GeoDrilling International

ESTABLISHED 1993

FRASTE

Borehole logging

Examining advances in the technology used for borehole logging and how it is used in the field

DTH

How does DTH work, where is it used, and what influences the choice of equipment used?

The UK market

What's new in the UK market, and who are the companies behind those new developments

ISSN 0969-3769

June 2024 www.geodrillinginternational.com

Election time

After much speculation, the date for the UK's general election has finally been announced. While there is much speculation as to which of the political parties will have the necessary majority to form the UK's next government, the main source of concern for our industry is what opportunities they will create.

Let us not forget that the current Conservative government introduced the HS2 high-speed rail link between London and the North of the country only to severely curtail the programme after many of the companies involved had already committed to preparing, for now, unavailable work. However, this same party has now launched an election manifesto to establish funding for 100,000 apprenticeships every year, which would be good news for the geotechnical industry.

"We may all have to metaphorically hold our breath"

But what of the Labour party? Traditionally, seen as the party of the working classes and supported by trade unions, the general workforce could benefit from its leadership, but would those benefits extend to helping contractors and increasing infrastructure projects that would provide an increase in work for the drilling industry? The party says it will get Britain building again by "following strict rules that strengthen public finances and by reforming planning laws, so we build more houses, giga factories, windfarms, roads, labs and ports, developing the skills needed to do so."

Then again with a presidential election looming in the US at the end of the year, we may all have to metaphorically hold our breath for the outcome of that contest before we can see what the future holds for the drilling industry.

DUNCAN MOORE, EDITOR

duncan.moore@aspermont.com

For news and updates, follow me on Twitter: @GeoDrilling

News 2

Features

Opinion: BDA 10
Borehole logging 12
DTH 21
Special report: Bauer 24
Tunnelling 26
UK 29
Preview: Geotechnica 36

Classified advertising 40

Next issue

HDD
Drilling consumables
Ground source heating
Scandinavia

COVER

Fraste's patented GT Robot is a revolutionary double-rotary-head geothermal drilling rig that can handle drill pipes and casings together up to 200m depth, completely hand-free. It is a "game changer" in the geothermal drilling market. The "Autonomous Recovery System" for rods and casings avoids operator intervention (all software controlled – no mistakes – great safety), increasing safety rate and smoothness of the drilling job; we can say that this option is really a milestone in the progress of drilling technology. www.fraste.com

Editorial

Group content director Ana Gyorkos
Editor Duncan Moore
duncan.moore@aspermont.com
Editorial enquiries +44 208 187 2300

Social

@GeoDrilling
linkedin.com/company/geodrillinginternational
geodrillinginternational.com

Subscriptions and circulation

Visit www.geodrillinginternational.com/subscribe
phone +44 (0) 208 187 2330
or email subscriptions@aspermont.com
Aspermont Media Ltd,
21 Southampton Row,
London, WC1B 5HA

Advertising

Head office
Aspermont Media, WeWork 1 Poultry, London EC2R 8EJ, UK.
+44 208 187 2350

Rest of world **Sales account manager** Gabriella Kiss
+44 208 187 2324 gabriella.kiss@aspermont.com
North America **Sales account manager** Chad Dorn
+1 720 855 3996 cdorn@miningadvertising.com

Digital and creative

Group digital & creative director Abisola Obasanya
Print management Print.management@aspermont.com

Executive

Managing director Alex Kent **Group chief operating officer** Ajit Patel **Group chief financial officer** Nishil Khimasia
Group chief marketing officer Joshua Robertson **Chief commercial officer** Matt Smith

GeoDrilling International (ISSN 096-3769, USPS 1430) is published 10 times a year in Jan/Feb, Mar, Apr, May, Jun, Jul/Aug, Sep, Oct, Nov, Dec by Aspermont Media, WeWork, 1 Poultry, London, EC2R 8EJ, United Kingdom

Airfreight and mailing in the USA by agent named World Container Inc., c/o BBT 150-15, 183rd St, Jamaica, NY 11413, USA.

Periodicals postage paid at Brooklyn, NY 11256.

POSTMASTER: Send address changes to GeoDrilling International, World Container Inc., c/o BBT 150-15, 183rd St, Jamaica, NY 11413, USA.

Subscription records are maintained at Aspermont Media, 21 Southampton Row, London, WC1B 5HA.

Air Business Ltd is acting as our mailing agent

ISSN 0969-3769

Geotechnica – the UK's premier geotechnical event

Equipe Group has confirmed that its Geotehnica event, the UK's premier geotechnical conference and exhibition, will return to the Warwickshire Event Centre on July 3-4, 2024.

Geotechnica 2024 (presented by John Lawrie Tubulars) will not only host a dedicated exhibition and trade show for the UK geotechnical sector but also incorporate a not-to-be-missed conference. The conference will provide essential information to help improve the UK ground investigation industry and celebrate EDI within geotechnics.

While no ground investigation ever runs precisely as planned, day one of the Geotechnica Conference will include talks on the hypothetical 'perfect' GI. This series of talks will discuss good practices and how to design and carry out effective ground investigations that ensure quality data while meeting client objectives.

Day two's focus will shift to celebrating EDI within geotechnics, with talks on inclusive PPE and site practices, neurodiversity and challenging damaging stereotypes.

Equipe's operations director, Calum Spires, said: "Geotechnica 2024 is proudly presented by our Platinum Sponsor, John Lawrie Tubulars. The event is free to attend, and all stakeholders, clients, designers, contractors, suppliers, manufacturers, and early-career practitioners will benefit greatly from attending. Over 65 of the industry's leading companies are represented at the exhibition, so anyone wishing to communicate, promote, network and learn with all of the industry's biggest movers and shakers should mark their calendars now. We can't wait to welcome you to the Warwickshire Event Centre in July."

Hyperbaric excavation for Italian tunnelling job

Trained workers enter the hyperbaric regime for the Casalnuovo tunnel project through gradual adaptation in a special compensation chamber

For the first time in Italy, an innovative and sustainable excavation technique is being used at construction sites for the Naples-Bari high-speed/high-capacity railway. Excavation is taking place in a hyperbaric atmosphere introduced by Webuild on the Naples-Cancello Lot to construct a section of the Casalnuovo artificial tunnel lying partially under the water table.

A fundamental characteristic of hyperbaric excavation is the use of compressed air as a method for carrying out excavation operations in the presence of water. In fact, the pressure introduced into the site keeps water out of the work areas, leading to advantages from an environmental point of view in that the aquifer does not come into contact with cement mixtures and chemical additives. About 650m of the new tunnel, which crosses a heavily urbanised region, are being excavated non-stop, seven days a week, 24 hours a day, thanks to this new technique, which represents one of the few applications for this type of work in Europe.

Alberta Drilling Accelerator launches in Canada

The Canadian Association of Energy Contractors (CAOEC) was joined by the Honourable Rebecca Schulz, Minister of Environment and Protected Areas, along with executives from Eavor Technologies Inc., Indigenous leaders, the Canadian Geothermal Energy Association (CanGEA), and officials from Brazeau County, for the launch of the Alberta Drilling Accelerator (ADA).

The ADA will provide a first-of-its-kind in Canada, technology-agnostic, market-driven test site to support the creation of novel drilling techniques and technologies within the geothermal, critical minerals, helium, and carbon capture and storage sectors.

"Canada is home to the most advanced drilling technology in the world. Not only do our members support the responsible development of oil and gas, but we are integral in the extraction of new energy resources, like geothermal and critical minerals. Our workers are at the epicentre of Canada's energy transformation. Our people, technology, and processes are leading the way towards a more diverse energy future. The Alberta Drilling Accelerator is a government-enabled policy approach to expand Alberta's drilling capacity and reach its full potential as the world's most diverse and technologically advanced producer and exporter of sustainable energy and critical minerals," Mark Scholz, CAOEC president and CEO, said.

The ADA reflects the Alberta Government's commitment to establishing the province as a new energy hub promoting technology development and global adoption to augment its net-zero 2050 ambitions and energy security.

BDA Spring Conference 2024

The British Drilling Association (BDA) successfully convened its AGM and Spring Conference on May 9, 2024, at the Institution of Civil Engineers in Westminster, London. This year's theme, *Sector Growth Opportunities for 2024 and Beyond,* attracted a diverse group of industry leaders, experts, and stakeholders, each contributing to a comprehensive dialogue on the evolution and future direction of the drilling industry.

Following an introduction from Richard Fielden, director of the BDA, the conference began with a presentation from the BDA's recent past chair, Paul McMann, who handed over to the new chair, Mark Toye.

The new chair, Toye, spoke about the Association's plans, challenges and ambitions for the next two years, including stagnation shifting to growth, falling prices, long-term labour pressures, investor caution, an ever-complex environment and the procurement predicament.

Next to take to the stage was Tim Chapman, of the Boston Consulting Group (BCG), who provided a thorough analysis of the current trends in the energy sector. Dr Michael Kehinde from the Environment Agency followed with a focused discussion on groundwater management and its regulatory environment. Joanne Eynon of the Coal Authority then offered an in-depth look at the innovative use of old mining infrastructure to support renewable energy projects.

Mohit Farmah and Mark Boulton, of Thames Water Strategic Resource Options (SRO) Portfolio, presented after the Coal Authority, detailing an update on the SRO projects currently being explored by Thames Water, which have a combined CAPEX value in excess of £5 billion.

Next up was Catherine McGrath of National Highways, who spoke about changes to the framework for the 'Delivery and Procurement for GI in the Roads Sector' and the work that National Highways has been doing over the past years to make it more relevant and amenable to the GI industry.

Geoff Ellison from the Ground Source Heat Pump Association (GSHPA) concluded the presentations with an address that expanded the market for ground source heat pumps and the critical role of drilling in this sector.

Van Oord's Svanen upgraded for larger monopiles

In just one night, Van Oord's heavy lift installation vessel, Svanen, grew 25m taller. As part of a major upgrade, a huge A-framed gantry extension weighing 1200t was installed on top of the vessel. The operation increased the total height of the Svanen to 125m, making it one of the largest heavy-lift vessels in the world and capable of handling the next generation of monopile foundations for offshore wind projects.

The extension had been constructed by Holland Shipyards. One of the largest cranes in the world was used for the installation at Mammoet Schiedam. Besides the gantry extension, the upgrade to the Svanen includes a modernisation of the lifting hooks that will increase the lifting capacity of the vessel from 3000t to 4500t, an improvement of the gripper to handle increased loads and a modification of the structure of the vessel to accommodate the latest hammer size. The improved Svanen will be ready for operation in the third quarter of 2024.

Marco Hoogendoorn, commercial director at Holland Shipyards, said: "We are immensely proud to have constructed one of the largest steel structures in our history for the extension of Van Oord's Svanen, including the provision of new accommodation units. This project required not only exceptional precision in engineering but also presented us with significant logistical challenges. Thanks to the extraordinary dedication and collaboration of all teams involved, we have successfully realised this technical milestone. We are honoured to have played a crucial role in enhancing the capabilities of the Svanen, thereby contributing to the future of renewable energy and offshore wind projects."

Van Oord's Svanen has been upgraded to allow it to handle the latest generation of offshore wind farm monopile foundations

South Africa's Weco acquired by Epiroc

Epiroc has completed the acquisition of the business of Weco Proprietary Ltd, a South African manufacturer of precision-engineered rock drilling parts and provider of related repairs and services.

Weco, which is based near Johannesburg, has more than four decades of industry experience, has about 80 employees and had revenues in the fiscal year ending May 31, 2023, of about ZAR160 million (US$8.6 million).

Weco's customers are mainly underground mining companies in the Southern African region.

One million metres of autonomous drilling at Mt Arthur South

Australian Cat dealer WesTrac has celebrated an autonomous drilling record set at Thiess' Mt Arthur South operation in New South Wales, where one million metres of autonomous drilling was reached in April using a fleet of three Cat MD-series drills running with the Cat MineStar Command Autonomous Drill System (ADS).

WesTrac Technology Solutions manager Nakia Brewer said the achievement reflects the successful deployment of Cat-built autonomous drills and the strength of a technology-driven partnership. "When implementing new technology, it is crucial that there is a clear understanding of the problem you're trying to solve – in this case, it was to reduce operating costs and increase consistency of drilling."

"The way in which Thiess approaches technology, understanding the problem statement and how technology will ultimately solve that for them, is world leading."

WesTrac, Caterpillar and Thiess began the programme in 2019 and, following a multi-phase three-year journey enabled a remotely located operator to control the three drills, a Cat MD6250 and two MD6310s, simultaneously.

Thiess' head of Autonomy and Operations Technology, Trent Smith, said: "Working in partnership with WesTrac and Caterpillar, we took a drill that didn't have any automation capability and went on the journey as a team to bring through what is now three drills running autonomously with a single controller.

"We initially needed to select reliable technology that could deliver operationally and implement it in the right application. Then we addressed the change management around people and process to ensure we delivered the performance.

"It's been quite exciting to see a technology product from its very infancy all the way through to an autonomous operation, and the Mt Arthur South project realising value from it."

Competency Centre for Surface Mining in opened in Tucson by Epiroc

Epiroc USA staff at the ribbon cutting of the opening ceremony for the company's new Competency Centre for Surface Mining

Epiroc has inaugurated its Competency Centre for Surface Mining in Tucson, Arizona, US. The move marks a significant strategic advancement for Epiroc USA, with the establishment of a state-of-the-art 28,000sq.ft Rebuild Centre to provide advanced support for surface mining customers, thereby fostering business growth in the region.

The Competency Centre serves as a hub of excellence, delivering world-class aftermarket support, training, and specialised technical assistance tailored to exceed industry benchmarks. Services offered range from machinery remanufacturing to planned component replacement programmes, along with streamlined logistics and distribution for machine parts and consumables.

The Rebuild Centre, housed within the new facility, is equipped with cutting-edge resources tailored to meet the evolving needs of the industry. With four rebuild bays capable to accommodate four Pit Viper 271 rotary blasthole rigs simultaneously, and 1500sq.ft of advanced office space, the centre embodies efficiency and stands as an example of innovation and excellence in the heart of Arizona.

In addition to operational excellence and innovative data and automation technologies, Epiroc is committed to investing in its people, workplace culture, and sustainability goals. By supporting future talent and fostering the well-being of local communities across Arizona and the USA, Epiroc aims to make a lasting impact on the mining industry's sustainable development.

The significance of this achievement was highlighted by Jon Torpy, president and GM of Epiroc USA, who emphasised: "The opening of the Competency Centre underscores our dedication to investing in the future of mining. By providing customers with advanced technical assistance to extend fleets' longevity, we are contributing to the industry's sustainable development. This marks a major step forward in our mission at Epiroc, ensuring swift, efficient solutions to support mining operations."

In Brief

Deep Isolation partnership

Deep Isolation has entered into a strategic partnership with Navarro Research and Engineering to collectively drive forward the safe disposal of high-level nuclear waste in deep geologic boreholes.

Under this partnership, Navarro and Deep Isolation will jointly develop strategies to demonstrate the feasibility of Deep Isolation's solutions for the disposal of high-level nuclear waste.

Equinor lithium deal

Equinor has entered into an agreement with Standard Lithium to acquire a 45% share in two lithium project companies in Southwest Arkansas and East Texas.

Standard Lithium and Equinor will respectively own 55% and 45% of the two project companies, with Standard Lithium retaining operatorship. Equinor will support the operator with core competencies such as subsurface and project execution capabilities.

US uranium drilling

Global Uranium and Enrichment, an Australian public-listed company that provides exposure to uranium exploration and development, has begun a drilling programme at its Tallahassee uranium project.

The 10-hole, ~2,300m programme is a fundamental step in the development pathway for the project, where historic drilling formed the basis of the project's JORC 2012 Mineral Resource.

Komatsu battery-electric launches

Komatsu's ZB21 bolter is now being offered in a battery-electric version

Komatsu has introduced the second generation of its Z2 product line of small-class development drill and bolting equipment with unique enhancements and additions, including the first battery-electric offerings within Komatsu's underground hard rock portfolio, an innovative pumpable resin system solution, optimised ergonomics and more.

The small-class ZJ21 jumbo drill and ZB21 bolter were initially launched in 2020 with a common platform. The new Z2 bolters and jumbos also feature optimised operator ergonomics designed to maximise comfort and visibility, user-friendly intuitive controls and engineering for ground-level maintenance.

The second generation ZB21 is a small-class bolter featuring a fully enclosed ROPS/FOPS-certified operator cabin, intuitive operator controls, integrated patented screen handling and industry-leading drifters manufactured by Montabert.

The bolter also introduces an optional Komatsu pumpable resin system using J-LOK P by Jennmar. The unique solution allows resin to be pumped into the drilled hole prior to bolt installation, permitting the use of more economical bolts and helping to decrease overall installed cost.

The second generation ZJ21 jumbo drill is a single-boom development drill with a fully enclosed ROPS/FOPS-certified operator cabin, innovative drilling feeds, advanced pilot hydraulics and renowned drifters manufactured by Montabert.

Federation of Piling Specialists welcomes new chair

The Federation of Piling Specialists (FPS) has announced the appointment of Malcolm O'Sullivan as its new chair. He succeeded John Chick, who has successfully completed his two-year tenure. O'Sullivan officially began his leadership role on May 16, 2024, and he will commit to furthering the FPS's core values and strategic objectives.

O'Sullivan, currently the COO at Van Elle, brings over 20 years of extensive experience in ground engineering and deep foundation construction to the role.

