

**GEOTECHNICAL COURSE DATES:**  
 Rock Description Workshop  
 2nd Sept. 2014, 7th Nov. 2014  
 In Situ Testing  
 8th October 2014

**GEOTECHNICAL COURSE DATES:**  
 Geotechnical Foundation  
 Design - 21st July 2014  
 Soil Description Workshop  
 8th July 2014  
 19th August 2014

**H&S COURSE DATES:**  
 Avoiding Danger from  
 Underground Services  
 8th August 2014, 12th Sept. 2014  
 Safe Supervision of  
 Geotechnical Sites:  
 23rd - 25th July 2014

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# THE WAIT IS ALMOST OVER

Geotechnica returns to the Warwickshire Exhibition Centre in July 2014 - details inside!

**Included in this month's issue:**

- The Advantages of Silonite Canisters
- Scottish Transport Minister site visit for Soil Engineering
- An Update on Chemical Bioavailability Testing in soils
- Minnovare introduce the Azimuth Aligner to the UK market



Issue No. **31**  
 June 2014





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Writing for theGeotechnica for the first time is Michael Beilby, Commercial Director of Minnovare Pty Ltd, an Australian company that was originally formed to leverage the demand for improved accuracy and efficiency of drill rig alignment in the Mining and Civil Engineering industries. In this article Michael introduces the award winning Azimuth Aligner to the UK market.

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2nd October 2014  
4th December 2014

## ROCK DESCRIPTION WORKSHOP - £225 + VAT

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# Welcome

Welcome to the 31st Edition of **theGeotechnica** - the UK's fastest growing online geotechnically focussed e-magazine.

This month, once again, we have a fantastic line-up of insightful and informative articles that make for a must-read.

Our cover this month focuses on the upcoming geotechnical conference and exhibition in July - Geotechnica 2014. The event has established itself as the premier trade event for the geotechnical sector in the UK, and looks to make another triumphant outing next month. Full details of the exhibition and particularly the Geotechnical Conference are revealed in this month's issue of theGeotechnica. A limited number of places are still available, and all interested exhibitors and visitors should register their attendance at [www.geotechnica.co.uk](http://www.geotechnica.co.uk). Full details can be found on pages 13 and 14.

The first article of this month's issue sees the return of a regular and highly valued contributor, Geraint Williams of ALcontrol Laboratories. In another excellently insightful article, Geraint discusses the potential advantages of using solinite canisters when sampling volatile organic compounds. They are suitable for a wide range of applications including soil gas, sub-slab, ambient and indoor air.

Our second article is penned by Soil Engineering Geoservices' Natalie Fennell. In this month's article, Natalie reveals exciting details of Scottish Transport Minister Keith Brown's visit to the A9 Ground Investigation Soil Engineering site on the 27th of May.

Following on from Natalie Fennell is another of our long-time regular contributors, Hazel Davidson of Derwentside Environmental Testing Services. In this month's issue of theGeotechnica, Hazel provides an update on chemical bioavailability testing in soils.

The final article in this month's issue comes from Michael Beilby, Commercial Director of Minnovare Pty Ltd, an Australian company that was originally formed to leverage the demand for improved accuracy and efficiency of drill rig alignment in the Mining and Civil Engineering industries. In this article Michael introduces the extremely exciting and award winning Azimuth Aligner to the UK market.

As with every new edition of the magazine, the Editorial Team here at theGeotechnica will be on the lookout for even more new, original and interesting content from all corners of the sector, and would actively encourage all readers to come forward with any appropriate and relevant content - whether it be a small news item or a detailed case study of works recently completed or being undertaken. If this content is media rich and interactive, then all the better. We are looking to increase the already large readership of the magazine through better social media integration and promotion, as well as improving content month on month.

Finally, for any content that is submitted we will ensure that an advertising space, proportionate to the quality of content provided, is reserved should you wish to place an advert in that single edition of the magazine. We hope you enjoy this month's edition of the magazine and are inspired to contribute your own content for the coming editions of **theGeotechnica**.

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theGeotechnica**

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# SILONITE CANISTERS

## THE LATEST METHODOLOGY FOR SAMPLING GROUND GASES INCLUDING VOCS

Writing for *theGeotechnica* this month is Geraint Williams of [Alcontrol Laboratories](#). This month Geraint discusses the advantages of using gas canisters.

Silonite canisters offer a very effective method of sampling volatile organic compounds (VOCs) and other gases. They are suitable for a wide range of applications including soil gas, sub-slab, ambient and indoor air.

Silonite canisters are supplied under vacuum from the laboratory. Readership of *theGeotechnica* may be most interested in soil gas and sub-slab investigations. In both cases the sample train restricts the flow of sample uptake into the canister. The sample train ensures that vapour samples are collected at a controlled flow rate. The assembly also includes a vacuum gauge that indicates when the canister is close to atmospheric pressure.

