can confirm whether they are in the right alteration zone while still on-site, saving time, money, and drilling metres.

Harraden said one of the advantages of LIBS technology, "and why it's really having a moment", is because it can see almost the entire periodic table of elements.

Similarly, portable XRF (pXRF) technology has evolved from a basic elemental analyser to a game-changer in gold exploration.

Portable PPB managing director Simon Bolster showcased how pXRF can now detect gold at parts-per-billion (PPB) levels, something previously only possible with lab assays.

Letting the soil speak is now a reality, enabling companies to pivot their drilling programmes based on real-time geochemical data. But he provided some sobering statistics. Less than 4% of explorers make a discovery in the first year, and sometimes up to three companies explore the same ground before a discovery is made, and it can be 16 years from the first drill hole until the first bar of gold comes out of the processing plant.

A GAME OF BATTLESHIPS

Bolster made the point that the industry has a problem, saying, "It's a bit like a game of battleships." He said XRF has developed significantly, with instruments today better and faster than those of previous years.

AI and hyperspectral imaging are now also giving geologists new insights. Remote sensing technology, once limited to large-scale surveys, is being used to map mineral systems at incredible resolutions.

AI-powered platforms, including IMDEX's aiSIRIS and aiSWYFT, analyse spectral data, identifying alteration minerals and geochemical signatures that the human eye might miss.

This fusion of machine learning and traditional geology is unlocking hidden deposits and making exploration more efficient than ever before.

Nick Williams, principal geophysicist at KoBold Metals, gave an insight into how the company uses stochastic inversions, which he said was a different framework for doing inversions that allows many models and ideas to be tested.

"For relatively simple physics, we can use direct physics to solve gravity or magnetic problems," he said. "But for larger, harder compute problems such as 3D-EM models, we can use AI support to help us short circuit that physics calculation and do it faster."

MAGNETIC MEASUREMENTS

Another advance in mineral exploration, discussed by SB Quantum CEO David Roy-Guay, is the use of quantum three-component magnetic measurements. These ultra-sensitive sensors can detect minute variations in magnetic fields, allowing geologists to map subsurface structures with unprecedented accuracy.

Unlike traditional magnetometers, quantum sensors operate with higher precision, making them invaluable in detecting subtle mineralisation signatures even in highly magnetically complex terrains. This technology is particularly promising for deep exploration, where traditional methods struggle to penetrate.

While technology is evolving rapidly, adoption remains a challenge. Bradshaw Research Unit for Minerals and Mining regional director Janice Fingler,



in her presentation, noted that "social innovation is lagging behind technical innovation".

It is one thing to develop game-changing tools; it is another to get companies, drillers, and field geologists to integrate them into their workflows.

Explorers are often navigating risk in complex socio-technical environments. Companies that succeed in bridging this gap through training, collaboration, and smart implementation will derive the benefits.

One of the most exciting shifts in mineral exploration is the ability to shorten the feedback loop between drilling and decision-making. The desire to achieve this provides much of the drive for IMDEX research and development to improve existing products and deliver new tools and technologies.

Traditional exploration involves long delays; samples are drilled and sent to a lab, and results take weeks (or even months) to return.

By using the latest technology, geologists can now analyse rock chemistry, alteration, and structure in near real-time, providing a pathway to sustainably find, define, and mine orebodies with precision, confidence, and at speed.

The ability to pivot a drill programme based on immediate data insights is a significant efficiency and sustainability gain. It reduces wasted drill metres, improves targeting, and speeds up discoveries, critical advantages in an industry where time is money. ▼

One of IMDEX's AI-powered platforms, aiSIRIS can analyse spectral data, identifying alteration minerals and geochemical signatures that the human eye might miss

"This technology is particularly promising for deep exploration"

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