During his tenure, O'Sullivan aims to focus on advancing all areas of safety, sustainability, diversity, and inclusivity. He plans to continue enhancing the profile of the piling sector, ensuring it is recognised as a pivotal part of the construction industry's growth, sustainability, and innovation.

Key initiatives O'Sullivan intends to promote include addressing key areas for improvement around safety, such as clearing concrete lines and preventing, locating and clearing blockages in CFA piling through specific working groups and commissioned research.

O'Sullivan also plans to drive the FPS's net zero carbon journey by embedding sustainability in the FPS audit process and reporting on members' project carbon footprints quarterly. He will also work on developing digitalisation within FPS members to facilitate information sharing for industry benefits.

An additional plan for O'Sullivan will be promoting opportunities for all within the sector and enhancing initiatives like the Young Careers Group to foster the next generation of industry leaders.

O'Sullivan's vision is aligned with the FPS's longstanding commitment to safety, high standards, and proactive collaboration with its members to drive industry improvements.

Reflecting on his appointment, O'Sullivan expressed his enthusiasm: "It is an absolute honour to be appointed chair of the FPS. I am eager to build upon the strong foundation laid by my predecessors and to ensure our sector continues to punch above its weight within the wider construction industry."

Caterpillar invests $90 million in Texas

Caterpillar Inc. has announced a $90 million investment to prepare its facilities in Schertz and Seguin, Texas, US, to produce the all-new Cat C13D industrial engine. The investment will create 25 jobs at Schertz starting in 2026.

"We appreciate the support from the local community as we prepare our Seguin and Schertz facilities to produce the C13D engine," Mark Stratton, vice president and general manager of Caterpillar's Industrial Power Systems – Large Engines, said. "The Caterpillar team in Texas will produce the quality parts and engines we need for our customers as we help them build a better, more sustainable world."

Cat's investment to produce the all-new Cat C13D industrial engine will create 25 jobs at Schertz starting in 2026

The C13D is a new 13L diesel engine platform designed to achieve best-in-class power, density and fuel efficiency. The engine optimises the performance of heavy-duty off-highway applications such as material handling, construction, mining, and aircraft ground support.

The investment includes new equipment installations at both facilities, $70 million in Schertz to make C13D engine components and $20 million in Seguin to assemble the engines. The new equipment installations will not impact current operations, which include manufacturing Cat and Perkins engines and generator sets.

C13D engine production is slated to start in 2026.

Sandvik's Hindustan Zinc contract

Sandvik has received an order from the Indian mining company Hindustan Zinc Limited to supply underground mining equipment at a value of approximately US$32 million.

The contract, which builds on a long-standing partnership between Sandvik and Hindustan Zinc, includes underground mining equipment and expands Hindustan Zinc's fleet of Sandvik equipment with more development drills, production drills, trucks and loaders. In addition to the equipment order, the deal also brings a significant aftermarket value.

MACA awarded Miralga Creek contract

Atlas Iron has awarded MACA the contract to provide mining, and drill and blast services at Miralga Creek.

Miralga Creek becomes MACA's second active Atlas Iron contract, situated in close proximity to Sanjiv Ridge, a project awarded in June 2020 providing infrastructure, drill and blast, and load and haul.

Operating at the project since mid-March under a Letter of Intent, MACA rapidly mobilised a fleet of excavators, trucks, drills and associated support equipment.

MACA has been awarded the mining, and drill and blast services contract at Miralga Creek

GA Drilling's US$15M to accelerate deep geothermal

GA Drilling, a specialist in deep geothermal, has announced the first close of US$15 million in financing after a series of successful tests.

The investment fuels the commercialisation of geothermal technologies to scale the renewable energy source as a real option to replace fossil fuels for baseload power. GA Drilling states that delivering deep geothermal faster and at deeper depths while remaining cost-effective is how it will go from delivering megawatts of energy to terawatts.

Investors include drilling rig, services, and technology provider Nabors, Christian Oldendorff's new Family Office, alfa8, the previous CEO of private equity firm EQT, Thomas von Koch, newly established geothermal fund Underground Ventures, and Slovakia-based Neulogy Ventures.

Igor Kocis, co-founder and CEO of GA Drilling, said: "The excitement around deep geothermal is well placed given that our innovations have taken the estimates for the geographical availability of geothermal energy from 3% to 70% plus of the planet. We couldn't say this 18 months ago, but now, if an energy operator or power company does not have geothermal in their strategy portfolio, they are already behind."

Enteq begins multi-well testing campaign

Enteq Technologies (Enteq) has started an extensive multi-well testing programme for its SABER Tool (Steer-At-Bit Enteq Rotary Tool), having secured a long-term contractual relationship in Australia.

Based on a concept originally developed by Shell, the SABRE Tool has been field-proven in a range of operating environments during testing in Norway and the Catoosa Test Facility in Oklahoma last year.

Responding to the news, Neil Bird, VP advanced drilling systems, Enteq, said: "After five years of development, testing and enhancement, we have a fantastic tool on our hands. The adjustments that have been made have been small, but this is why field trials are vital. They allow us to develop a tool that isn't just good, it's great."

The SABER Tool deploys a unique internally directed fluid pressure differential system for steering rather than using pads or pistons. By removing external components, SABER offers significantly improved reliability and has the potential to drive operational efficiency across hydrocarbon production, geothermal energy, methane capture and carbon capture and storage at a lower initial cost.

Idaho Copper's next step with Veracio tech

Veracio will deploy a TruScan core scanning unit to begin digital scanning and measurement of the metal grades of over 60,000ft of drill cores pulled from Idaho Copper Corporation's (ICC) CuMo project over the past 20 years.

The TruScan mobile scanning unit contains sophisticated software and XRF scanning equipment that analyses drill cores on as small as 1.5cm intervals to detect and measure copper and molybdenum grades.

XRF technology is non-destructive and works by measuring the fluorescent (or secondary) X-ray emitted from a solid material sample when it is exposed to a primary X-ray source. Each of the elements present in a sample produces a set of characteristic fluorescent X-rays that is unique for that specific element.

ICC will utilise this data to confirm previous laboratory analyses of the metal distribution within the core, and compare the detailed scan results with previous studies. The results will then be used to determine potential ore sorting parameters in an updated Preliminary Economic Assessment (PEA) and to select various bulk core samples for detailed metallurgical and ore sorting studies.

SURF begins excavation to expand underground research space

The Sanford Underground Research Facility (SURF) has conducted the first underground blast in a major expansion of new research space nearly a mile below the surface.

"Multiple generations will benefit from this blast," Casey Peterson, board chair of the South Dakota Science and Technology Authority (SDSTA), who set off the 350lb of explosives from the 4850 Level of SURF, said. "This is the extended future of the lab. Our grandchildren and great-grandchildren could work here someday, thanks to this effort."

The first blast was conducted for a new access tunnel, called a drift, that will lead into two large caverns set to house future generations of cutting-edge underground research. The access drift is the first phase of the expansion and is expected to be completed this autumn. Phase two, which includes the larger caverns, is expected to commence around 2028 and take two to three years to complete.

Blasting drifts into solid rock underground is a highly controlled and carefully engineered process. The volume of explosives is carefully calculated and placed by mining engineers and technicians to achieve a precise outcome and contour of the drift. Following the blasts, excess rock is removed and the walls and ceiling of the drift are secured with rock bolts. All rock excavated from SURF stays on site; the rock excavated in the creation of this access drift will all be kept underground.

(L-R) Mike Headley (Mike Headley, executive director of the SDSTA) and Casey Peterson (board chair of SDSTA) at SURF

"This first blast is the culmination of years of hard work to secure funding and complete excavation plans, and it sets a strong foothold for a multidisciplinary lab at SURF for the future," Mike Headley, executive director of the SDSTA and the laboratory director at SURF, said.

The excavation of this access drift is thanks to an investment made by the State of South Dakota, which allocated US$13 million for the expansion of SURF during the 2023 legislative session in Pierre, South Dakota.

2026 dates announced for next edition of Geofluid

Piacenza Expo has announced the dates for the next edition of Geofluid, the international exhibition of technologies and equipment for the exploration, extraction and transport of underground fluids, and a European reference point for drilling and foundations.

Having broken attendance records when it was last held in Piacenza, Italy, in 2023, the next edition of the event will take place in 2026 from 7 to 10 October.

The show's organisers have confirmed that the themes of water and new energies will continue to be dominant at the next Geofluid. A feature that will be further enhanced by a technologically changed exhibitor fleet with the adoption of greater digitalisation thanks to artificial intelligence applied to site processes. A green revolution in these sectors will again be supported by EU funds for the environment and investments by energy multinationals that can encourage new construction sites on both large-scale works and punctual interventions and have a greater impact on the issues of environmental protection, hydrogeological instability and alternative sources.

Once again, geothermal energy, soil remediation and tunnel maintenance for road networks will also be reference interventions for geotechnical operators attending the Italian exhibition.

The new equipment, software and technology already available for the shipbuilding industry will be the added value of the event, which boasts the certified status of an 'international exhibition'.

For the British Drilling Association, employee training plays a pivotal role in shaping the future of the drilling sector
Photo: BDA

The crucial role of training in the drilling sector

The British Drilling Association asserts that the cornerstone of success in the industry lies in the continuous development of its workforce

As the British Drilling Association (BDA) proudly unveils its 'New Entrant Training Scheme' for the 2024/25 session, it underscores the pivotal role of training in shaping the future of the drilling sector. It reinforces the Association's belief that training is not just an obligation but the bedrock upon which safety, quality, and professionalism thrive.

Training serves as a catalyst for exponential growth, fostering a culture of competence and innovation within organisations. By investing in employees' skills and knowledge, companies enhance productivity and fortify their competitive edge in the market. This investment in training spans from honing technical proficiencies to nurturing leadership capabilities, equipping individuals with the tools they need to excel in their roles and drive organisational success.

Moreover, the importance of training extends to promoting safety and mitigating risks in drilling operations. By instilling best practices and adhering to industry standards, trained professionals contribute to a safer working environment for themselves and their colleagues. In an industry where every operation carries inherent risks, the value of comprehensive training cannot be overstated in safeguarding lives and assets.

Additionally, training elevates the quality of workmanship and service delivery in the drilling sector. By upholding rigorous standards and implementing best-in-class practices, trained professionals ensure that projects are executed precisely and efficiently. This commitment to quality not only enhances client satisfaction but also strengthens the reputation and credibility of the industry as a whole.

The BDA's New Entrant Training Scheme stands at the forefront of training excellence – an initiative designed to cultivate the next generation of skilled professionals in the land drilling sector. This comprehensive 18-month programme empowers novice employees with the expertise and confidence to assume leadership roles as lead drillers.

Through a blend of theoretical instruction and practical hands-on experience, the scheme equips trainees with a robust set of competencies needed to excel in their roles. The attainment of the prestigious National Vocational Qualification (NVQ) in Land Drilling, Level 2, is a testament to their readiness to navigate the industry's challenges with proficiency and poise.

The scheme welcomes participants from diverse land drilling sectors, offering a versatile platform for skill development and career advancement. It is also fully endorsed by the Construction Industry Training Board (CITB), which means the scheme benefits from the backing of industry regulators and stakeholders, ensuring its alignment with industry standards and best practices.

Eligible employers can leverage grants to offset the costs associated with training new entrants, promoting inclusivity and accessibility within the industry, too.

As the training provider, the BDA assumes responsibility for managing all aspects of the scheme, from administrative tasks to coordinating training sessions and assessments, ensuring a seamless experience for all stakeholders involved.

In an interconnected world, collaboration and knowledge sharing are key drivers of progress and innovation. Training initiatives should foster partnerships and networks both within the industry and across construction sectors to facilitate the exchange of best practices, insights, and experiences.

Training has never been easier, and we can now leverage digital platforms and virtual learning environments to facilitate remote collaboration and knowledge sharing. Online forums, webinars, and virtual workshops enable professionals to connect with peers, mentors, and subject matter experts from around the world, enriching their learning experience and expanding their professional networks. It does not even have to be formalised – simply engaging in anything that improves knowledge is good.

The landscape of the drilling sector is constantly evolving, with new technologies, regulations, and challenges emerging

regularly, and training programmes must evolve alongside industry trends to ensure that professionals remain equipped with the latest knowledge and skills.

Callum Allardyce's journey serves as a prime example of the impact of these apprenticeship programmes. Starting his career in drilling and working for numerous companies, Allardyce embarked on the British Drilling Association Apprenticeship. Over the 18-month training period, he gained a wealth of knowledge about the drilling industry, later achieving his NVQ in Land Drilling Operations as a lead driller.

Allardyce's continuous development took him across the globe, employing various drilling methods on land, offshore, and nearshore. After qualifying as an assessor, his progression from a drilling manager to a BDA auditor highlights the comprehensive career paths available within the drilling industry. Reflecting on his apprenticeship, Allardyce noted the value of sharing best practices and stories with fellow apprentices, a testament to the programme's emphasis on collaborative learning and professional growth.

Training, therefore, plays a fundamental role in shaping the future of the drilling sector, driving innovation, safety, and professionalism. By investing in comprehensive training programmes, organisations can empower their workforce to excel in their roles, adapt to evolving industry dynamics, and contribute to the continued advancement of the sector. We can ensure a bright and prosperous future for the drilling industry through continuous learning, collaboration, and a commitment to excellence.

The apprenticeship programmes introduce several key benefits that underscore their value in the drilling sector. Apprentices can meet and engage with others on the same pathway, sharing experience and knowledge and discussing best practices. This engagement fosters a collaborative learning environment where best practices and various methodologies are exchanged, enhancing their professional development.

Apprentices are exposed to intense modules on critical areas of the drilling industry, including drilling applications, geothermal, anchoring, and drilling and grouting. These modules provide knowledge and insights into aspects of drilling not covered in traditional paths, such as the Level 2 Diploma in Drilling Operations, enriching their learning experience.

In addition, Land Drilling NVQ Ltd, one of the BDA's trusted training organisations, invites industry experts to talk to the apprentices, providing them with direct exposure to leaders in their respective fields. Site visits are incorporated into most modules, allowing apprentices to observe live drilling practices such as anchoring and, drilling and grouting, which significantly enhances their understanding by correlating theoretical knowledge with real-world applications.

Another unique aspect of the apprenticeship is the inclusion of a wire rope familiarisation course and test, aligning with the BDA Audit requirements. This, along with visits to working laboratories, gives apprentices a holistic view of the drilling process, from practical execution to the analysis of samples, further instilling invaluable knowledge.

The role of borehole geophysics for assessing slope stability

Graham Comber, geotechnical adviser at Robertson Geo, discusses the role of borehole geophysics in assessing slope stability

Logging at distance for a hazardous slope overlooking a coastal railway

Ground conditions typically represent the greatest unknown for civil engineering design, which is especially true when the stability of slopes needs to be considered. Geophysical borehole logging plays a key role in the assessment of potentially hazardous slopes by providing a wealth of high-quality subsurface data not readily available by other means.

SLOPE STABILITY

A slope is considered stable when it can withstand its own weight and external forces without displacement occurring. Slopes are analysed by calculating a Factor of Safety (FoS), defined as the ratio of forces resisting shear to those driving it, where a safety factor of less than 1.0 implies that the slope is unstable.

The factors that affect slope stability are primarily the angle of the slope and the cohesion of the slope material, where the slope angle dictates the driving force, generally gravity, and the cohesion is the resisting force resulting from the slope material's shear strength. In addition, there are many contributing factors that influence whether a slope is stable or not, including height, weathering, water table level, drainage and vegetation.

Slope failure may occur incrementally or be catastrophically triggered by severe events such as intense rainfall, earthquakes, volcanism or man-made factors. Over time there may be an accumulation of separate events that contribute to the ultimate failure of a slope. Spatial methods allow slope profiles to be delineated cost effectively, identifying the precursors of failure which may prompt more detailed investigation.

SLOPE MANAGEMENT

Urban development in cities with space limited by mountainous terrain needs careful management to ensure landslide risk is mitigated, especially on steeper slopes. In Hong Kong, for example, slope management is key, as buildable land is scarce, the bedrock includes problematic weathered granite and the area is subject to typhoons and heavy rainfall. Seismically active urban areas need to take extra precautions as earthquakes notoriously trigger landslides on unstable slopes. Other cities may suffer from unregulated urbanisation, which can decrease the stability of hillsides by cutting into them to make space for buildings.

Linear infrastructure, in the form of roads, railways and waterways, may need to cross hilly or mountainous terrain. To minimise elevation changes carefully designed and maintained cuttings may be needed to ensure slope stability around the infrastructure.

Mining activities, as they constantly create and change slopes, need to manage their stability. For open-cast mines, the overburden needs to be removed and deposited in heaps. Geotechnical investigation can provide data that allows higher inter-ramp angles of mined faces with a significant cost benefit from reduced waste stripping. Management of tailings is also needed especially where an embankment dam is used to hold back liquified material from ore extraction processes.

Earth-fill embankment dams, dykes and levees in even the flattest terrain also need slope management to protect against flooding in areas adjoining rivers or coasts.