Canisters feature a fused silica lining that provides an extremely inert receiving vessel to collect soil vapour. Once sampling is complete,

canisters are sent to the laboratory for analysis in specially designed carrier boxes.

With on-going improvements, canisters have continued to grow in popularity in the US, particularly for those involved in vapour intrusion, due to their ease of sampling, extended holding times (30 days) and the ability to perform multiple analyses in the laboratory.

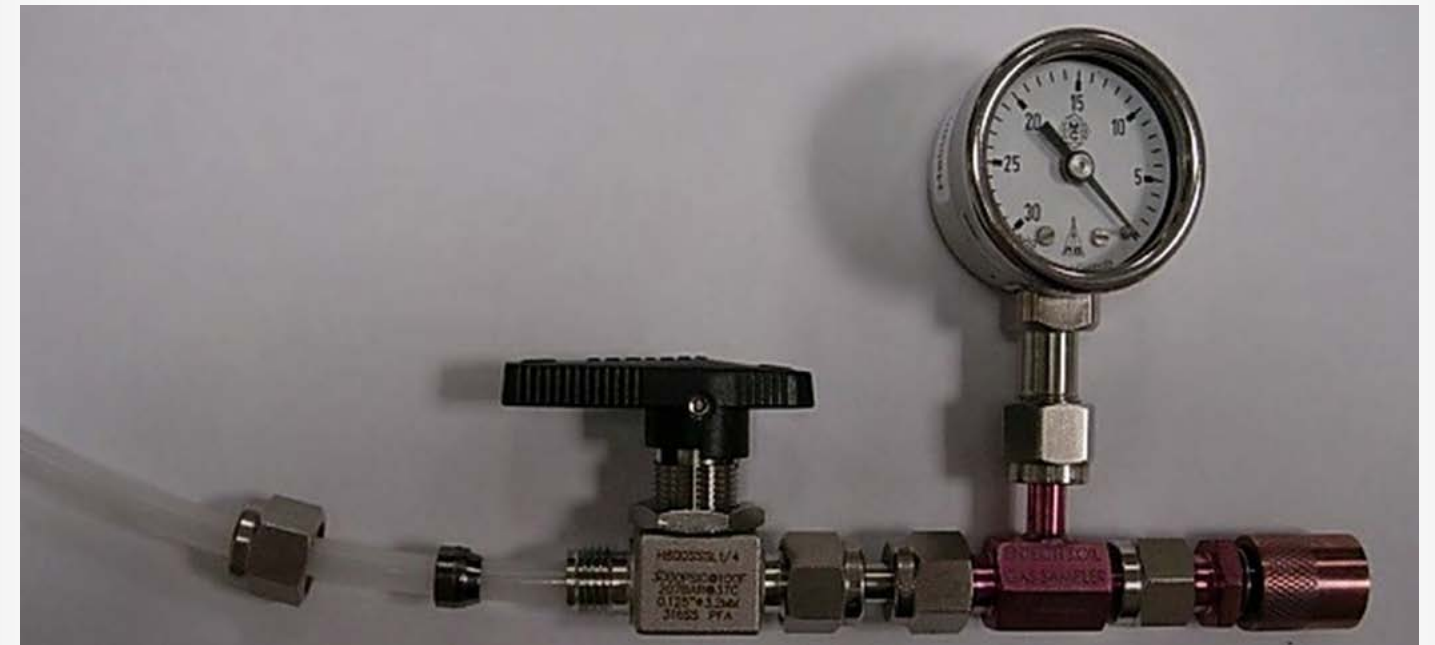
**“Interest in canisters in the UK is much more recent, but this approach is now becoming increasingly adopted by consultants investigating and assessing risk from sites where VOCs may be present.”**

Interest in canisters in the UK is much more recent, but this approach is now becoming increasingly adopted by consultants investigating and assessing risks from sites where VOCs may be present. As part of detailed quantitative risk assessment, indoor air sampling can confirm the presence of a vapour pathway. Canisters have also been used for validation purposes by range of remediation companies.

Analyses include:

- VOCs Trace gases target list (based on TO-15)
- VOCs Trace gases target list (based on TO-15)
- TPH Aliphatic and Aromatic split (C4-C12)
- C1-C7 analysis
- Bulk Gas Screen

Permanent gases and VOCs should not necessarily be considered separately since they often occur together. The presence of methane under anaerobic conditions and carbon dioxide under aerobic conditions is often



used as an indicator of natural attenuation of petroleum hydrocarbons. Canisters are very useful for very volatile compounds such as vinyl chloride and chloromethane. New internal surface coatings have made it possible to include more reactive compounds such as hydrogen sulphide as part of the list of analytes.