STABILITY ASSESSMENT

Geophysical borehole logging supplies key in-situ data for slope stability analysis, which

Table 1: *Geophysical Probes Used for Slope Stability Assessment (most common first)*

Probe	Outputs	Data Usage
High Resolution Acoustic Televiewer® High Resolution Optical Televiewer®	Unwrapped, oriented borehole wall image	Fracture identification and characterisation Bed boundary delineation Depth and orientation control for core samples
3-Arm Caliper (Gamma)	Diameter, gamma	Bed delineation and weak zone identification Correlation between boreholes
PS Logger®	P-wave velocity S-wave velocity	Poisson's ratio and small strain moduli Shear strength of rock-mass
Formation Density	Bulk density	Density profiles Rock-mass determination (weight)
Nuclear Magnetic Resonance (NMR)	Porosity, permeability	Water distribution profiles Permeability estimation
Electric Log	Resistivity	Hydrogeological characterisation
Focussed Electric Log	Resistivity	Hydrogeological characterisation
High Resolution Flowmeter	Flow rates	Inflow and outflow determination
Temperature Conductivity	Temperature, conductivity	Location of aquifers

complements other techniques such as spatial mapping, surface seismic and CPT. Borehole logging works equally well in all types of formation, from unconsolidated sediments through to the hardest rocks, producing digital data that can easily be combined into structural databases. The nature of slopes means that logging crews need to be flexible to successfully log boreholes that may be difficult to access and are often angled or even horizontal. Once setup however, the logging crew can deploy a range of geophysical probes including those shown in Table 1.

Borehole Televiewers, producing unwrapped oriented images of borehole walls, are the go-to probes for slope stability investigation. Acoustic Televiewers need a fluid-filled borehole, while Optical Televiewers work in dry or clear fluid-filled boreholes. When using Televiewers, it is not imperative that core samples are collected though this is still the normal practice. The digital data derived from processed televiewer logs now routinely enhance or replace costly traditional core logging. See Table 2 for the benefits of using Televiewers versus conventional core logging techniques.

In addition to Televiewers, all the probes shown in Table 1 have also been deployed for slope stability assessment. The Three-Arm Caliper produces natural gamma profiles which are useful for bed delineation across multiple boreholes. The diameter data is used for identifying weak zones and providing QC for other probes affected by washouts from the drilling process.

The PS Logger probe measures compressional (P) and shear (S) velocities in hard and soft formations enabling Poisson's ratio to be determined. When combined with bulk density values from the Formation Density probe or Nuclear Magnetic Resonance (NMR) probe, small strain moduli profiles can be calculated, with the shear modulus being critical for calculating cohesion in slope materials. The bulk density values also enable accurate weight calculation, usually the primary force acting on the slope. Data from the remaining probes are mainly used for determining the groundwater conditions, an important factor in slope stability.

Table 2: *Advantages of Televiewers versus Conventional Core Logging Techniques for Slope Assessment*

Factor	Benefit
Improved Quality of Data	Conventional core logging requires the logger to individually assess each fracture and may lead to erroneous identification of drill induced fractures. Televiewer data is based on the in-situ borehole wall image, improving rock mass quality estimates. Using structural information from televiewers eliminates human error from manual core measurements.
Accurate Depth Control	Televiewers measure depth with centimetre accuracy while core samples may not match driller depths due to incomplete recovery. The possibility of incorrectly reconstituting a highly fractured core sample is also eliminated. Televiewers show only the in-situ borehole wall, whereas core samples may, in the worst cases, be irrecoverably broken up.
Automatic Orientation	All televiewers record directional information in real time so that borehole data can be automatically converted from apparent to true orientation. Whether the borehole is near vertical, steeply angled or even horizontal the derived structural features can be characterised in true orientation using automated processing software such as GeoCAD®.
Simple Fracture Zone Characterisation	It is difficult to accurately assess the orientation and true thickness of fractures from recovered core. Simple to use processing software (GeoCAD®) allows for accurate determination of the azimuth, dip and fracture thickness. Features can be displayed in a variety of ways including tadpole plots and pseudo core images then analysed statistically.
Slope Design Optimisation	Televiewers provide more accurate structural information for fractures and bedding which improves the quality of structural databases and leads to better slope models. Slope design can then be better optimised as confidence in safety factors is improved.
Time and Cost Benefits	Digital files automatically produced from televiewer surveys reduce the time spent determining the orientation and depth of structures and speeds up input into structural databases. Traditional core logging can be time consuming, is more prone to human error and requires QC vigilance on the measurements.

The NMR probe is now gaining popularity for its ability to discriminate between clay-bound, capillary-bound and mobile components of the overall water content when measuring porosity. From this data estimates of permeability and bulk density can be derived.

The Focussed Electric and Electric Logs produce resistivity profiles, which are routinely used by hydrogeologists analysing groundwater conditions. Finally, the Temperature Conductivity probe and High-Resolution Flowmeter are used for identifying and quantifying borehole flows respectively.

GEOPHYSICAL DATA

Professionals tasked with assessing natural slopes and designing man-made slopes need to determine Factors of Safety and failure mechanisms, identifying hazards and sensitivity to triggers to produce safe, reliable economic designs with appropriate mitigation and remedial measures.

This process requires detailed, accurate information about slope geometry (spatial methods), geology (trial pits and boreholes) and soil/rock mass properties and groundwater characterisation from geophysical methods, including borehole logging. A range of analysis techniques are available, including finite element limit analysis, discontinuity layout optimisation and finite difference methods, to calculate probabilities of failures and the consequential risk. Digital data from borehole logging can simplify the task of feeding these large computer models.

THE FUTURE

The assessment, analysis and mitigation of potentially hazardous slopes is of increasing importance as global temperature rises. There is an increased likelihood of major weather events, which may trigger slope failures, typically through landslides. Prevention and mitigation are always preferable to risking human lives and the costs associated with remedial action after a major slope failure. Borehole geophysics, by providing detailed and accurate subsurface data, will play an increasing role in the investigation of potentially hazardous slopes thereby improving confidence for engineers when calculating safety factors and managing slopes.

The importance of boreholes

Debbie Darling looks into the history of borehole logging and then moves on to consider the current technology used in the process of recording the information that can be found about the geological formations within them

Borehole geophysical logging is the practice of creating a detailed record or well-log of the geological formations of any given borehole

Photo: Robertson Geo

Here in *GeoDrilling International*, and anywhere with content relating to geological drilling, you will often encounter the phrase borehole, which is the generalised term for any narrow shaft drilled into the ground, vertically or horizontally. Engineers and environmental consultants use the term borehole to collectively describe all of the various types of holes drilled as part of a geotechnical investigation or environmental site assessment.

In addition, boreholes are used for extracting resources such as water, gas, and petroleum. Samples collected from boreholes are often tested in a laboratory to determine their physical properties or to assess levels of various chemical constituents or contaminants.

BOREHOLE HISTORY

Borehole drilling has a long history; in fact, it is as old as civilisation itself. The first records of borehole drilling date back nearly 5000 years. The Egyptians created copper drill bits and used these along with sand, gravel and water to cut through different types of soil as early as 2500 BC.

By the Han Dynasty, which ran from 202 BC – 220 AD, the Chinese used deep borehole drilling for mining and other projects. The Chinese method of deep drilling was accomplished by a team of men jumping on and off a beam to impact the drilling bit while buffalo and oxen rotated the boring tool. A western Han Dynasty bronze foundry discovered in Xinglong, Hebei, had nearby mining shafts that reached depths of 328ft with spacious mining areas; the shafts and rooms were reinforced with timber frames and completed with ladders and iron tools.

By the first century BC, Chinese craftsmen cast iron drill bits, and drillers were able to drill boreholes up to 4800ft deep. However, the process was incredibly time-consuming. As the depth of the holes varied, drilling a single well could last nearly a decade. It was not until the 19th century that Europe and the West would catch up and rival ancient Chinese borehole drilling technology.

BOREHOLE LOGGING

Borehole geophysical logging, also known as well logging, is the practice of creating a detailed record or well-log of the geological formations of any given borehole. Data is collected, analysed, and interpreted during this process to understand the in-situ ground conditions encountered in boreholes. It measures the physical, geophysical, chemical and structural properties of the materials penetrated by the borehole.

The data contained in a bore log include project details such as name, number and place, details of the type of drill rig, the boring depth, method of drilling used, soil classification, including density and consistency, as well as sedimentary structure, mineral composition, right through to details of water content and moisture.

The information recorded is the result of a visual inspection of samples brought to the surface or from geophysical measurements along the axis of a borehole and measurements transmitted using a special logging device that is lowered into the hole.

The device is manipulated up and down the borehole, recording geotechnical data. The data covers key information relating to both soil and rocks. The logging cable and probe are lowered down the hole from a drum on a winch with appropriate slip rings on its axis to pass the electrical signals from the cable to the selected logging system. The cable passes over a pulley with a depth encoder, which provides the logging system with information on the depth of the probe in the hole as it moves down or up. Borehole logging systems take the information and measure-

ments from inside boreholes with borehole probes containing sensors and instrumentation.

A borehole log provides key pieces of information such as the type of soil-cohesive (clays) or non-cohesive (sands and gravels), water table, and consistency of the soil. The information gathered is useful in determining the desirability of the identified formations depending on the type of well. The data is also essential in informing the drillers if water from the boreholes should receive additional treatment before it is used commercially.

The borehole logs are used by a variety of specialists, including geologists, geoscientists, geotechnical engineers, and other experts. These experts can consult the borehole logs while drilling to determine a formation's suitability and to identify any issues or problems that can occur that can impact future works. Bore logs also provide valuable information for oil and gas exploration, groundwater studies, mineral exploration, and geothermal exploration.

Borehole logging techniques are used to maximise the information obtained from geotechnical borings. Borehole tools range from mechanical devices, through nuclear/gamma, acoustical, electrical, and imaging, to sensors for fluid properties. Different probe sensors are available, which can measure the physical properties of the rocks or soils surrounding the hole, such as magnetic properties, electrical resistivity, radioactivity, acoustic velocity, density, and porosity. Some probes contain more than one sensor and can produce more than one log from each trip down a hole.

Common borehole logging techniques include video, resistivity, natural gamma, electromagnetic induction, calliper, spontaneous potential and borehole deviation. Data acquired is usually documented in a standardised log spreadsheet. Boreholes provide a way to view rock, water, and other materials, as well as physically obtain samples.

BOREHOLE DATABASE

More than 20,000 boreholes are estimated to be drilled annually at an average cost of £4000 per borehole. Furthermore, a staggering 80% of borehole data is estimated to be missing. If that data were captured and accessible, there would be the opportunity to re-use it, and crucially, this would create significant costs and efficiency savings and create an information resource to fuel data and analytical models.

Contractors are actually becoming better at accessing the existing stores of bore logs with the Boreholes Geological Database, holding over 1 million borehole records. Some of the records date back as early as the 1600s; many date back to the 1800s, with the majority dating from the 1900s onwards. Boreholes drilled for water resources or mining purposes are required to be deposited with the BGS (British Geological Survey) under statute, but those drilled for civil engineering purposes are not.

Records of all onshore (or near-shore) boreholes, trial pits, shafts, and wells held in the BGS archives are either in paper, microfilm, or digital format. The records range from simple, single-page lithological logs through to hydrocarbon completion reports. Spatial coverage will vary considerably depending on drilling activity, collecting activity and donations. Most new data is from site investigation reports with concentrations in urban areas along transport routes. Over 50,000 new records are added per annum.

THE FUTURE

Whether it be the simple record of the drilling process or a detailed geological/geotechnical description of the ground, 'borehole logs' mean different things to different people, but the information comes at a cost, so boreholes should be designed with an end purpose in mind to maximise the benefit and ensure that appropriate information for project designers is obtained in a cost-effective manner. For geotechnical investigations, this generally includes the geological sequence of material types, their strength, stiffness/compressibility, and geochemical composition.

Boring helps us determine the capacity of the soil to provide support to the structures on the surface, and it reveals the permeability of the soil to establish its suitability for future uses. Today, while most drilling jobs involve boreholes, a number of them also require data from those same holes to be logged.

Overall, the success of borehole logging will depend on a number of key factors, including the combined skills of the investigation designer selecting the most appropriate techniques, the drilling crew recording as many aspects of the ground conditions as possible and the logger interpreting the findings in the context of these various limitations.

"Boreholes should be designed with an end purpose in mind to maximise the benefit"

Digital is one of the options for saving the data acquired during borehole logging operations
Photo: Socotec

Understanding borehole geophysical survey probes

Ben Cornish, Igne's director of water wells provides *GDI*'s reader with a guide to borehole geophysical survey probes and then offers up an example of them in operation

To better understand the properties of a borehole a range of geophysical survey techniques can be employed at depth down the hole. These geophysical surveys provide a vast amount of data that when interpreted alone or in conjunction with other data sets, can add significant value to a project through risk reduction for example, or by influencing early design changes to reflect actual ground conditions.

A multiplicity of probes can be used to acquire a wide range of data sets when logging a borehole

In short, borehole geophysics is a tool for recording properties of a borehole. The data collected can be used in conjunction with core sampling and logging, borehole testing and monitoring for an overlap or partial overlap of data.

Examples of the end use of data can include:

- Hydrogeology
- Site investigation
- Mineral exploration
- Resource evaluation

Data is collected, analysed and interpreted to better understand the borehole's properties. The downhole instruments used are called sondes or probes. They are lowered into the borehole on a winch with a tripod situated over the hole. The sondes are moved down and up the borehole, either continuously collecting data or collecting data at discrete depths.

The equipment is usually mounted in and operated from a vehicle that includes storage for the sondes, a power source, the data collection equipment and facilities to view the data in real-time. This ensures clients receive a dynamic delivery of survey data from this single vehicle, reducing mobilisation times and associated costs.

Data can be viewed in real-time during surveying. Following a survey's completion, graphical logs as well as any video footage or samples can be presented to the client as required in the format needed.

PROBE TYPES

A calliper probe with motorised, spring-loaded arms follows the profile of the borehole recording the borehole diameter and any changes in it, the borehole's condition and integrity, and identifying any fractures. It allows accurate borehole volume calculations to be made.

A natural gamma probe measures gamma radiation that is emitted by different geological units – the intensity is dependent on the concentration of different radioactive isotopes within the geology. This allows for depth correlations, stratigraphic correlations and the identification of shale and clay content.

The fluid temperature and conductivity probe continuously measures the temperature and conductivity profile of borehole fluid. It can be used to identify temperature gradient and temperature anomalies, groundwater salinity and saltwater encroachment as well as groundwater movements.

The impeller flowmeter probe detects flow rates and flow direction in a borehole. It contains an impeller that spins in response to fluid flow. It is used to identify flow profile, zonal identification, casing leak determination, location of permeable and flowing zones, identification of hydraulic gradients, identification of transient fractures and fracture flow, and qualitative and quantitative aquifer characteristics.

Discrete sampler captures either 1L or 2L in volume.

A disturbed sample can be taken at a specified depth capturing the water with its specific quality parameters.

Acoustic televiewer and optical televiewer for oriented structural information, breakout analysis, borehole deformation analysis, thin bed analysis, core orientation referencing, stratigraphic studies, cased hole inspection, and fracture identification.

Verticality which determines the verticality of the borehole and ensures it is not deviating.

Finally, full waveform sonic lithology is for identification, seismic data correction, formation porosity, and cement bond evaluation.

CONCLUSION

Borehole geophysics is another asset in the toolbox that, when used in the correct situation, can provide huge value to a drilling project. Testing is most commonly utilised in the UK on geotechnical or hydrogeological projects. The use of geophysics can allow correlations across multiple fields of boreholes, to identify saltwater encroachment in water abstraction boreholes, identify the depth of flowing zones of lithology, and evaluate cement bond.

"Borehole geophysics is another asset in the toolbox"

A borehole geophysics case study

Igne was contracted to drill a borehole to 250m for a water supply. Strict verticality requirements were set out in the contract as well as a requirement for permanent casing and grouting to 150m.

1. Verticality testing was undertaken at 50m intervals to ensure the borehole remained on course within tolerance.
2. Once the borehole was drilled to 150m deep, the calliper, verticality and natural gamma probes were used to measure the borehole profile to allow an accurate grout volume calculation to be undertaken.
3. Once again, the verticality of the borehole was measured to ensure it remained within tolerance and to allow for depth and stratigraphic correlations.
4. On completion of casing and grouting, the full waveform sonic probe was used to confirm the cement bond between the casing and the annulus of the borehole. It was important to check the integrity of the cement bond as this supports the casing and prevents fluid leaks to surface.
5. Once the borehole was drilled to the completion depth of 250m, the following probes were run down the borehole: natural gamma, verticality, calliper, fluid temperature and conductivity. Discrete samples were also taken for laboratory testing.

All the data provided a comprehensive data set which was used to further design the pumping and installation of the borehole.

Exploring efficiency advances in fibre-optic seismic profiling

Annabel Green, CEO of Well-SENSE, discusses how the company's FiberLine Intervention method has been used to address many of the drawbacks of retrievable encased fibre systems used for vertical seismic profiling of boreholes

Vertical seismic profiling (VSP) is a valuable tool in geophysical analysis. It provides a subsurface image of the reservoir architecture, fluid interfaces, stratigraphy, faults, fracture networks and caprock, allowing engineers to optimise drilling operations and inform reservoir optimisation strategies. However, due to the limitations of traditional VSP survey techniques, they are frequently considered too time-consuming and expensive and are rarely performed.

A low-cost VSP acquisition solution that provides rapid, high-quality data would increase the opportunity for operators to benefit from its advantages and lower the risks in pursuit of exploration, EOR and field development.

VSP utilises acoustic sensors in the borehole to measure seismic wavefields travelling through the stratigraphic sequence from a surface-generated sound source. A VSP is often used to calibrate a surface seismic survey, providing high-resolution imaging of the formations around the wellbore. However, VSPs also offer the opportunity to examine deeply buried reservoirs, where the size of the target reservoir is small compared to the depth, in which case conventional surface seismic imaging may be difficult to obtain.

CONVENTIONAL VSP ACQUISITION

Borehole seismic data are traditionally acquired by deploying multi-component geophones on wireline logging equipment. For cost and operational efficiency reasons, these are typically deployed as part of a more extensive logging programme, limiting the opportunities to acquire specific VSP data. Multiple wireline geophones can be included in a single string, but the quantity is limited by the data transmission capacity of the copper conductor wires in the wireline cable. To acquire a full VSP data set, multiple single-point survey stations are required with seismic sweeps being repeated at each station. With typical intervals between stations in the order of 100ft, the time taken to record a full dataset of simple offset seismic can be lengthy. When operations are on a critical path for drilling and well completion, this is often not justifiable.

More recently, fibre optic cables have been deployed in wells to provide distributed acoustic sensing (DAS) to monitor the low-frequency strain response. DAS can record full wavelength data simultaneously

Well-SENSE's FLI equipment can be transported to a site in a pick-up truck and then deployed by just one technician

at 1m intervals along the wellbore, enabling surveys to be performed quickly and with a high spatial sampling interval. Evaluation of DAS against traditional geophones by Willis et al. (2006) demonstrated that DAS can provide a comparable data quality over a range of comparison points. In this example, the fibre-optic cable was permanently installed on the casing string and cemented in place, providing strong coupling to the formation. While this may be a good solution for seismic reservoir monitoring, the cost of permanently installing fibre optics makes this option cost-prohibitive for most applications.

An alternative to permanently deployed fibre optic cable is to deploy fibre optics within a retrievable wireline system, either alongside copper conductors in a traditional multi-strand wireline or by deploying fibre-in-metal-tube (FIMT). This solution requires similar surface equipment to deploy as geophones but retains the advantage of densely spaced sampling of the seismic wave field. Unlike geophones, which have a mechanical anchoring system to ensure coupling to the cemented casing, the fibre in wireline is an entirely passive system that relies on gravity and 'slacking off' additional cable into the wellbore to ensure acoustic coupling. This has proven highly successful in deviated wellbores but is difficult to achieve in vertical wells or at low well deviations.

FIBERLINE INTERVENTION

An alternative to retrievable intervention solutions is to use a single-shot, disposable, bare fibre system. This FiberLine Intervention (FLI) method has been used to address many of the drawbacks of retrievable encased fibre systems, providing a low-cost means of obtaining a quality VSP survey in oil and gas, geothermal, CO2 storage and mining applications. Introduced by UK-headquartered company Well-SENSE, the FLI system can be used in shallow, deep, vertical, deviated and horizontal wellbores, acoustically coupling to the wall of the wellbore and providing accurate depth calibration. There are three key advantages:

1. With no wireline units, cable drums, lubricators or complex pressure control equipment, the rig-up footprint is reduced by 95%. Surveys can be performed by a single engineer, independently of wireline operations, offline and in difficult to access locations.
2. With rig-up and deployment to depth requiring only 1-2 hours, coupled with the efficiency of DAS VSP, the survey is extremely fast and multiple VSPs can be obtained within just a few hours.
3. The lightweight, bare optical fibre readily couples to the wellbore, providing better results than cable-deployed fibre optic systems.

FiberLine Intervention uses real-time distributed acoustic or temperature sensing (DAS/ DTS) to capture data from bare fibre optics deployed along the length of the wellbore. The fibre is also used to transmit data from electronic systems within the probe to provide single-point pressure surveys. The data is useful in a variety of applications, from cement evaluation at the start of well life to confirming barrier integrity in decommissioning. Notable features include dramatically reduced costs and run-time, stand-alone intervention capability and a lightweight, portable system.

Bare single-mode or multi-mode optical fibre consists of a core, cladding and an acrylate coating with a total diameter of just 250 microns. As there is little tension on the fibre and no lateral movement once deployed in the wellbore, conventional encapsulation and protection within a metal sheaf is not required. Without this cladding, greater sensitivities to acoustic events and strain can be achieved and lengths of up to 30,000ft of fibre can be wound onto a bobbin and installed in a 2.75in diameter probe. Once deployed into the wellbore, a combination of the light fibre weight and a grease coating applied during manufacture ensures that the fibres adhere to the borehole wall in both gas and liquid environments to enable good coupling to be achieved, even in vertical wellbores.

The full probe assembly comprises of one or two fibre bobbins and an optional electronics section. The entire assembly is approximately 1.2m long and weighs under 5kg. The optical fibres are retained using an adapter system in the hydraulic release launcher and terminated with an E-2000 connector within the fibre optic cable head. The launcher system includes full pressure control and can be made up directly to the wellhead, or alternatively, a simple C-plate option can be used if no pressure control is required. All equipment can be loaded into a single vehicle or container for transport to the well location.

The probe is deployed by releasing at surface and allowing it to free fall into the well or by being pumped down in a highly deviated or horizontal well. The fibre is fixed at the surface and pays out from the probe as it deploys, minimising excess surface fibre and ensuring accurate depth control. The deployment is monitored using the DAS waterfall display to confirm the probe is on bottom and at the final depth. The VSP survey commences once the deployment is complete.

Both the probe and the fibre are single-use and not intended to be retrieved. The probe's lightweight aluminium construction can be readily milled out or simply left in the well's sump.

VSP FIELD TRIAL

FLI has been deployed in multiple onshore and offshore applications, including cross well strain monitoring, injection flow profiling and leak detection. It has a strong commercial track record and is well-suited to VSP applications.

FLI's probes are gravity deployed and lay bare fibre along the wellbore ►

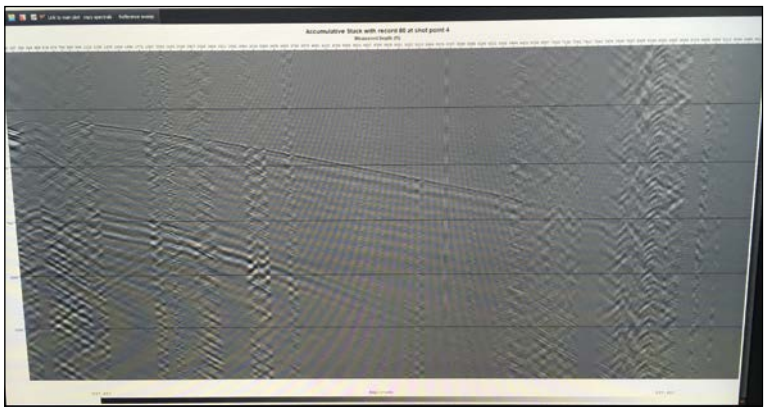


Figure 1: FLI's stacked offset VSP data

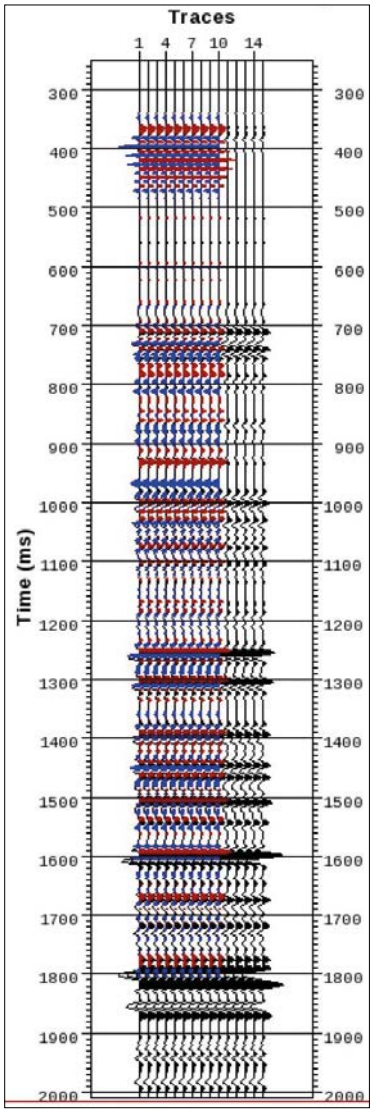


Figure 2 (right): VSP corridor stack showing geophone data (black) and FLI data (red/blue)

In its first VSP trial, FLI was deployed in an onshore well in the US to demonstrate the speed, quality and effectiveness of the system for acquisition of DAS VSP and to compare the results against a conventional geophone system. The well was completed with a 9-5/8in surface casing to 1280ft, a 7in intermediate casing to 8792ft and a 4-1/2in production casing from 8571ft to 14,280ft. The well deviation varied between 0 – 10 degrees in the intermediate section before kicking off at around 9000ft to a horizontal lateral.

Prior to deploying the disposable fibre, a conventional string of four geophones was deployed on wireline, and a survey of zero-offset VSP and offset VSP was performed using two 45,000lb trunk-mounted vibrators.

For the FLI deployment, a 2.75in-diameter disposable fibre probe comprising a single bobbin with 11,000ft of single-mode fibre was connected to the data recording box at surface. The probe and launcher were then lifted onto the wellhead and bolted down. Rig up was completed in 35 minutes and the probe was launched. The probe's progress into the wellbore was monitored with a DAS waterfall display, and it landed in the heel section of the well at around 9150ft after 26 minutes.

Six individual 20-sweep VSPs were recorded over a two-hour period, including the time taken to reposition the trucks at three different offset locations. On completion of the survey, the fibre was cut at the surface, and the launch plate was rigged down. The total time from rig-up to rig-down was approximately four hours.

"The acquired data was shown to have a good signal-to-noise ratio"

RESULTS

The acquired data was shown to have a good signal-to-noise ratio, with both upward and downward P and S waves evident. Figure 1 shows an example of the stacked data. Comparison to the geophone data concluded that the data quality was noisier in some areas but demonstrated good repeatability and good quality. Figure 2 shows the data from the geophones (black) overlayed with the disposable fibre data at a single well depth.

Some weeks after the VSP survey, the well was completed using the plug and perf method for multi-stage hydraulic fracturing. This technique requires multiple wireline runs into the well to deploy perforating guns and bridge plugs into the horizontal section that are ultimately milled out before the well is placed on production. The presence of optical fibre or the probe was not evident throughout these operations or during subsequent well production.

The results served to demonstrate the simplicity, speed and portability of the FiberLine Intervention system for VSP surveys.

CONCLUSION

The single biggest barrier to the routine acquisition of VSP data is the cost and complexity of the acquisition. However, this new low-cost, high-quality, disposable fibre system can address that challenge.

Early field trials demonstrated that good-quality data can be acquired in low-deviation wells. The system has been deployed in several commercial VSP surveys for the energy sector, including oil and gas, geothermal, CO2 storage and mining. Based on this track record, it can be concluded that it offers an efficient and reliable solution for acquiring borehole seismic data.

While the current system is targeted at land and offshore platform applications, it also has the potential for subsea deployment.

Basics of DTH drilling

DTH drilling is a long-established technology for many geodrilling applications, but broadly how does it work, where is it used and what factors influence the choice of equipment? Richard Barrett has the answers

For any geodrilling project, making the best choice of drilling technique, drill-bit type and diameter – coupled with the right size and power of drilling equipment, rotational speed and torque – achieves a swift result and minimises the frequency with which worn-out bits and other components need to be replaced.

Making that optimal selection depends on the hardness and consistency of the materials to be drilled, as well as the depth and diameter of the hole required. Particularly hard materials often demand a hammer-action drill, in addition to the rotation applied to a drill bit, to effect rapid and steady penetration.

Fractured or mixed materials along the length of a hole, and often the presence of groundwater, also need to be taken into account.

The hammer action needed to drill at depth through hard materials such as rock, very firm soil, a mixture of both – and nowadays sometimes softer ground – has become known as down-the-hole (DTH). It is so-called because the hammer unit is attached directly to the bit and rotates and proceeds down the hole with it as drilling proceeds.

HAMMER ACTION

DTH hammers are cylindrical. They have a tapered thread at the top to connect to the drill string and a chuck, or holder, at the bottom to retain the bit. In between, within their robust cylindrical body, compressed air flows into a piston that repeatedly drives into the bit assembly to achieve the striking blows of the hammer. The force is thus transferred efficiently and directly to rock and soil through the bit.

The entire hammer and the bit that it holds are simultaneously rotated by a drilling rig on the ground surface via the drill string. The punching motion of the hammer, combined with the rotary movement of the bit-face, pulverises and cuts away at the material it impacts.

Compressed air passing through the hammer and channels in the bit returns to the ground surface via the gap between the external surface of the hammer body and the internal surface of the hole created, flushing out cuttings to the surface with it.

The important penetration rate of DTH drilling is related directly to the pressure of compressed air used, but that is not the only factor to consider when using the technique. Thought also has to be given to the potentially damaging impact of overly high-pressure air on the quality of a borehole, the load capacity of a compressor – in terms of air volume and pressure – and the specific air feed requirements of any particular model of hammer.

DTH SET-UP

Wide ranges of hammer diameters and power are available for different applications. Many specialised drill bits are designed specifically for the rigours of the combined percussive and rotary motion they encounter in DTH projects.

Broadly, DTH hammers are designed to combine power and speed to achieve high productivity while minimising fuel consumption.

High-strength drill pipes are also needed to rotate the DTH hammer and bit assembly and to supply it with air. A rotary rig and air-compressor unit at the surface complete the main elements of an overall DTH drilling set-up.

Sometimes, a tubular casing system is also used to line the hole created, particularly when loose overburden material is present, which could interfere with the flow of cuttings. For example, Sandvik, which supplies a wide range of DTH equipment, notes that its Tubex overburden system simultaneously drills and cases through loose overburden materials.

DTH hammers are designed to combine power and speed to achieve high productivity
Photo: Epiroc

MULTIPLE CHOICES

Choosing the best combination of DTH equipment to achieve efficient and cost-effective results for specific ground conditions and underlying geology while suiting the particular purpose of holes created involves many factors.

The diameter and depth of the holes to be drilled are naturally fundamental considerations when selecting the right hammers, bit sizes, rotary rig and associated equipment needed to create them.

Marrying drill bit diameter to hammer and hole size is particularly important for DTH drilling in order to achieve an optimal annular gap between the hammer and the inner surface of the hole drilled so that cuttings can be freely evacuated at a suitable flow rate from the hole.

"Ideally, the size of the hammer should match the required hole ►

Epiroc's unique piston design allows the COP M-series hammers to strike the rock at high frequency
Photo: Epiroc

dimension as closely as possible, leaving just enough space for cuttings to evacuate the hole efficiently," Epiroc summarised.

The compressed air pressures and volumes needed to drive DTH hammers and flush out cuttings determine the compressor size and power needed to provide them. Rig power and work site accessibility are further factors to take into account.

Part of its DTH range, Epiroc's COP M-series of hammers provides a good example of some of the hammer options available from a leading manufacturer for different hole diameters, as well as some design considerations that have been made to maximise their performance.

"COP M6, M7 and M8 have proven themselves to be very effective in all kinds of rock, in all kinds of climates, and with a great variety of drill rigs," Epiroc noted. "Strong and tough materials, fewer parts, new solid shank bits and long-lasting interior parts make sure that the COP M-series hammers will give you much higher reliability," it added.

Epiroc indicates that the 6in COP M6 hammer is designed for bit diameters from 165mm upwards, the 7in M7 accommodates bits from 200mm diameter, and the 8in M8 takes bits from 229mm upwards, thus providing a continuous hole-diameter range by selecting the right size of the hammer.

"DTH hammers can achieve greater depths drilling in hard rock than other methods"

According to Epiroc, the optimum range of hole size for DTH drilling is 90mm (3.5in) to 254mm (10in), noting that smaller holes are generally drilled by using top-hammer drill rigs, while larger holes generally use rotary drill rigs.

By exchanging one or two components within them for low or high airflow, the COP M-series hammers can be quickly adapted to the different air pressure and volume of various rigs.

"This two-in-one feature makes our hammers fit all rigs operating at different altitude and climates," Epiroc explained, adding that its unique piston design allows the COP M-series hammers to strike the rock at high frequency, reducing fuel consumption and providing lower running costs.

LOWER PRESSURE DRILLING

Mines and quarries, particularly in remote locations, present some of the toughest environments for DTH operations and often require DTH hammers running at high pressures, but applications in urban environments encounter challenges of their own.

TerraRoc noted that DTH drilling is being usefully applied for foundation works, well and geothermal drilling. Drilling for such applications in urban areas often needs to be undertaken during restricted hours, so reducing downtime in the periods available for work is important.

TerraRoc's Terranox DTH hammers are designed for optimum performance in low-pressure operations. The range is designed for a maximum working pressure of 25 bar, but TerraRoc normally recommends that in overburden drilling applications, the air pressure is kept in the range of 12-14 bar. The hammers are designed to be rugged, reliable and, when needed, easily repaired or replaced.

To ensure proper hammer performance throughout an entire drilling operation, the compressor model is chosen to match the corresponding maximum hammer air consumption for the size of hammer being used.

Size ranges from the Terranox 3 hammer, which has a 79mm outside diameter and a length of 902mm (without a bit), to the Terranox 8, with a 181mm outside diameter and a length of 1443mm. Terranox 4, 5 and 6 hammers complete the size range in between.

A guide for engineers and drillers to understand DTH hammers, available on TerraRoc's website, notes that DTH hammers are most used in hard rock formations and are designed to tackle complex tasks like drilling in populated areas without putting existing structures at risk. "In these areas, they are ideal for drilling large-diameter boreholes in hard rock formations, typically ranging from 3in (85mm) to 48in (1,219mm) or more," noted the guide.