**“A GC-grade Silonite ceramic coating on the canisters enables much wider range of recovery relative to other methods and by taking the whole sample into a the canister, there is no reliance on absorbents or chance of breakthrough. Repeat analysis is also possible using this method.”**

A GC-grade Silonite ceramic coating on the canisters





enables a much wider range of recovery relative to other methods and by taking the whole sample into the canister, there is no reliance on absorbents or chance of breakthrough. Repeat analysis is also possible using this method.

When canisters were first introduced, a Summa passivated canister was the only option available. Historically, canisters were always selected to be large enough to allow the laboratory to meet the required limits of detection. Advancements in laboratory instrumentation, combined with years of R&D have resulted in many improvements in the

**“As analytical techniques have become ever more sensitive, there is less of a requirement for very large volumes to be sampled which has seen a corresponding reduction in the size of canister used.”**

methodology. As analytical techniques have become ever more sensitive, there is less of a requirement for very large volumes to be sampled which has seen a corresponding reduction in the size of canister used.

The 1.4L canister (also known as a Silocan) is much easier to use and transport than the traditional 6L version. Along with a reduction in canister size has been the development of

**“Bottle-Vacs are the most economic containers available for whole air sampling...”**

deactivated glass (Bottle-Vac) canisters. Bottle-Vacs are the most economic containers available for whole air sampling making them less expensive, even than Tedlar bags. However, because they are glass they are less robust than the Silocans.

In terms of the laboratory analysis, the analytical method utilizes a multi-staged, cold trapping system that can separate the major components, nitrogen, oxygen, carbon dioxide and water from the target VOCs of interest prior to injection into a GC. Analytes are separated on an appropriate analytical column before being detected by Mass Selective Detector. Analyte responses are quantified against a 6-point calibration curve and corrected against internal

**“In the case of non-target compounds being identified with the sample, the response factor of the nearest standard is used to calculate analyte concentration.”**

standards. In the case of non-target compounds being identified with the sample, the response factor of the nearest



standard is used to calculate analyte concentration.

As per the requirements of USEPA Method TO-15 canisters must be cleaned and evacuated prior to use. Cleaning is performed by attaching canisters to a vacuum manifold between evacuation and filling with high purity nitrogen to prevent any cross-contamination. Canisters can be cleaned in a single batch and then certified as such by filling and analysing the canister. The sample train is also subject to a similar rigorous cleaning procedure. ■



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2nd & 3rd July 2014



## GEOTECHNICAL CONFERENCE THE FUTURE OF GEOTECHNICAL ENGINEERING

The Geotechnica 2014 Conference will provide an impelling insight into the future of the geotechnical industry, as well as providing everything consultants and contractors need to be aware of to comply with current and changing standards. Attendance is a must for those procuring, specifying, supervising and carrying out geotechnical and drilling works across the UK.

The conference is led by Equipe, the UK's leading training provider for the geotechnical and drilling industry and is supported by many leading industry speakers. Topics which will be covered during the two day conference will include ground investigation, piling, ground improvements, laboratory testing, data management and health and safety. The speakers include many of the UK representatives on the CEN (European) Standards committees and UK mirror committees which themselves represent the industry and relevant trade associations such as FPS, AGS and BDA. The imminent commencement of HS2, combined with the consistent growth already seen across the UK over the last 12 months, provides a major challenge to the UK geotechnical and drilling industries, which hasn't been seen since the 1980's. As this growth comes on the back of the most severe recession in living memory - how will the UK industry sectors cope? There are many questions which are not being asked but we will at Geotechnica.

Unlike other conferences, Geotechnica encourages audience participation and discussion which allows the industry to challenge potential problems, shortfalls and more importantly how we can drive standards and best practice across. Issues such as competence, compliance, resources and quality will be discussed with particular attention to potential impact on growth for 2014 and beyond.

Geotechnica  
2014   
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### Wednesday 2nd July

#### Main Conference Room

Ground Investigation, Field Instrumentation, Laboratory, Data  
Chairman: Pete Reading, Equipe Group

09:45 to 10:15 **Introduction and Welcome**  
Dr John Powell, Technical Director, GEOLABS

10:15 to 11:00 **Keynote Address - Recession is Over: Start preparing for the next one**  
Tim Fitch, Construction Strategist - Director, Inventt

11:00 to 11:30 **New Standards for Instrumentation and Monitoring - What will they mean for you?**  
Dr Andrew Ridley, Managing Director, Geotechnical Observations

11:30 to 12:30 **BS1377 - are we about to throw away 24 years' experience?**  
Roger Brown, Associate Director - Laboratories, Fugro

12:30 to 13:00 **What does the new BS 8574 on Geotechnical Data Management mean for your organisation?**  
Dr Roger Chandler, Managing Director, Keynetix

14:00 to 14:45 **Panel Session: Is UK practice compatible with Eurocode compliance**  
Dr John Powell, Technical Director, GEOLABS & Matthew Baldwin, Technical Director, Soil Engineering Geosciences

**Health & Safety**  
Chairman: Pete Reading, Equipe Group

14:45 to 15:15 **HSE update**  
John Underwood, Construction Inspector, Construction Sector Safety Team, Health & Safety Executive

15:15 to 15:45 **Preparing the industry for CDM changes**  
Tom Phillips, Director, RPA Safety Services

15:45 to 16:15 **PAS 128 - what the new underground utility detection, verification and location standard requires, and how to use it**  
Dr George Tuckwell, Director, RSK

#### Small Meeting Room

10:30 to 12:30 **The future of Ground Source Heat**  
With updates on recent industry developments, a look forward to sector growth and examples of training, drilling and installation successes the GSHPA is excited to be speaking on:

- The time is right for geothermal solutions
- Dispelling the myths surrounding geothermal drilling
- Training developments to ensure appropriate competencies & skills
- Scalability of GSHP systems - "the opportunities are endless"



### Thursday 3rd July

#### Main Conference Room

Geotechnical Processes  
Chairman: Pete Reading, Equipe Group

10:00 to 10:15 **Introduction and Welcome**  
Pete Reading, Equipe Group

10:15 to 11:00 **Keynote Address - The future of geotechnical engineering**  
Professor Barry Clarke, University of Leeds

11:00 to 11:30 **EC7 evolution and progress**  
Tracey Wilkins, Programme Manager - Construction, BSI

11:30 to 12:00 **Current and emerging landscape regarding geotechnical codes & standards for foundation solutions**  
Dr Derek Egan, Technical Director, Keller & UK representative on CEN/TC288 Execution of special geotechnical works

12:00 to 12:30 **The evolution of pile design to EC7**  
Chis Raison, Director, Raison Foster Associates

**Geo-environmental and Remediation**  
Chairman: Pete Reading, Equipe Group

12:30 to 13:00 **Measuring hydrocarbon vapours in gas mixtures which contain methane using a combination of IR and PID**  
Chris Dakin, Gas Data

13:30 to 14:30 **Sustainable Remediation**  
Prof. Paul Nathanail, LQM, University of Nottingham

14:30 to 15:30 **Sustainability assessment of HS2**  
Prof. Paul Nathanail, LQM, University of Nottingham

#### Small Meeting Room

10:00 to 12:00 **AGS Contaminated Land Working Group Meeting**

12:30 to 13:00 **Workshop: Taster session of LQM Dose Response Roadmaps**  
Prof. Paul Nathanail, LQM, University of Nottingham



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by Platipus Anchors

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# SCOTTISH TRANSPORT MINISTER OVERSEES START OF WORKS ON A9 GROUND INVESTIGATION

Writing for *theGeotechnica* this month is [Soil Engineering Geoservices](#)' Natalie Fennell. In this month's article, Natalie reveals details of Scottish Transport Minister Keith Brown's visit to the A9 Ground Investigation Soil Engineering site on the 27th of May.

Soil Engineering were recently awarded the Birnam to Tay Crossing Ground Investigation work package, a five mile section of Transport Scotland's £3 billion A9 Dualling scheme.

It is proposed to improve and upgrade the existing A9 between the Pass of Birnam

and the River Tay Crossing, from single carriageway to dual carriageway standard. The ground investigation is being undertaken to provide geotechnical and geo-environmental information for the design process for the new road scheme.

The objective of the

**"The objective of the investigation is to form exploratory holes in soil and rock to obtain samples for geotechnical analysis..."**

investigation is to form exploratory holes in soil and rock to obtain samples for geotechnical analysis whilst facilitating in-situ testing and the installation and monitoring of in ground

**"The investigation works are to be undertaken on or adjacent to the existing A9 carriageway and the existing Highland Mainline Railway..."**

instrumentation.

The investigation works are to be undertaken on or adjacent to the existing A9 carriageway and the existing Highland

Mainline Railway, as well as a number of water courses and environmentally sensitive areas.

Scottish Transport Minister Keith Brown was on site 27th May to meet Soil Engineering and to officially launch the start of the works. Mr Brown said "Our commitment to dual the A9 between Perth and Inverness is unwavering, and underlined in recent weeks with the first of three multi-million pound design contracts awarded, and the remaining two expected before the year is out"

"I've seen for myself today the start of ground investigations work for the section between Birnam and Tay Crossing which is vital to help inform the design process and help move towards publishing the draft orders next year. This section presents some particular challenges and we are working hard to minimise

any impacts to properties, the railway and the environment."