It also indicates that DTH hammers can achieve greater depths drilling in hard rock than other methods: "Depending on the size of the hammer and the rock formation being drilled, DTH hammers can achieve depths of up to 1000ft (305m) or more." Drilling deep boreholes requires large and powerful hammers that can withstand the high pressure and temperature of deeper drilling.

In addition, the guide explains that a benefit of low-pressure DTH hammers is their ability to drill through a wide range of soil types. "Whether it is hard rock or soft soil, low-pressure DTH hammers can provide efficient and effective drilling without causing significant ground disturbance," it noted, adding that this enables drillers to use a single drilling method for all types of soil conditions, reducing the need to switch between drilling methods and thus minimising the time required for drilling.

BIT DESIGN

DTH bits have to combine strength, hardness and resilience. They usually have inserts made from cemented carbide for increased strength, hardness, toughness and wear resistance.

For example, Sandvik noted that its PowerCarbide helps to extend drill bit life, leading to fewer bit changes and increased productivity. It adds that its DTH drill bits are designed to make

operations easier by drilling further, whatever the conditions: "They have optimised head length with maximised steel support for the cemented carbide buttons, deep face grooves for excellent flushing and an aggressive cutting structure."

The company supplies concave, convex, flat and bulldog bit face designs to suit different applications and ground conditions. Its product range includes DTH bit sizes from 95.00mm (3.75in) to 245.00mm (10.00in).

Sandvik offers cemented carbide in a range of grades and notes that high-grade carbide offers long life in challenging applications: "PowerCarbide SH69 is capable of increasing your service life by up to 45%."

The number and shape of DTH bit buttons (inserts) in a DTH drill bit can also make a difference. Epiroc, for example, noted: "Our traditional buttons are always up for the task, but in certain formations, the Epiroc Trubbnos trapezoidal-shaped buttons will optimise the upsides of spherical and semi-ballistic buttons."

Epiroc also highlighted that its DTH bits used with its COP M-series hammers feature a patented and reliable solid shank, airflow system, and its Enduro buttons. In its new (sealed exterior) flushing system, air passes outside the shank and goes up the annular space before flowing through.

FLUSHING MEDIA

In some site conditions, the flushing of cuttings is enhanced by using water or foam in addition to air.

Xiamen Good Drilling and Mining Equipment (GMD) pointed out that flushing capacity depends on gravity, particle size and particle shape: "The need for flushing is greatest if the cuttings consist of heavy, large and spherical particles." In those situations, water or foam can help the air to lift cuttings up to the surface.

The use of water also controls dust dispersion when drilling dry holes, noted GMD, but its injection into the air supply needs careful control to achieve effective flushing. Insufficient water risks turning the cuttings into a paste that sticks to drill pipes or the hole wall, potentially creating blockages.

For example, it suggests about 0.25L of water addition per cubic metre of compressed air as a "rule of thumb," and indicates, for example, that 2-6L of water per minute (at 18 bar air pressure) injected into the main air line can be sufficient to control dust when drilling with a 6in hammer. Of course, when choosing flushing media, all operators of DTH equipment need to consider the model and type of hammer in use, specifically the manufacturer's operating instructions, for any given project.

"Too much water injection will have a very negative influence on the penetration rate of the hammer," GMD warned. It also stressed the need to increase the lubrication rate when injecting water into flushing air.

Where groundwater pressure is present in a borehole, foam can also help carry cuttings through the water. GMD said that the use of foam to improve flushing performance can be particularly valuable for non-consolidated formations. Foaming concentrate mixed with water is pumped into the main air line by means of a high-pressure pump.

Foam is also sometimes used when drilling and casing a borehole simultaneously, where it can act as an aid to lubrication at the interface between the casing outer surface and the inside wall of the borehole.

STAYING SHARP

Given the aggressive environments in which DTH hammers and bits operate, regrinding of drill bits at the intervals recommended by their manufacturers – according to the amount and type of wear they suffer from specific operating conditions – is essential to maximise their operating efficiency and life.

Many leading manufacturers have created helpful online videos to demonstrate how to keep DTH hammers in good condition, including their disassembly, component inspection, cleaning and lubrication, and correct reassembly in readiness for their next task. They also offer replacement parts and service internationally.

"As a rule of thumb, a DTH hammer used in production drilling should be replaced when it has lost 10% in net penetration rate," noted Epiroc, pointing out that the total drilling cost per metre increases drastically when productivity drops. The company noted that all of its hammers have a rebuild option with an "E-kit", which comprises external and internal wear parts. "This is a valuable option, particularly in abrasive to medium-abrasive formations," it explained.

Also providing detailed maintenance instructions, replacement parts and service for its DTH hammer range, Sandvik stressed the importance of lubrication to help keep DTH hammer components in good order: "Most environments encountered while drilling are considered to be corrosive to a greater or lesser degree," it noted. "Minimise corrosion by using correct lubrication and thread grease," it advised.

The frequency of equipment inspection depends on the drilling environment. Hammers used in hard-abrasive, wet or muddy conditions generally need more frequent inspection than those operating in dry and softer soil situations.

The choice of flushing media also has an influence. "If the hammer is used with water or foam injection or in wet holes, clean and lubricate it after each use," Sandvik recommended.

Sandvik says the PowerCarbide SH69 is capable of increasing service life by up to 45%
Photo: Sandvik

Sustainability and geotechnical ground treatments

Jason Redgers, head of International Soil Improvement at Bauer Spezialtiefbau, talks to *GDI* about the company's work with geotechnical ground treatments and the sustainable benefits they offer compared to traditional piling options for deep foundations

German geotechnical drilling specialist Bauer Spezialtiefbau has many departments. While perhaps best known for its work in the deep foundations and piling sectors, the company is also very involved with geotechnical ground treatments.

The company's involvement in ground treatment began in the '50s, as Jason Redgers, head of International Soil Improvement at Bauer Spezialtiefbau, explained. "Bauer started as a coppersmiths and water drilling company in 1790, but its major expansion into geotechnical services and its major upswing started in 1952 with the appointment of Dr Karlheinz Bauer."

The appointment of Karlheinz Bauer led to a series of innovations, such as the development and use of injection anchors in 1958. In 1969, the company started to build its own specialist equipment as nothing existed on the market to the level it required to deliver safety, quality and production.

A HOLISTIC APPROACH

"Right now, we are one the few companies that can offer a full suite of solutions so we can work with the client to deliver the optimum solution as we can offer a full design and build package to support the client's vision: from the expected traditional solutions such as shoring and retaining system to piling and soil improvement.

"We always strive for the holistic approach in design and construction, and now we are focusing more on sustainable and renewable practices to meet these needs, so soil mixing, soil improvement (vibro stone columns, vibro compaction, dynamic compaction), full displacement columns (rigid inclusions, as well traditional piling and grouting works," Redgers said.

In order to achieve this holistic approach, Bauer invests a considerable amount of its turnover in research and innovation. Its investment in modern digital tools for tender, design, and site recording and management (its B-Project digitalisation), which is allied to its rig development, gives it the status of the market leader.

Allied with this investment is the company's willingness to engage with potential clients, as Redgers explained: "We are always pleased to discuss the appropriate treatment for the required development."

An RTG RG 25 S is used by Bauer for the construction of the MIP retaining structure with single layer tie-back on a project in Frankfurt, Germany

LIMITATIONS

Among the topics for discussion when considering ground improvement, which is the techniques relating to the treatment of the in-situ soils to achieve the necessary specifications, while avoiding dig and dump or importing of large amounts of concrete and steel, are the limitations and values of economy alongside the environmental aspects.

"To offer the best value engineering, we need to understand the site conditions (both in a physical location and access) to the inherent soil on (and under) the site," Redgers explained. "Once the load and settlement tolerances are known and in conjunction with the environmental aspects and design life, then the appropriate treatment or treatments can be applied.

Construction of a new water reservoir in the desert of the UAE's Ra's al-Chaima saw dynamic soil compaction work undertaken with a Bauer MC 96 duty-cycle crane

TECHNIQUES

Typically, this would mean the application of the basics of soil mechanics, such as improvement by compaction, consolidation, reinforcement, or a combination of techniques.

Bauer Spezialtiefbau can typically offer vibro stone columns (VSC), vibro compaction (VC), Bauer dynamic compaction (BDC), soil mixing (cutter soil mixing CSM), single column mixing (SCM), deep soil mixing(DSM) or its rigid inclusions by full displacement columns (FDC).

Redgers explained that "in basic terms, free draining materials can be compacted (sands/gravels) and cohesive materials (silts/clays) are more suited to reinforcement or where there are mixed grounds or made ground then a combination of compaction, reinforcement and consolidation can be considered.

"For deeper treatment, stone columns are widely used in British Columbia for bearing capacity and liquefaction, whereas in Florida, we have undertaken lots of CSM works for seepage repairs, whilst in the UAE and KSA, stone columns and vibro compaction to 25m are not unusual whereas in Europe 6-12m dry bottom feed columns are standard.

"It really is a case of step by step in each project, but an excellent project was Diavik Diamond Mine in the North West Territories, 220km south of the Arctic Circle, where we undertook vibro compaction, curtain grouting, cutter soil mixing, and jet grouting to work with in-situ materials and locally produced crushed materials."

LOCAL MATERIALS

The use of locally produced materials, such as in the Diavik Diamond Mine, is a prime example of how sustainability is a key feature of modern geotechnical ground treatments. But just how is sustainability defined in terms of ground treatments?

For an explanation of this, Redgers referenced the United Nations Brundtland Commission, which, in 1987, defined sustainability as "meeting the needs of the present without compromising the ability of future generations to meet their own needs."

In order to meet that definition, Bauer Spezialtiefbau applies the six basic principles of reduce, reuse, recycle, refuse, rethink and repair. To embrace these principles, Redgers suggested that traditional techniques are sometimes the right solution "as we can look to optimise the environmental impact during the design to reduce drilling, spoil removal, optimise steel reinforcement and the use of innovations in concrete technology; this alongside supply chain management and efficient rigs and working practices helps to reduce the environmental impact as much as possible.

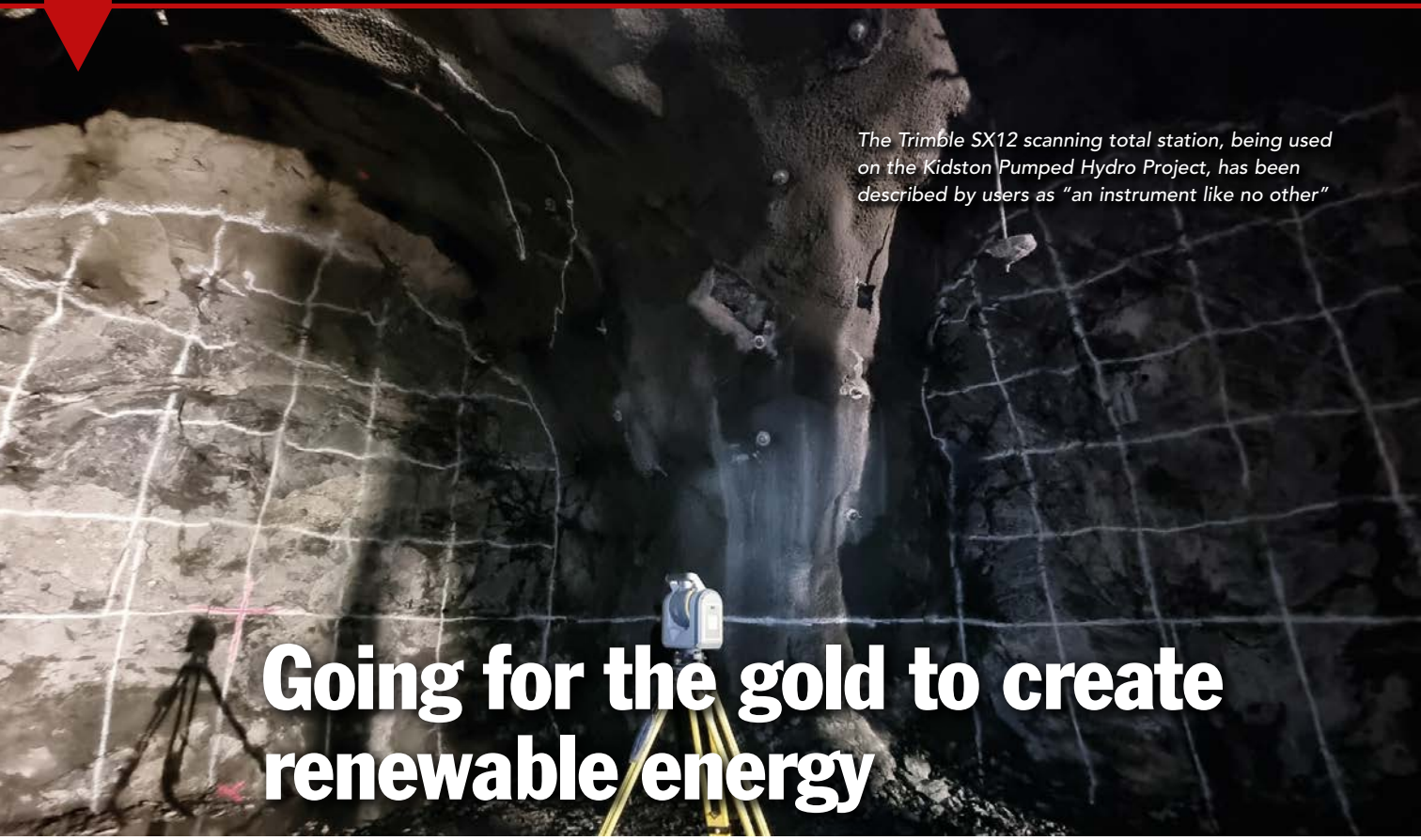
ENVIRONMENTALLY FRIENDLY

However, he also noted that "where technically appropriate ground treatments are available, they are always more environmentally friendly than traditional methods". An example he provided to illustrate this ideology is the use of soil mixing for a cut-off wall or retaining system, which means bringing cement powder to the site (or other suitable binder) and using Bauer's high-powered machines to cut and mix the in-situ soil with the brought-in binder. This is instead of excavation of the soil and cart away of the soil, the use of bentonite or polymers, and the import of concrete and potentially steel.

The mixed-in-place (MIP) method is particularly suitable in non-cohesive soils for the construction of cut-off systems, and this is one of Bauer's soil mixing systems that carries the EPD (Environmental Product Declaration) to prove its benefits in carbon emissions. Where stone columns are used instead of piles, the immediate benefit again is that there is no spoil removal from the augering (Regders noted that Bauer can also use displacement piling or rigid inclusions as an option), but the great benefit of soil improvement is allowing the use of ground bearing solutions as opposed to suspended beams and slab on a traditionally piled scheme as this offers savings in reinforcement steel as well as slab thickness and hence also in time on site.

It is also common practice in the UK and Europe that recycled aggregates can be used instead in the stone columns. It is also a source of pride for Redgers that Bauer Technologies in the UK is the only geotechnical contractor in the world to attain BRE BES 6001 sustainability certification.

"Where technically appropriate ground treatments are available, they are always more environmentally friendly"



The Trimble SX12 scanning total station, being used on the Kidston Pumped Hydro Project, has been described by users as "an instrument like no other"

Going for the gold to create renewable energy

Brent Dawson, product manager – monitoring, mining & tunnelling, UPG/SITECH Construction Systems, tells *GDI* about Trimble's involvement with the construction of the Kidston Pumped Hydro Project in Australia, which is a part of Genex Power's larger Kidston Clean Energy Hub

"The Trimble SX12 scanning total station is an instrument like no other"

The Kidston Pumped Hydro Project (K2-Hydro) in Australia is the world's first pumped storage hydroelectric project to be built on an abandoned gold mine. Located in Kidston, in the far-north region of Queensland, Australia, the facility is the flagship piece of Genex Power Ltd's larger Kidston Clean Energy Hub, which includes fully integrated solar, wind and hydroelectricity generation and storage.

When complete, the K2-Hydro will provide 250MW of pumped storage capacity. It is the first pumped hydro project in Australia for over 40 years, the first to be developed by the private sector, and the third-largest electricity storage device in the country. Genex selected the joint venture team of McConnell Dowell and John Holland to provide engineering, procurement and construction services for the effort.

The construction of this project requires a complex mix of bulk earthworks, underground tunnelling and structural/mechanical components, all of which require accurate survey control and construction techniques.

PITS AND SPILLWAYS

Like a pumped storage hydroelectric project, the K2-Hydro project has several fundamental components, all of which take advantage of the old gold mine's existing infrastructure.

They include:

- Upper reservoir: formed by a 20m-high dam around the existing Wises Pit
- Lower reservoir: utilising the existing Eldridge Pit
- Powerhouse cavern: 250MW generation capacity
- Tailrace (channel): transports water from the powerhouse to reservoirs
- Spillway: supports water release from the upper reservoir to the Copperfield River

The significant difference in water levels between the two pits (Wises and Eldridge) enables the generation of power when water is dropped from the higher pit to the lower pit. During times of peak demand, water is discharged from the upper reservoir to the lower reservoir through reversible pump turbines to generate electricity. The vast quantity of water the pits can hold means the K2-Hydro facility will have a high electrical efficiency and can support 2000MWh of continuous power generation in a single generation cycle (i.e. 250MW of peaking power generation over an eight-hour period).

To reuse the existing gold mine, the Wises Pit walls must be broadened and reinforced to create a dam, which will then be connected to the underground powerhouse through pressure tunnels. The powerhouse will also be connected to the lower reservoir (Eldridge Pit) via horizontal pressure tunnels.

The K2-Hydro project presented unique surveying challenges for the JV team and its surveyor-of-record, MinStaff Survey, because the project's components cover a vast area with over 50 pieces of equipment for excavation, haulage and tunnelling, working both day and night shifts.

Headquartered in Toowoomba, Queensland, MinStaff Survey was selected for its proven track record on major projects and experience in underground surveying, mining, infrastructure and bulk earthworks. For the K2-Hydro project, the team is using a combination of technology, including a scanning total station and field-focused tunnelling and mining software, to complete this remarkable project with safety, accuracy and speed.

NEXT-LEVEL CONFORMANCE

The cycle times between excavation, shotcrete, drilling for blasting, and blasting are very tight, whether for the dam, tunnels or spillway.

It is a multi-step digital workflow that begins with a set-out. For instance, the modifications to the tunnel walls require the survey team to set up near the tunnel face to measure the newly excavated surface or recently completed shotcrete to confirm conformance to the design.

A Trimble SX12 scanning total station is used to survey the as-constructed tunnel. Because of the system's scanning and total station capabilities, all work is completed in the field on datum. The Trimble Access software field-focused workflow significantly reduces office time, which, in the past, has been associated with scan registration and georeferencing, according to MinStaff. A single file import allows for the user to have all imported data, including survey data, 3D point cloud, and photogrammetry, registered and ready for analysis. As well, the 3D photogrammetry can be quickly shared to the cloud for browser viewing by the project team and stakeholders.

Paired with the Trimble SX12, the survey team uses a Trimble TSC7 field controller with the purpose-built Trimble Access Tunnels and Trimble Access Mines field software to quickly mark out the tunnel face. Within the app's surface inspection feature, a heatmap allows for the identified areas to be painted up, showing required rework if applicable, saving a return trip down the tunnel. Before the survey team has left the face, it can provide guidance to equipment operators and field supervisors. The survey team can also automatically operate the scanning total station instrument remotely and turn to the point of interest with a predefined pause for markup. Further, a single file import allows for the surveyor to have all imported data, including survey data, 3D point cloud, and photogrammetry, registered and ready for analysis. All linked photographs and scans are on survey datum.

Once the work has been completed underground including set-out, survey of as-constructed tunnel, and bolt and scanning, photogrammetry captures, import into the office is very simple. A drag-and-drop of the job file allows all linked photographs and scans to be imported already on survey datum.

With the field data collected, the surveyor team back in the office uses Trimble Business Center field-to-finish survey CAD software as the survey control centre for the project from the design phase through to as-constructed reporting of the tunnelling. It is used to develop automatic conformance reports at both excavation and shotcrete stages for the JV team and the owner at desired intervals.

As a cloud-based collaboration platform, Trimble Connect allows the survey team to view, take measurements, and overlay designs in 3D minutes after the survey data is uploaded. It allows the project team to bring data from the office and the field into one environment that can be shared with other stakeholders on site.

PRODUCTION FOCUSED

MinStaff's Kidston Project survey manager, Greig Russell, said: "The JV team are well pleased with the reduced time to survey, particularly in the underground cycle. The overall process is speeding up production while maintaining a high accuracy set out."

Russell noted the importance of streamlined and straightforward tools and workflows, concluding: "This project is no different from any other major project in the country now, with the struggles of skilled workers. The ability to upskill our surveyors was aided by simple workflows presented in Trimble Access and Trimble Business Center. The Trimble SX12 scanning total station is an instrument like no other for ease of use and speed of operation, allowing tasks that would normally require a survey team of two to be completed by a single person in less than half the time."

Construction of the K2-Hydro project commenced in 2021. The power plant's commissioning is expected in the second half of 2024, and operations are expected to begin in 2025.

A Trimble SX12 scanning total station is used to survey the as-constructed tunnel during the construction of the Kidston Pumped Hydro Project

Tsurumi dries out the Mega-Metro

Half-time at the Metro Grand Paris project. Tsurumi has been supplying dewatering pumps right from the start of this large-scale infrastructure project, and now its heavy-duty KTZ pumps are being added to the range of plant being used

Grand Paris Express is the name of the ambitious infrastructure project in the French capital. A partially driverless metro network is being built to connect the suburbs and improve local transport. Four new lines are being built, two will be extended, and existing ones will be modernised. The scope is considerable: with 227km of track and 308 stations, the network is already the fourth largest in Europe. By the end of the project in 2030, another 200km and 68 stations will be added.

DOUBLING THE SIZE

Tsurumi has been involved since the project was launched in 2016. With its EU headquarters in Düsseldorf, Germany, the Japanese company has equipped several construction sections with dozens of submersible pumps.

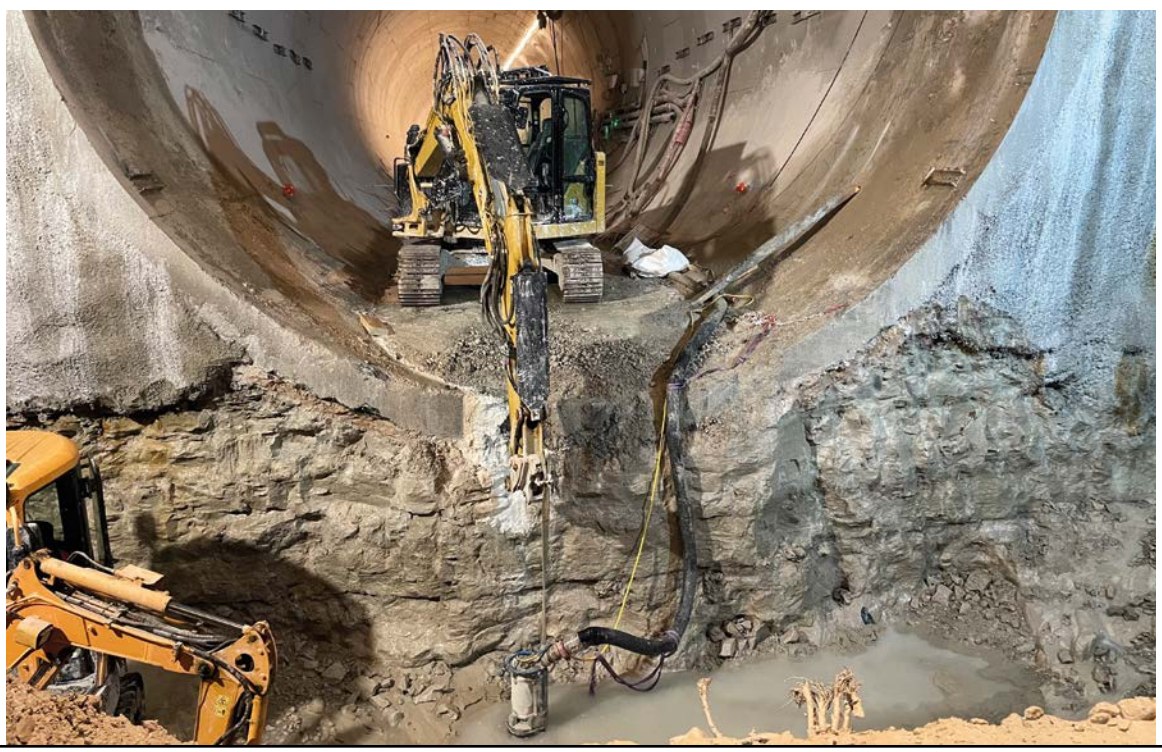
The operator placed another order at the end of 2023 based on its positive experience. The new order includes a series of pumps, especially from the KTZ model range. This pump is one of the most successful in the manufacturer's product range. It was developed for use in tunnelling and mining. There are 17 types of this versatile submersible pump, providing flow rates of up to 3960l/min and a delivery head of 71m.

This includes the KTZ 415, which reaches 2000l/min and 55ms. Its motor output of 15kW is impressive. However, the 146kg dry weight is a result of the robust design, which relies on resistant materials, including chrome cast iron and silicon carbide with diamond-like hardness. The robust pump is built to fulfil the company's slogan, "Stronger for longer".

30M BELOW PARIS

The units keep the grounds dry and thus help keep the schedules on time. Three of the four new lines run in tunnels. Each tube with a diameter of 10m will contain two tracks. The tunnels are found at an average depth of 30m and thus in the aquifer. Therefore, continuous drainage is crucial for success: the work can only continue when it is dry.

Tsurumi is probably one of the preferred partners for the project management because it is able to supply pumps for delivers from stock rather than on order. According to Tsurumi, almost all of the 500 pump models offered in the EU, with delivery capacities of up to 30m3/min or 216m head height, can be delivered within 24 hours. The Japanese know that tunnelling is one of the supreme disciplines in the tunnelling and mining industry and without reliable and quickly available equipment, it cannot be completed on time.



The Paris Grand Express is a project of superlatives that sets standards even in France. However, nothing works without proper dewatering

BGS launches a 'living laboratory'

The British Geological Survey is implementing a low-carbon heating system to help meet its net zero targets and provide data to the public

The British Geological Survey (BGS) has broken ground on its geothermal heat pump project at its headquarters in Keyworth, Nottinghamshire, with the help of Ruth Edwards, MP for Rushcliffe.

The new £1.7 million ground source heat pump and living lab project is majority funded by the Natural Environmental Research Council (NERC) with a further contribution from the UK government's Public Sector Decarbonisation Scheme, which is run by the Department for Energy Security and Net Zero and delivered by Salix Finance.

The renewable energy system will be the largest system of its kind in Rushcliffe, consisting of an array of 28 boreholes drilled to a depth of 225m. It will save approximately 30t of carbon dioxide (CO_2e) annually and reduce the organisation's heating bill.

DECARBONISATION

Forming part of BGS's Keyworth campus decarbonisation plans, the proposed system will involve the removal of greenhouse gas-emitting gas boilers. It will heat two buildings on the Keyworth site, where more than 400 members of staff work, including tenants and non-BGS staff.

The heating system will also benefit from advanced monitoring, which will assess the running costs and efficiency of the heat pumps and provide a case study for other organisations, such as schools and hospitals, that are considering switching from fossil fuel boilers to clean heat pumps.

The project will constitute a 'living laboratory', with state-of-the-art sensors deployed in the heat extraction boreholes and buildings. The technology will provide data in real-time to help increase the public's understanding of ground source heat pumps and how they can be an effective solution for heating both new and existing buildings in the UK.

As part of this project, BGS will also be taking rock samples for further analysis to help get a better understanding of the flow of heat and water underground. The type of geology on-site at Keyworth means that this information is transferable to a large part of the UK; the information generated will be of help to other similar projects.

The installation of the ground source heat pump is part of a wider project to help achieve UK Research and Innovation's (UKRI) aim of reaching net zero by 2040. This also included the installation of 1000 solar panels above BGS's car parking area in 2022.

MINISTERIAL SUPPORT

To mark the installation of this technology and the ground source heat pump, BGS invited local MP Ruth Edwards to the site, where she met with senior staff, scientists and members of the estate's team at BGS to learn more about the project as well as to see the borehole drilling taking place.

Ruth Edwards, Member of Parliament for Rushcliffe, said: "I was really honoured to be asked to break ground on the new geothermal heat pump at the British Geological Survey in Keyworth. This is a hugely exciting opportunity to help decarbonise the public sector estate. I'm thrilled that we are trialling the technology here in Rushcliffe and that the data generated by the trial will be used to inform other projects around the country."

A LIVING LAB

Mike Potter, senior environment manager at NERC, said: "This inspiring project to decarbonise heat at the BGS Keyworth campus will reduce our reliance on fossil fuels. This is the first geothermal heat pump system to be installed on the UKRI estate and will support our journey to net zero in 2040. What makes this project extra special is the 'living lab' feature, which will support data collection and knowledge sharing and could inform the heat pump sector as a whole."

David Boon, senior engineering and geothermal geologist at BGS, said: "Geothermal energy is heat that naturally occurs under the ground and is available 24/7 across the UK. This project will demonstrate the deployment of ground-source heat pump technology to decarbonise existing buildings across the public sector estate."

Daniel Crow, head of BGS Estates and Facilities, said: "This exciting project gives us the opportunity to blend our observation of the subsurface with leading low-carbon heating. The disruption to BGS staff will be kept to a minimum, with short closures of a couple of buildings to allow for the installation of heat emitters. The drilling and heat pump installation is due to last around three months. The borehole installation should not impact on Keyworth site operations due to the careful planning and specification involved in the project."

Breaking ground ceremony. L to R: Sami Massum (BGS), David Boon (BGS), Councillor Rob Inglis, Michelle Bentham (BGS), Mark Thorpe (Pick Everard), Ross Goodband (Pick Everard), Ruth Edwards MP, Daniel Crow (BGS), Gershwyn Soanes (BGS), Andrew McConnochie (BGS), Mike Potter (NERC), James Howell (NERC) and Edward Leddy-Owen

The Just Drill story

Just Drill may be a relatively new player in the UK domestic drill rig and tooling marketplace. However, founders Adam and Laura Baker are driving the business forward, constantly adding new product lines and increasing their customer base. *GDI* gets the inside line on how Just Drill started and where it is going

Just Drill's founders Adam and Laura Baker at the UK's geotechnical event Geotechnica in 2023
Photo: Virashni Langstone

Founded in 2022, Just Drill is a tooling and rig supplier serving the UK and Ireland as its home market but also supporting global customers. It partners with quality, mainly European companies that align with the founders' vision of being instrumental in supporting their customers' drilling projects.

The Just Drill team focuses on the technical details, supporting customers from the project tendering phase to completion. They also provide support and solutions for customers requiring same-day tooling.

The co-founders of Just Drill are married couple Adam and Laura Baker. Adam has a long career history in the industry, working for multiple respected companies while being involved in drill tooling design and manufacture and drilling projects that have taken him to locations all over the world. Most recently, prior to founding Just Drill, he held the role of vice president of the DTH product group for Robit PLC, a position which saw him responsible for the tooling product line, large tendering and management, manufacturing, technical and providing training.

Laura left a business management role within the private sector, which she had held for 15 years, to join Adam and launch Just Drill. She said of her decision to back Adam: "I want to build a successful family company, and my love for leadership and management ensures the focus and structure within the company will make this happen."

BUSINESS PARTNERSHIPS

Indeed, it has been happening since 2022, when Adam changed his focus from the global for Robit to his home markets of the UK and Ireland. However, he kept his relationship with Robit, representing the Finnish company in his home country in addition to bringing together business partners he had previously had relationships with or first-hand experience with.

With Adam's technical knowledge and Laura leading on the company's marketing strategy, the pair combine their strengths to build positive customer relationships and bring to market brands that will benefit their customer. "At Just Drill, we are keen to partner with companies that share the same vision and excitement as ourselves," Adam said. Laura added: "We are several manufacturers' exclusive or preferred partner. The first company we partnered with was Robit (top hammer, down-the-hole and casing system tooling). That should come as no surprise here as Adam was part of the senior management team and has unrivalled knowledge of these products; on that basis, Robit and Just Drill were keen to

move forward together to bring a new opportunity and option for the UK and Irish markets."

PRODUCT CHOICES

Talking about the company's product choices, Adam explained that "our focus is on promoting innovative brands and new equipment". He cited the intelligent rig solutions from Geomachine as a prime example of Just Drill's philosophy. "Here's a company [Geomachine] that offers rigs for drilling from ground investigation to deep geothermal where projects have been completed at over 2000m deep."

Geomachine, a Finnish-based manufacturing company, has been involved with Just Drill since the early stages of its start-up. "A long history of ground investigation rigs designed for the harshest environment allowed Geomachine to produce and introduce the first 2000m deep rig specifically designed for low impact, small footprint geothermal drilling," Adam explained the importance of bringing Goemachine to the UK. He continued: "Not only this, Geomachine produces intelligent solutions, meaning the GM2000 rig is coupled with automated drilling and data logging equipment. After witnessing the capabilities of the first GM2000 rig, I knew that this equipment would be key to developing a scalable and low-cost deep geothermal drilling solution in the UK and Irish markets."

The Robit Steel Fist casing system project is now available in 219mm diameter due requests from Just Drill customers

INNOVATIVE BRANDS

Another example of the innovative brands Just Drill works with is Qmatec rigs. "We knew that Qmatec drill rigs would be a hit for our home market after our own hands-on experience with them within Scandinavia for the geothermal and construction market," Adam explained. "Qmatec rigs produced in Norway, formally under the Nemek brand name, are of exceptional quality, and it is no fluke that they are the market-leading well drilling and construction rig provider within Scandinavia. It's still a family-owned company, and a new factory is currently under construction metres away from the existing one meaning that rig production will be tripled in volume when complete.

"Just Drill and Qmatec have made the commitment that service and repair will be carried out by in-house staff, as we know that response time is key for our customers. What's more, the IoT remote rig telematics means that we can monitor, adjust and diagnose any issues from our office or the factory, further improving response time. We can also schedule the servicing of machines via remote monitoring, so that's one less thing for the customer to be concerned with."

Talking about the choice of business partners, Laura said: "Just Drill's partner companies all have a long history of production and are market leaders in certain markets. Just Drill is here to bring these technologies into key markets where the brands have been less known previously."

"All our partners who we represent are long-term commitments, and we all share the same understanding that support and quality differentiate us and our partners from the competition.