Soil Engineering Geoservices are acutely aware of the environmentally sensitive nature of the Pass of Birnam to River Tay Crossing area and the challenges this presents e.g.the River Tay Special Area Conservation (SAC) and the proximity to settlements at Birnam, Dunkeld and Inver.

Soil Engineering propose to undertake the works with the following modern plant and equipment:

- 6 No. Cable percussive rigs
- 5 No. Rotary drilling rigs

Testing of samples obtained will be carried out at Soil Engineering Geoservices in house geotechnical laboratory.

Site works are programmed to last 22 weeks. ■





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# AN UPDATE ON CHEMICAL BIOAVAILABILITY TESTING IN SOILS

Writing for the *Geotechnica* this month on behalf of [Derwentside Environmental Testing Services](#) is Hazel Davidson. In this article Hazel provides an update on chemical bioavailability testing in soils.

For many years the chemical testing of soil has used methods intended to extract the maximum amount of various contaminants from the soil – aggressive acidic extractions for metals, or polar solvents such as methanol or dichloromethane for organics are just two examples. **“From a human health risk assessment perspective this has been recognised as not necessarily the most meaningful approach...”**

However, from a human health risk assessment perspective this has been recognised as not necessarily the most meaningful approach, and several physiologically based extraction tests (PBET) have

been proposed over the years, to provide an indication of the bioavailable proportion of the contaminant in question. Using this information may save significant costs when remediating contaminated sites, either by retaining material on site (no landfill costs), or by reducing the need for soil treatment.

A three day conference organised by the British Geological Survey (BGS) and the University of Nottingham, was held last November at BGS, Keyworth, reviewing many of these methods, and international speakers presented current research and ideas on this subject – the 7th International Workshop on Chemical Bioavailability in the Terrestrial Environment.

**Bioaccessible/bioavailable**  
It is important to understand the difference between

**“Bioaccessibility is a measure of the contaminant in the soil in a form that can be ingested/solubilised into the gastro-intestinal (GI) tract and is potentially available to the organism.”**

bioavailability and bioaccessibility, as this causes some confusion within the industry.

Bioaccessibility is a measure of the contaminant in the soil in a form that can be ingested/solubilised into the gastro-intestinal (GI) tract and is potentially available to the organism.

Bioavailability is a measure of the proportion of the ingested contaminant that passes through the gastro-intestinal lining into the systemic blood and organs and is actually



Soil + contaminants



Extraction

**Bioaccessible**



GI Cell membrane

**Bioavailable**



Blood/organs

available.

Bioavailability can therefore only be measured by in vivo animal studies – exposing mice/piglets to the contaminant of interest in their food, and then monitoring the levels in their blood or other organs. This route has ethical issues and is very expensive.

The emphasis within the industry has therefore concentrated on defining chemical – in vitro – tests which mimic the uptake by receptors and can provide an indication of risk to exposure. They are sometimes referred to as predictors.

## History

Interest in this area of science began in 1990, but only nine papers were published in the subsequent five years, including the first paper in 1993 by Ruby et al, outlining the original PBET method. Research moved fairly slowly, but interest began to gather momentum, and between

2003 and 2007, 135 papers were published. In 2013, over 100 authors contributed 72 papers from 40 countries on this topic (data collated by Dr **“Initially, the two contaminants of interest were arsenic and lead, but this has now extended to include several other metals including copper, nickel, and cadmium...”**

Joanna Wragg, BGS). Initially, the two contaminants of interest were arsenic and lead, but this has now extended to include several other metals including copper, nickel, and cadmium, and also organics such as polyaromatic hydrocarbons and total petroleum hydrocarbons.

The basis of bioaccessible methods is to mimic the extraction of the human body, and this involves using

extraction solutions similar to saliva, gastric acid, and intestinal secretions. Of the published methods, these range from a simple one step to a sequential three step method involving the use of a food substrate.

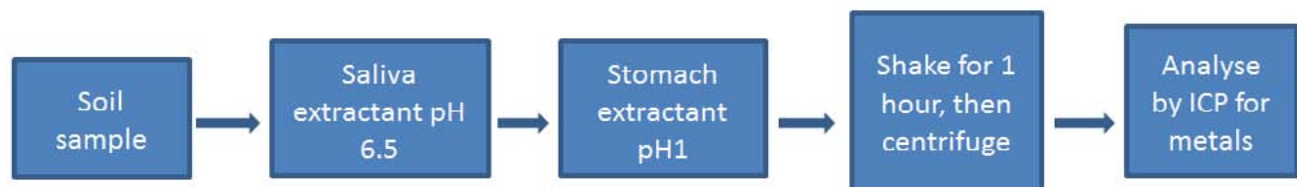
Examples of methods:

- PBET, Advances in bioavailability of inorganics in soil, Ruby et al (1996)
- IVG (In Vitro Gastrointestinal) method, Rodriguez et al (1999)
- Dutch (RIVM) method (2004)
- RBALP (Relative Bioaccessibility Leaching Procedure) (2007) – only for lead
- CE-PBET (2011) Colon Extended Physiologically Based Extraction Test
- SHIME Dynamic Bioaccessibility Gastrointestinal Method Simulator System
- FOREhST (2010) Fed Organic Estimation human Stimulation Test

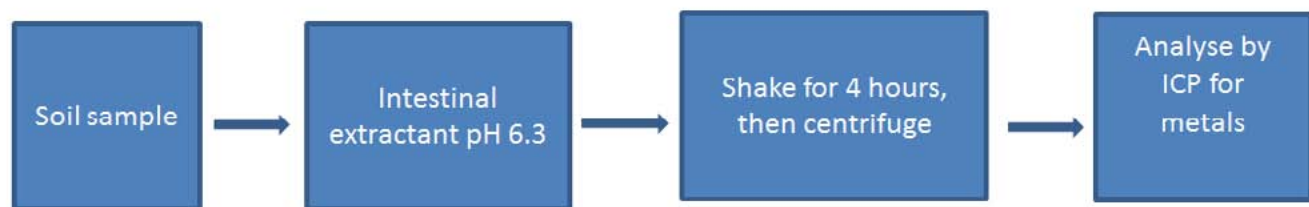
However, the early



Gastric extraction



Intestinal extraction



**Schematic of BARGE method for metal - The BARGE group in the UK is chaired by Dr Mark Cave, with Dr Joanne Wragg as secretariat, both of BGS.**

data was variable, with inconsistency between laboratories and methods, and the regulators/end users of data were reluctant to accept the concept of bioavailability as robust enough to use.

A group was set up in 1998 in Europe known as BARGE – the Bioaccessibility Research Group of Europe – and interlaboratory studies conducted in the early 2000s demonstrated a wide range of variability in the data due to the different methods in **“BARGE set up trials and reviewed data, eventually producing a Unified BARGE Method (UBM) in 2007...”**

use. BARGE set up trials and reviewed data, eventually producing a Unified BARGE Method (UBM) in 2007 and trials were performed using this, plus some studies correlating the bioaccessibility

data to bioavailable data using animal studies.

**Potential for Cost Savings**

In 2005, the Environment Agency estimated some 300,000 hectares of former industrial land in England and Wales could be classified as ‘contaminated’, when assessed by standard chemical methods.

A well documented study on bioaccessible metals sponsored by the Natural Environment Research Council (NERC) and BGS resulted in estimated cost savings of £3.75 million.

An additional example was a joint project performed by BGS, Land Quality Management (LQM), and the University of Nottingham staff, which saved between £7 million and £30 million in remediation expenses on one site. Bioaccessibility testing not only reassured local residents, but also helped to kick start the stalled local housing market.

**Summary**

This is a complex topic with some conflicting opinions on certain aspects of bioavailability/bioaccessibility testing and how best to gain an understanding of quantifying the risks to

**“Much progress has been made over the last 10 – 15 years, but there is still a profusion of methods, which can lead to varying interpretations.”**

human health. Much progress has been made over the last 10 – 15 years, but there is still a profusion of methods, which can lead to varying interpretations. However, in Europe, the Unified BARGE Method (UBM) is becoming recognised as a consistent method, and several countries have now run validated trials using this. The cost savings from less remediation can be significant. ■



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# MINNOVARE INTRODUCE THE AWARD WINNING AZIMUTH ALIGNER TO THE UK MARKET

Writing for *theGeotechnica* for the first time is **Michael Beilby**, Commercial Director of [Minnovare Pty Ltd](http://minnovare.com.au), an Australian company that was originally formed to leverage the demand for improved accuracy and efficiency of drill rig alignment in the Mining and Civil Engineering industries. In this article Michael introduces the award winning Azimuth Aligner to the UK market.

A breakthrough innovation first put to work in the rugged underground mining terrain of the Australian outback has been adapted for use on the £15 billion Crossrail project.

Tired of the time-consuming and error-prone traditional method of aligning an underground drill rig, veteran Aussie mining services

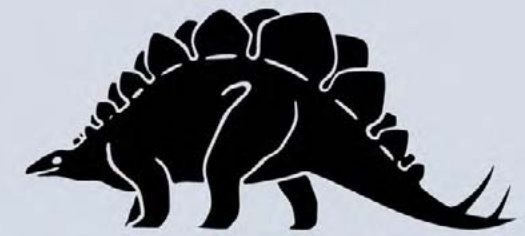
operator Mike Ayris turned to a combination of military gyroscopic technology and state of the art fibre optics to produce the Azimuth Aligner. The outcome: it does in five minutes what used to take up to 1.5 hours.

"The Azimuth Aligner substantially boosts productivity, with a

corresponding decrease in costs," said Callum McCracken, Managing Director of Perth-based Minnovare Mining and Civil, the company he formed with Ayris and Michael Beilby to commercialise the invention.

**"Attached to the lead rod of a drill rig, it enables a single operator to align that rig in just five minutes..."**

"Attached to the lead rod of a drill rig, it enables a ▶▶



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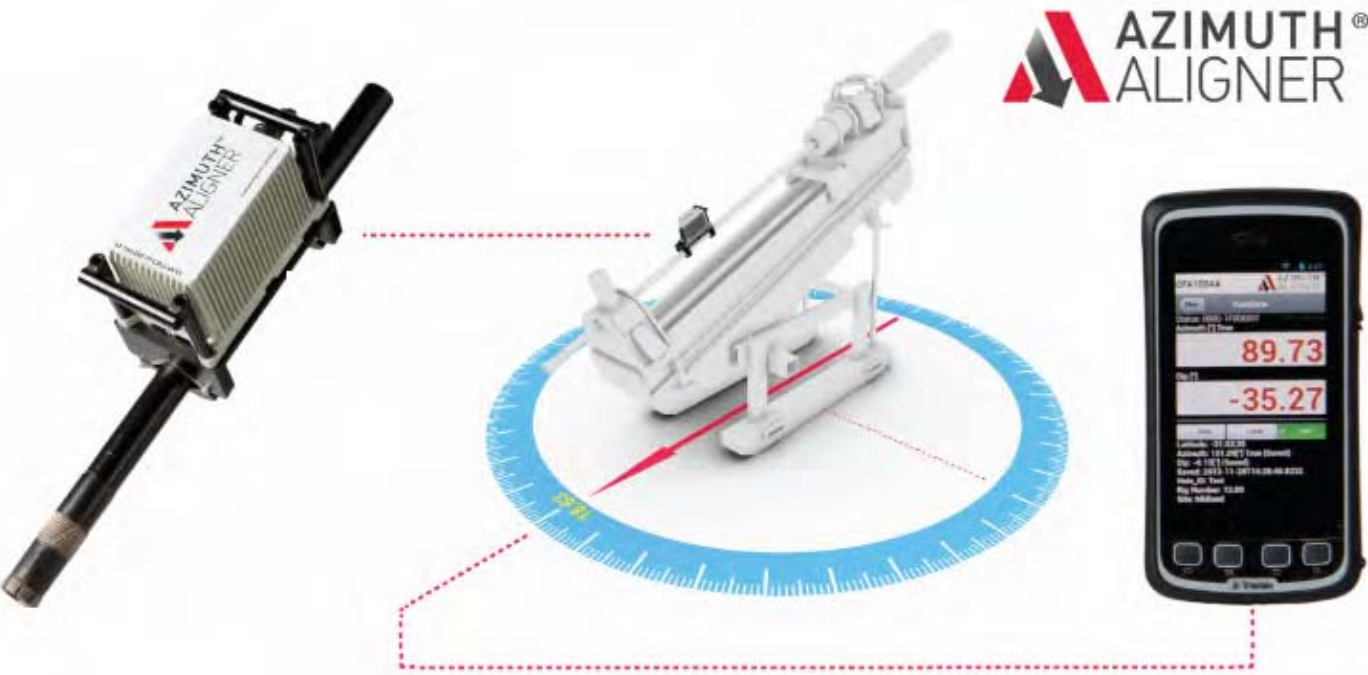
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single operator to align that rig in just five minutes – that’s compared to the hour and a half it takes using traditional methods where multiple backsight foresight markers are repeatedly set and re-set with a surveyor, assistant and engineer all required.

“That process is time-consuming and prone to human error, apart from having inherent increased risk because of all the marking required.

“Compare it to the Azimuth Aligner which measures the rotation of the earth and in just a matter of minutes streams ‘live’ data on azimuth, dip and roll to a hand-held display unit to a precision of  $\pm 0.2^\circ$ .”

**“The revolutionary technology was first deployed in civil engineering on the just finished Port of Miami Tunnel Project...”**

The revolutionary technology was first deployed in civil engineering on the just finished Port of Miami Tunnel Project in the United States where contractors were required to drill 100 horizontal freeze grout holes to form two emergency service passages connecting two parallel tunnels 37 metres below one of the U.S.’s busiest cruise and cargo ports.

Drill rig set-up time was cut by 80-90%, achieving

significant cost savings, and the contractors now mandate use of the Azimuth Aligner for all future set-ups.