"All our supply partners have extensive experience in other markets, and some are also the market leaders. Due to this, there is a wealth of experience and support, even with brands that some of our customers may not be familiar with. This has been reassuring for some, and others have embraced the techniques and products. Some customers are happy to carry on with the same methods they have been using for years, others understand that they need to embrace the developments and techniques, and this is where we can support them.

"Our goal is not just for sales; our target is to share the knowledge and support our customers to optimise their operations."

Just Drill's UK customers getting a demonstration of the Geomachine GM2000 rig, the first 2000m deep rig specifically designed for low-impact, small-footprint geothermal drilling

SHARED KNOWLEDGE

That desire to share knowledge is one of the points that set Just Drill apart from its competitors, and it is an aim that can be achieved because, as a relatively young company, it is not saddled with outdated ways of doing business that are carried on because that is the way it has always been done. "Just Drill recognises the need to provide exceptional customer support and with a speed that is

"Our focus is on promoting innovative brands and new equipment"

New 2024 Qmatec rig model – 507 TSX for micro piling and soil nailing

refreshing within the industry," Laura said. "Support is provided with exceptional speed from service to product quotations. We live drilling, just like many of our customers, 24 hours a day, seven days a week – the phone is never off, and we don't work regular office hours. This philosophy, coupled with our in-depth product and process knowledge, has allowed us to rapidly gain customers and be part of some large and exciting projects already."

Adam continued: "We have been able to showcase our rigs and tooling with several customers on jobsites throughout Europe to share our knowledge and drilling practices from other countries. There's always something to be learned, and there's nothing better than building brand awareness by showing tooling or rigs in daily operation with long-standing customers of the manufacturing partners we support.

"At Just Drill, we are passionate about sharing drilling technologies that we have witnessed firsthand and have been a part of in our background. We aim to provide not just an alternative for the current tooling or rigs on offer, we want to drive the industry forward by providing access to some of the latest technologies.

"The whole purpose, of course, is to ensure the correct solution for the end drilling customer. This may involve improving efficiencies, reducing overall project costs, improving safety, or providing a more sustainable solution. This can be done with the current products produced by our partners or through the development and adaptation of other products. Although a relatively new company, the knowledge and experience within Just Drill is certainly not new!"

Just Drill's UK-specific product offering

Building on the desire to provide customer– and market-specific solutions, Just Drill has been fortunate to develop several rig packages specific to its customers' requirements. For the customer, this means operating bespoke rigs specifically designed or adapted for that particular purpose. This means improved efficiency and safety, allowing them to pass the efficiency savings onto their customers, meaning that they are even more competitive at the tendering phase.

Building upon this theme, Adam Baker, co-founder of Just Drill, said: "Qmatec works on this basis. It has produced such a variety of rigs and equipment over its 50-year history that it is able to quickly tailor base machines with a modular design to produce bespoke customer units.

"Outside of the rigs built specifically for individual customers, we have been able to produce two new UK-specific rig models from Qmatec and also put these into UK inventory for sale or long-term rental.

"The Qmatec 510 TS was the first rig we brought into the UK market – a multipurpose 10t pullback rig fitted with a Eurodrill RH 10x unit, allowing a simple change from percussive to rotary drilling. With a full-length safety cage, 2.7t crane, onboard generator, welder, and multiple pumps, this compact rig was very well outfitted to take on a multitude of projects. As with many of the Qmatec rigs produced recently, the 510 TS is also equipped with an external electric powerpack hook-up. So, if any customer requires the rig to run in a fully electric mode, then a separate power pack can be purchased, and the onboard Deutz diesel engine shut down. The beauty of this is that customers are able to provide a fully electric drilling solution but also utilise standard diesel configuration when electric power is not accessible.

"On top of this, the 407 TSX model specifically designed for the UK and Ireland allows for micro piling or 4m soil nailing to be installed with unprecedented reach and manoeuvrability even on the most challenging site or project. All designed to improve safety and efficiency, providing the customer with an advantage over the competition."

On the subject of bespoke tooling, Baker explained that "Robit has been a great example of how we are able to produce customer-specific variations. On one project recently completed, site access and layout in a central urban environment flanked by a river with challenging ground conditions meant that a DTH casing system was required. However, due to tight access, a smaller than usual air compressor was all that was available, but Robit was able to produce a bespoke system to our requirements utilising a smaller DTH hammer that still allowing the correct flushing and cleaning of rock cuttings from the hole. Not only did this mean the customer was able to complete the project with the equipment they had available, but savings were also made with lower compressor running costs and smaller diameter DTH hammers while the drilling speed was not compromised."

Following that successful project, alongside Robit, Just Drill is now offering the Steel Fist wing casing system for 219mm casings and a full range of wall thicknesses. Its system was previously reserved for larger drilling diameters, but through UK customer requests and Robit's development, Just Drill can now offer it to its customers. "The main benefit of this new sized Steel Fist system is the removal of the requirement for any higher cost ring system," Baker explained. "This means that on large-quantity projects where permanent casing is required, we can offer a low-cost system, which our customers are excited about.

"We don't just supply products from catalogues; we listen to our customers' requirements and develop new products with them to truly add value to their operations."

All-electric battery-powered drill rig successfully tested in the UK

The world's first all-electric battery-powered geotechnical drill rig has been put to the test in the UK for the first time by JKS Boyles UK Ltd and Dynamic Sampling Ltd

JKS Boyles, a Comacchio dealer for 26 years, assisted by Dynamic Sampling, has been thoroughly testing Comacchio's all-electric, battery-powered eGEO 405 to understand the rig and its battery capabilities.

Nathan Jones, managing director at JKS Boyles, said: "Throughout testing, the rig performed very well, drilling holes to 40m. These holes consisted of coring 16.5m using Geobor S followed by open holing at 6in diameter down to 40m through clay, sandstone and mudstone."

Joe Taylor, lead driller at Dynamic Sampling, added: "I was really impressed with the rig in general and the battery life. There was plenty of power when drilling, even when the torque was on a low setting. Using a Geobor S none coring device usually puts a lot of strain on rigs when drilling due to the sheer volume of material that must be lifted from the hole. The eGEO 405 coped perfectly and didn't struggle at all."

The team reported that tracking the machine to the borehole location, drilling, recovering, washing down the rig and moving to the next location took 6.5 hours, which depleted the onboard battery by 60%.

"The rig exceeded all expectations. Our initial predictions were that we would need at least one battery change during a day's shift, but this is not the case. The eGEO 405 has proven it can complete a full shift on a single charge," Jones said:

Pete Stanojevic, managing director at Dynamic Sampling Ltd, said: "From what I saw, the rig worked really well, and the batteries lasted well, too. It's very impressive."

Rowan McGee, Owen Maycroft and Joe Taylor, the drill crew from Dynamic Sampling who assisted JKS Boyles with the UK field trials of the battery-electric Comacchio eGEO 405 drill rig

BATTERY TECHNOLOGY

Comacchio designed the eGEO 405 to take a major step towards a whole new technology that is based on the use of lithium-ion rechargeable batteries.

The rig is complete with two removable battery packs and a standalone battery charger to ensure continuous operations even under "extreme load" conditions. Switching out a depleted battery with a fully charged one can be done in minutes. The battery system is compact, placed on the rear of the machine in a separate and exchangeable box, designed to be easily handled using a forklift, telehandler or other ancillary lifting equipment.

The 33kW charger has been designed to ensure the spare battery pack is fully charged by the time the onboard battery is depleted, allowing for continuous drilling. The eGEO405 also has an onboard charger, allowing the rig to be plugged directly into mains power.

The standalone charger allows the spare pack to be charged in ►

"The eGEO 405 has proven it can complete a full shift on a single charge"

Comacchio's battery-electric eGEO405 in testing in the UK showing one of the removable battery packs on the rear of the machine

less than two hours from 15% at a mains supply or via battery storage systems. Based on the results of the UK tests, the manufacturer is confident that there will be no "charge anxiety" when using the eGEO 405.

Jones noted: "The sustainability and financial benefits of the eGEO 405 are huge and are expected to be a driving factor in the adoption of this kind of rig in the UK and the rest of the world."

The use of this machine will save up to 310kg of CO_2 in an eight-hour shift due to saving 130L of diesel. The cost of charging a battery pack is estimated to be £20 compared to £200 to fill the diesel tank of the eGEO 405's diesel counterpart. This is a saving of £900 a week–£45,000 annually. Ideally, if the batteries are charged from green energy sources, the eGEO 405 generates completely zero emissions.

"It was a nerve-racking start to testing when we broke ground for the first time knowing the time and effort put into the development of such a project, and wondering whether the rig would do what it was actually designed to do…. drill. As the rig progressed, and we were taking the first-ever core samples using a fully battery electric geotechnical drill rig, the nerves became more excitement as to what we are now able to offer the industry as we look to a more sustainable future. The eGEO405 is a world first, and it works," Jones said.

"All parts of the rig seemed very responsive to the levers with no delays when using them. The triplex and mist pump also worked very well under the electric motor and seemed to have more than enough power for what we needed," Taylor added.

PUBLIC DEBUT

The rig was presented for the first time during the bauma exhibition in Munich, Germany, in 2022 and in the UK at the Geotechnica exhibition in 2023.

"The success it enjoyed with the public is proof that the demand for sustainable technologies is growing at a very fast pace.

"The eGEO 405 is a masterpiece of technology and innovation: it is the first battery-powered electric drill rig in our range and is currently the first fully electric rig designed for soil investigation and mineral exploration applications available on the market," Emanuele Comacchio, technical and sales manager at Comacchio, explained.

Comacchio has extensive experience in supplying electric drill rigs that are based on the use of three-phase motors connected to a mains supply. These are often required when there is a need to operate fume-free, for example, inside buildings and small tunnels. The electric motor is fitted onto the rig in place of the diesel engine. This can be driven from a three-phase mains supply or a mobile diesel generator located outside, where fume build-up is not a problem. This has been a common option on drill rigs for many years. However, with the eGEO 405, Comacchio wanted to challenge the status quo.

The 'heart' of the eGEO405 is the battery pack, which consists

of a modular battery system. The battery system delivers a total energy capacity of 78kWh and reaches a nominal voltage of 350VDC. It is characterised by high energy density, scalability and extensive safety features. The manufacturer said that the eGEO405 is robust against all conditions and excels in applications requiring high peak power, fast charging and a high number of charging cycles.

OVERCOMING CHALLENGES

"The biggest challenge in electrifying a drilling rig is integrating the batteries into a piece of equipment designed to accommodate a thermal powertrain. We developed the battery system and the power management from the ground up, including designing and implementing a software solution to effectively and safely manage power and energy between the batteries, the inverters and the electric motors powering the rotary head and the main loads of the rig. The power supply of the machine is controlled using CANBUS technology, allowing all the components to communicate with each other and managing the current flow from the battery according to the actual operating needs. The machine's operating parameters can be viewed on a display located on the control panel," said Emanuele Comacchio.

The eGEO405 is equipped with a 6500daN retract mast and a 3500mm stroke. The high-performance rotary head can reach 850daNm peak torque and a speed of 650rpm. It can be operated in slow and fast gear, with the advantage that the adjustment of torque and rpm according to the actual operating conditions can be carried out in an extremely precise manner. The machine is equipped with a mud/water pump (with a max flow rate of 200L/ min and max pressure of 45 bar) and a 600kg wire-line winch with an automatic guide device. The eGEO 405 also features a rod rack holding up to 84m of rods on board.

COMPACT AND FLEXIBLE

The overall dimensions of the eGEO 405 are very similar to those of the diesel engine equivalent, keeping the machine as compact as possible to facilitate transport. It is designed to perform as well, if not better, than the diesel-powered equivalent GEO 405. Regardless of the drilling method, it can offer the same functionality and provide the maximum required power, covering the full spectrum of applications connected with site investigation programmes.

The eGEO 405 enables drillers to carry out open-hole rotary drilling, hollow or solid stem auger drilling, conventional and wire-line coring and DTH drilling. The rotary head's multipurpose design allows for multiple drilling types with minor changes to the machine. This operational flexibility results in reduced downtime and lower total cost of ownership.

The safety features of the machine include protection against moving parts, such as an interlocking guard, meeting the European requirements of EN 16228.

The eGEO 405 can also be equipped with a data logging system, including ComNect, a remote monitoring software developed by Comacchio that provides data for machine diagnostics and operational analyses.

"While creating the eGEO 405, we have chosen the most proven electrification technology available on the market in order to provide reliable operation in any operating conditions," Emanuele Comacchio said. He continued: "We are approaching companies that are willing to become early adopters of new technologies. Carbon reductions will become a more important differentiator as many companies want to score well on key environment, sustainability and governance (ESG) performance indicators, which is increasingly important to investors. Such ambitions will likely accelerate in the next few years, and Comacchio is committed to exploring new solutions, including not only purely battery-electric drives but also hydrogen-powered motors."

"We have chosen the most proven electrification technology available"

The eGEO 405 benefits

Higher efficiency

Deisel-run hydraulic drill rigs are estimated to lose 60% of the fuel energy due to thermal loss and another 30% due to the hydraulic system. Electric engines deliver 90% of energy at the output shaft and are, therefore, considered the most efficient option. Moreover, using electric motors eliminates energy losses and fuel consumption connected to the idling times of hydraulic pumps and diesel engines. With an electric drill rig, the current output from the battery is provided according to the actual load, accumulating operating hours only when truly in operation.

Low noise

Noise pollution is an underestimated threat to health and safety. Even the latest diesel engines are noisy, whereas electric drill rigs are extremely quiet. The eGEO 405 will help remove noise distraction, enhancing both on-site productivity and safety. "It was quite strange the rig being silent but not listening to a big diesel engine all day was brilliant," Joe Taylor, lead driller at Dynamic Sampling, said.

Reduced maintenance

Electric drives require much less maintenance than conventional combustion engines. Electric drill rigs have far fewer parts than their diesel alternatives, which means fewer breakdowns, longer service intervals and less maintenance. Additionally, the lifetime of an electric motor is much longer.

Operational precision

High-performance motor control provides accurate speed and torque adjustment, offers smooth rotation over the entire speed range, and has the advantage of sustaining full torque at zero speed and fast acceleration and deceleration. This enables greater control of drilling parameters, resulting in faster and higher-quality drilling.

Geotechnica 2024 preview

Geotechnica, the UK's largest geotechnical conference and exhibition, is once again returning to the Warwickshire Event Centre. *GDI* has listed some of the key companies in the drilling industry taking part in the event, which will be held on July 3-4, 2024

The team from 1st Line Defence will be on hand to discuss unexploded ordnance risk mitigation during Geotechnica

1st Line Defence

www.1stlinedefence.co.uk

Main business sector: Unexploded ordnance (UXO) risk mitigation.
At the show: Come and talk to our team about UXO risk in the UK, and how we can help research and mitigate hidden risks on your site.
Stand number: 16 and 17

BAM Ritchies (Ground Engineering Business Unit of BAM UK & Ireland)

www.bamnuttall.co.uk/groundengineering/

Senior BAM Ritchies team members will be at Geotechnica to discuss how the company can enable low-carbon solutions within the geotechnical and ground engineering sector

Main business sector: Ground engineering and geotechnical engineering
At the show: We are looking forward to an exceptional show. With the opportunity to catch up with our peers, clients and good friends. We will be discussing our developments in supporting the energy transition and how we are delivering a sustainable tomorrow through our market-leading integrated services.

A number of BAM Ritchies senior team members will be in attendance, looking to engage and discuss how we can support our clients or work with our peers to enable low-carbon solutions within the geotechnical and ground engineering sector.
Stand number: 36 and 37

British Drilling Association

www.britishdrillingassociation.co.uk

Main business sector: Membership organisation (drilling/geotechnical sector)

Casagrande UK

www.casagrandeuk.com

Since its launch in 1978, over 3000 Casagrande C6XP-2 rigs have been sold worldwide

Main business sector: Supply of piling and drilling equipment for the geotechnical industry
At the show, we will be exhibiting: A selection of rigs and equipment that are popular in the UK market: the Casagrande C6XP-2, a Hutte HBR204, a Eurodrill RH24X, and a Casagrande Drill tool Manipulator.

The Casagrande C6XP-2 represents one of the best-selling drill rigs across the world with over 3000 units sold since the first one in 1978.

Our Hutte HBR204 is a popular and versatile rig suited to well drilling, geothermal drilling, mini piling CFA/SFA and micro drilling. The rig is supplied with a high-speed, high-torque Eurodrill RH52X head capable of 52kNm and 150rpm. Winch and magnet rod handling enable rod storage in the near vertical rod carrier.

The very popular Eurodrill RH24X will also be on display. This unit offers a robust design that can be specified with interchangeable options of percussion, floating drive spindle or fixed drive with a 117mm through passage.

Casagrande UK will debut the CDM excavator-mounted rod manipulator, which will enable drilling contractors to adhere to the latest manual handling guidelines while installing rods and casing or augers onto their drill rigs.

This year will also mark the release of a new Hutte rig proposal, designed with the UK well drilling and geothermal markets in mind, with auto rod handling and storage in a package of around 15t.
Stand number: Outdoor area stand 5

Concept Site Investigations

www.conceptsi.co.uk

Main business sector: Ground/site investigations
At the show, we will be exhibiting: Our services – ground investigation, pathology and structural investigation and geotechnical laboratory testing
Stand number: 53

Equipe Group

www.equipegroup.com

Main business sector: Geotechnical, land drilling
At the show, we will be announcing: New RhinoCutter – eliminating the risk associated with splitting coreliners; Brand new on-site logging apps: KeyLogbook for Drillers and KeyLogbook for Engineers; RhinoCorebox – the eco-friendly solution to core transportation and storage; Specialist geotechnical and health

and safety training courses; NVQs for Land Drilling (Level 2 and 3) and the brand new Level 3 Geotechnician qualification.
Stand number: 20-23

Gas Data

www.gasdata.co.uk

Main business sector: Gas analysis instrument manufacturer
At the show: "We will be exhibiting Gas Data's new GM25 range of portable gas analysers for the first time. Suitable for a whole range of applications, including site investigation, landfill monitoring, biogas and more, the GM25 is an exciting new product that takes Gas Data's 30 years of knowledge and experience to improve on its previous offering, providing a better solution for your gas analysis needs.