On the back of that success, the technology crossed the Atlantic to the Crossrail project when Bachy Soletanche was contracted to undertake compensation grouting works by the BBMV joint venture formed to complete the project. London use of the Azimuth Aligner mirrored benefits achieved in Miami. First unveiled at the annual conference of the Prospectors and Developers Association of Canada in March 2012, the Azimuth Aligner’s enthusiastic reception there was followed up with a marketing campaign which resulted in almost 250 enquiries from drill companies around the world. That accelerated Minnovare into overdrive to manufacture the device and, with dozens now already at work, the company continues to fast-track production with the objective of doubling the number available by the end of 2014.

Down-under the Azimuth Aligner is infiltrating the mining industry as fast as units can be manufactured, with major mining services providers and global miners such as BHP Billiton and Rio Tinto using the device.

However, it has been its crossover to civil works, where absolute accuracy is required, which has quickened Minnovare’s development of version 2 – the Azimuth Aligner Wireless which is 50% more accurate, able to store

and export data, is smaller and lighter and, as it says, wireless.

Crossrail exemplifies not only the accuracy civil engineering requires, but the device’s capability in delivering it. The extensive compensation grouting program to support the structural integrity of the city structures above was conducted among underground workings and sewer lines, thereby demanding that the thousands of holes had to be drilled to a precision of 0.1 degrees to ensure no potentially catastrophic intersections.

**“Interest has been further piqued by industry recognition of the Azimuth Aligner.”**

Interest has been further piqued by industry recognition of the Azimuth Aligner. It has been recognised with a Highly Commended Award in the Product and Equipment Innovation category of this year’s Ground Engineering Awards, following its acclaim as Innovative Mining Solution in the Australian Mining Prospect Awards last year.

Minnovare estimates its product has a potential worldwide market in mining and civil construction of hundreds of millions of pounds annually and is establishing a global network of distribution agents under the ‘hub and spoke’ corporate strategy the company has embraced to speed commercialisation. ■



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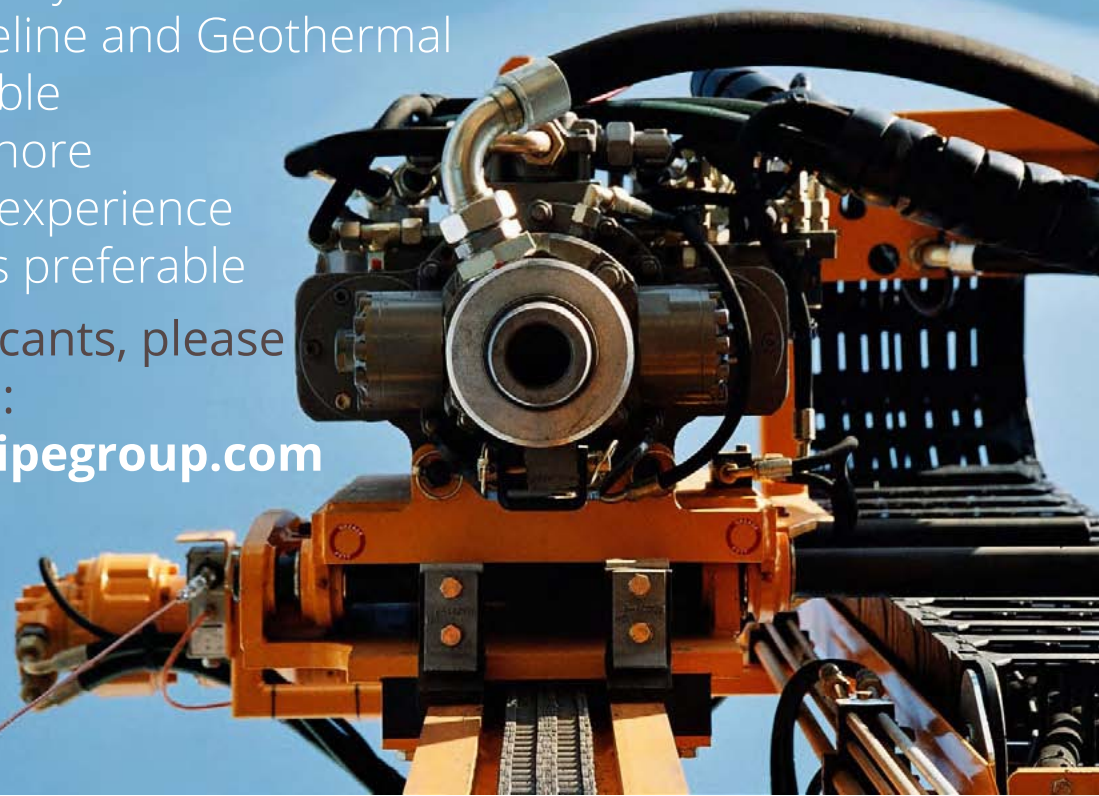
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