Gas Data will also be exhibiting its Gazoscan laser based methane detector allowing for rapid detection of methane leaks at a range of over 100m as well as its Click! fixed analyser.
Stand number: 26

Geolabs Ltd

www.geolabs.co.uk

Main business sector: Geolabs is an extensively equipped laboratory in the UK with offices in Watford and Birmingham that offers geotechnical testing services for soils, rocks and aggregates, many of which are accredited by UKAS.
At the show: Geolabs will be announcing its expanded capacities in different sections, particularly advanced and rocks testing, and visitors will have the opportunity to meet with the expert staff and learn more about the tailored laboratory's testing services and the 'Proficiency Scheme'.

As an independent testing-only facility that has provided high-quality laboratory testing services since 1995. Geolabs has organised a comprehensive proficiency and interlaboratory comparison testing scheme (PICTS) for over 15 years to help raise standards within the soils and rocks testing industries.

In addition to its vast routine laboratory testing services, Geolabs offers advanced testing services, such as cyclic triaxial, advanced triaxial (with bender elements and local instrumentation), resonant column, cyclic and monotonic direct simple shear, Imperial College type suction probe test, and constant-rate-of-strain consolidation testing. The laboratory uses state-of-the-art equipment and methods to ensure the accuracy and reliability of its test results, with experienced staff dedicated to providing high-quality testing services.
Stand number: 24 and 25

i2 Analytical

www.i2analytical.com

Main business sector: Analytical and geotechnical testing
At the show: Terry Stafford, geotechnical quality manager at i2 Analytical will be presenting, 'Six Steps to Improve your use of Geotechnical Laboratory Testing' on Wednesday, 3rd July 2024, 14:30 – 15:00.
Stand number: 32

Igne

www.igne.com

During Geotechnica Inge will have representatives from all of its specific service areas

Main business sector: In 2023, six of the best businesses in their respective fields (geo-environmental, site investigation, unexploded ordnance threat mitigation, construction materials testing, geothermal and water supply) combined to form Igne, ensuring service delivery for clients can be integrated.
At the show: We are bringing representatives from every area of the company to Geotechnica, and looking forward to focusing on these specific service areas:
Cone penetration testing (CPT):
CPT for geotechnical soil investigation:

- Identification of material types
- Assessment of geotechnical parameters for engineering design
- Assessment of groundwater conditions

Measured parameters:
Tip Resistance (qc)

- Local Sleeve friction (fs)
- In-situ pore pressure (dissipation testing)
- Inclination (Ix, Iy)

Electrical CPTu cones and piezocones are high-precision measuring instruments purposely developed for geotechnical soil investigation.

In the Cone Penetration Test (CPT), a cone on the end of a series of rods is pushed into the ground at a constant rate and near-continuous measurements are made of the resistance to penetration of the cone and of a surface sleeve.

Data collected by the CPTu cone can provide information on the subsurface strata, groundwater conditions and physical/mechanical properties of the subsurface strata.
Borehole geophysics:
Borehole CCTV, verticality, temperature and conductivity, natural gamma, impellor flowmeter, dual focused resistivity, inclinometer, discrete fluid sampler (1l and 2l), sonic sonde, acoustic televiewer, and optical televiewer.
Laboratory information management system (LIMS)
LIMS from Spectra QEST, field data capture, concrete testing, scheduler app, barcode moisture scanning, and compaction testing.
Stand number: 18

In Situ Site Investigation

www.insitusi.com

Main business sector: In Situ Site Investigation is a specialist geotechnical and geo-environmental site investigation company carrying out all aspects of cone penetration testing (CPT) techniques as well as all methods of pressuremeter testing. Our expanding range of ►

The GM25 portable gas analyser's launch builds on Gas Data's 30 years of knowledge

In Situ Site Investigation will use Geotechnica to showcase one of its 20t CPT rigs

rigs and equipment enables us to work on any site across the UK and worldwide.
At the show: We will be showcasing one of our 20t CPT rigs as well as a good selection of our CPT and pressuremeter cones and equipment. Our team of technical experts and field staff will be available to answer questions and show you around the rig and give demonstrations.

We will also have a marquee packed full of games, sweets, a well-stocked fridge and many other goodies so please come and say hi.
Stand number: Outside area stand 1

Jet Materials Ltd
www.jetmaterials.com

Main business sector: Testing equipment
At the show, we will be exhibiting: Thermtest MP-1, thermal conductivity testing of soils, liquids and building materials; Mexe Probe soil assessment cone penetrometer; two types of portable shear vane Apparatus, including the popular Pilcon model; two type of moisture meter, the Microlance and the Aggrameter; and DCP's pocket penetrometers, test sieves, shakers and much more.
Stand number: 80

JKS Boyles UK Ltd
www.jksboyles.co.uk

Main business sector: Manufacturers and suppliers of drilling equipment
At the show, we will be available to discuss all your drilling needs from tooling to drill rigs.
Stand number: 48 and 49

LECA UK
www.leca.co.uk

Main business sector: Groundwork solution
At the show, we will be exhibiting: Leca Lightweight Aggregate (LWA) is a natural, unique and sustainable lightweight clay aggregate. LECA LWA has remarkable properties, which ensures its versatility for use in a vast number of structural and geotechnical applications. It is the only "all in one" aggregate solution for architects and civil engineers to overcome problematic areas in construction and design.
Stand number: 38

MGS Ltd
www.mgs.co.uk

Main business sector: Ground investigation and ground source heat recovery products
At the show, we will be exhibiting: Our extensive range of products used in ground investigation, mineral exploration, water well construction, ground source heat recovery and groundwater monitoring.

This will include the Aquaread LeveLine range of groundwater monitoring dataloggers together with telemetry and data visualisation software and our range of Alucast aluminium monitoring well protection covers.

We will also be presenting our new 45mm and 50mm ground source Thermo-Loops along with our range of 45mm Electrofusion fittings.

Once again, we will also highlight and discuss the completely new and innovative developing technology called Microbial Polybiotics. This technology can be used in conjunction with specialist bioplastics to produce not only a carbon-negative product but also a controlled in-situ biodegradable pipe.

In the future, products such as Coreliner could be made to be compostable thus eliminating the need for landfill. Prototype samples of EnviroLine-PB wellscreen and Coreliner-PB material will be available to view together with a presentation explaining the technology.
Stand number: Stands 4-7

One Stop Testing Equipment Ltd
www.onestoptesting.co.uk

Main business sector: Testing equipment
At the show, we will be exhibiting: A full range of pile testing equipment from Pile Test; Instrotek No Nuke, advanced non-nuclear asphalt density gauge; Instrotek Xplorer density gauge; Zorn high weight deflectometer (LWD); and much more.
Stand number: 81

QED Environmental Systems Inc.
www.qedenv.com

Stand number: 15

Rockbit UK Ltd
www.rockbit.co.uk

Main business sector: Manufacture and supply of drilling tooling and accessories as well as being the exclusive UK agent for Massenza Drilling Rigs.
At the show, we will be exhibiting: Most of our Wildbore products: MudMaster, LoopMaster, and GroutMaster, and Massenza Mi8 and Mi5 rigs, along with our tooling and equipment.
Stand number: Outside area stand B

Sigma Plantfinder
www.sigmaplantfinder.com

Main business sector: Specialist supplier of used piling, drilling, geotechnical and associated foundation machinery.
At the show: This is Sigma Plantfinder's first year exhibiting at the show. Sigma Plantfinder is a specialist supplier of used piling, drilling, geotechnical and associated foundation machinery globally. For almost 50 years it has built up a strong client base of over 8000 companies in more than 150 countries. Prior to shipping, all of its machines are thoroughly serviced, checked and tested to ensure that they will be 100% ready to start work as soon as they arrive at site, wherever that may be in the world. No downtime and no repairs – that is the Sigma Guarantee.

Sigma has its own in-house shipping department, which controls every aspect of machinery transportation and documentation globally, from start to finish. All shipments are fully insured. Sigma also buys used machines, so if you have any that you are thinking of selling, please contact us. There is no charge to sell your machine with Sigma.
Stand number: 47

SoilCloud

www.soilcloud.tech

Main business sector: Geotechnical data management software
At the show: Geotechnica is the opportunity to discover our web solution, SoilCloud, dedicated to digital transition in geotechnical engineering. SoilCloud is widely used in Europe with more than 2000 users. SoilCloud is a reference in Europe for managing geotechnical data and is becoming a world-class reference. With SoilCloud, you can log your boreholes, edit your PDF factual reports, analyse your geotechnical data and do much more! We are also compatible with the AGS format.
Stand number: 19

Soil Engineering Geoservices

www.soil-engineering.co.uk

Main business sector: Ground investigation, drilling and grouting
At the show: We'll discuss our continued investment in technology and the rollout of our new 'Specialist Geoservices' business line. Providing standalone complex drilling and testing services, or combined with our instrumentation and monitoring capabilities, Specialist Geoservices delivers drilling, insitu testing, and technical support at a truly bespoke level.
Stand number: 9 and 10

Stratum Drilling Solutions

www.straumdrillingsolutions.com

Main business sector: Geotechnical and civil engineering
At the show, we will be exhibiting: A UK first – the Ripamonti EX221THV excavator attachment with our first showing of a standard across the range UK compliant safety cage. Also another UK first will be the all-electric Ripamonti Birdie tracked drilling rig. A range of electric and pneumatic grouting equipment from Italswiss, along with a range of our market-leading drilling support products including DTH Hammer striping bench, DTH hammer lubrication units, mist/foam injection pump and button bit refurbishing tools. We will also have on show a small amount of our market-leading ground investigation tooling and consumables.
Stand number: Outside area stand 3

Structural Soils Limited

www.soils.co.uk

Main business sector: Ground investigation, drilling services, soil, rock and materials laboratory testing, insitu testing and monitoring
At the show: We are delighted to be Silver Sponsors at Geotechnica 2024. Established in 1964, Structural Soils Ltd has evolved into a multi-award winning national, multidisciplinary ground investigation company.

With an integrated geotechnical and geoenvironmental proven capability, the capacity and confidence to undertake contracts of any size, in any location and virtually any scope. The company undertakes contracts across the UK through its offices and laboratories in Bristol, Castleford, Coventry, Glasgow, Hemel Hempstead, Wigan, Plymouth, and Tonbridge.

We were announced as the deserving winner of the Technology Team of the Year Award at the 2022 Construction New Workforce Awards for our custom-designed mobile data capture app.

With recent significant investment, we now offer an independent downhole borehole geologging service, advanced packer testing, high-pressure dilatometer (HPD) testing and nuclear magnetic resonance (NMR) service.

We have also invested in low-ground-pressure rotary drilling and window sample rigs. Our red soil laboratory, based in Castleford, is one of only two in the country.

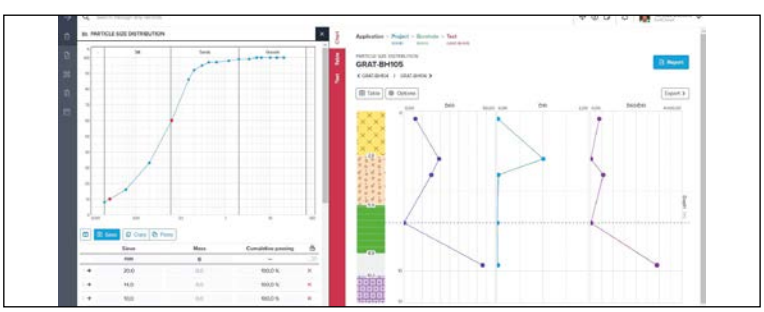
Come and visit us at Stand 51 at Geotechnica 2024 for a chat about all things ground investigation. Download our free *Engineers Quick Reference Guide* from our website and for more information on our comprehensive service offering e-mail ask@soils.co.uk.
Stand number: 51

Terra Sonic International

www.terrasonicinternational.com

Main business sector: Sonic drilling; manufacturer of sonic drill rigs, heads and tools for environmental drilling, geotechnical drilling, mining and mineral exploration, geo-construction drilling, geothermal installation, water resource exploration and dewatering
At the show, we will be exhibiting: The new TSi 150CCE Sonic drill rig, built locally in Italy and fully complying with CE regulations and European standards, which combines a clever and compact design with true SONIC performances, thanks to the exclusive TSi 150 Series Sonic Oscillator that generates up to 222kN of resonant sonic energy.

Among the various optional features, the TSi 150CCE also features fully radio remote-controlled operations and a built-in dual head for diamond coring.
Stand number: Outside area stand B



Soilcloud allows users to log boreholes, edit PDF factual reports, and analyse geotechnical data

Soil Engineering Geoservices' Specialist Geoservices business line delivers drilling, insitu testing, and technical support at a truly bespoke level

BITS

MGS +44 (0) 1359-271167

BOREHOLE PUMPS

GEOQUIP WATER SOLUTIONS LTD Tel +44 (0) 1473 462046
www.geoquipwatersolutions.com. Borehole Pumps, Downhole CCTV, Wellmaster Rising Main, Starter Panels, Compression Fittings
PROQUIP DIRECT LTD Tel: +44 (0)20 8712 5982
www.proquipdirect.com. Franklin Borehole Pumps, SS and PVC Wellheads, I-GON Iron Bacteria Remover, QUAD 4 Joint Kits, BORELINE Flexible Rising Main

CASING & ANCILLARY EQUIPMENT

MGS +44 (0) 1359-271167

CORE BARRELS & ANCILLARY EQPT

MGS +44(0) 1359-271167

GEOTHERMAL EQUIPMENT & MATERIAL SUPPLIES

MGS +44 (0) 1359-271167

LOGGING

PACKERS

PUMPS

SITE INVESTIGATION

STRUCTURAL SOILS LTD, The Old School, Stillhouse Lane, Bedminster, Bristol BS3 4EB, UK.
Tel: +44 (0) 117 947 1000 E-mail: ask@soils.co.uk
www.soils.co.uk

DRILL RIGS FOR SALE

WANTED

DRILLING FLUIDS

MGS +44(0) 1359-271167

DRILL PIPES, RODS & TUBULARS

MGS +44 (0) 1359-271167

WELL REHABILITATION

PROQUIP DIRECT LTD, Tel: +44 (0)20 8712 5982
www.proquipdirect.com. Franklin Borehole Pumps, SS and PVC Wellheads, I-GON Iron Bacteria Remover, QUAD 4 Joint Kits, BORELINE Flexible Rising Main

POWER OF KLEMM

DYNAMIC
POWER.

KR 704-2E
Vertical drilling rig for confined spaces
Electric drive
Zero Emission
Engine power: 45 kW
Weight: 5.1 t

UNSTOPPABLE!

KLEMM drilling equipment stands for the latest, most sophisticated drilling technologies made in Germany. Because every detail is thought through and designed in a particularly robust way our systems stand for a unique, unstoppable DYNAMIC POWER! Benefit from excellent reliability and performance with the lowest total cost of ownership (TCO). We'll tell you how we can make you unstoppable – give us a call: **+49 2761 705-0**

www.klemm.de

KLEMM
Bohrtechnik

Go below the surface

Mining Magazine INTELLIGENCE

Established 1909

The launch of the Mining Magazine Intelligence (MMI) suite of research reports is a natural progression for Aspermont into the research space, leveraging Mining Magazine's 110-year history and following the trail blazed by the Mining Journal Intelligence unit.

The *MMI* research focuses on the key technology and innovation proliferating the mining space, focusing on the leading mines, miners and suppliers. As with *Mining Magazine*, *MMI* will take a global view of the market.

The Automation Report *provides a comprehensive review of automation within the mining industry. It collates interviews with industry leaders and profiles on mines at various stages of automation to help stakeholders understand the operators and suppliers at the leading edge of this technology.*

The Digitalisation Report *provides a comprehensive review of digitalisation within the mining industry. It collates interviews with industry leaders and profiles on mines at various stages of digitalisation to help stakeholders understand the operators and suppliers at the leading edge of this technology. This report also contains company profiles that analyse and describe digitalisation strategies at a corporate level.*

The Future Fleets Report *is a comprehensive review of the most innovative fleets in place across the leading mines and development projects in the industry. It attempts to quantify how this equipment is being deployed, how it is changing operations, the next steps for innovation and, wherever possible, how much capital is being invested.*

The Exploration Report *analyses the processes and technologies delivering currently underwhelming discovery rates, alongside recent greenfield and brownfield success stories. The report is divided into three sections: the findings from our first Exploration Survey with commentary and analysis from other leading providers of exploration research; a technology review; and an aggregation of outstanding intercepts, maiden resource publications, and then technical profiles of the 10 most distinguished recent success stories.*

Mining Magazine Intelligence Reports **are included in your premium subscription.**
For non-premium readers, you can upgrade or purchase each annual report individually.

Register at **www.miningmagazine.com/subscribe**

subscriptions@aspermontmedia.com +44 (0)208 187 2299