"Knowledge is power, community is strength and positive attitude is everything"
-Lance Armstrong

WING UK GOAL

Our goal is to support and contribute to the development of Geothermal technologies and the role of women in this thriving industry

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WING UK

Exchange knowledge, supporting the development and improvement of the Geothermal technologies.
Find news and relevant information on the Geothermal activity in the UK.
Network with likeminded individuals to share experience and advice.
Advertise internship and job opportunities.
Find Match-Making Opportunities, where the solutions of one body/organization, can help another

https://wing.wildapricot.org/

Women in Gothermal (WING UK)

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WING UK PRESENTATIONS

Following the success of our 'Think & Drink' webinar series, we aim to continue conversations, keeping the geothermal community connected and engaged.

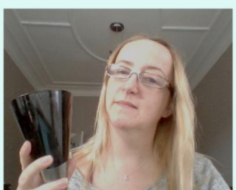
We will be hosting monthly webinars where guest speakers will be invited to present their work in the geothermal industry.

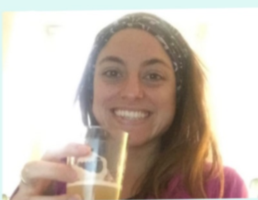
Wednesday 26th August, 16:00 BST
Nadia Narayan, Durham University
A Special Geothermal Broad -Karst: The Resource Potential of Carboniferous Limestone in Great Britain

Wednesday 30th September, 16:00 BST
Engie
Southampton District Heating Scheme

Wednesday 28th October, 16:00 BST
Cornish Lithium
Extraction of lithium from geothermal brines in Cornwall

If you are interested in giving a presentation for one of our monthly webinars, please contact us at: womeningeothermal.uk@gmail.com



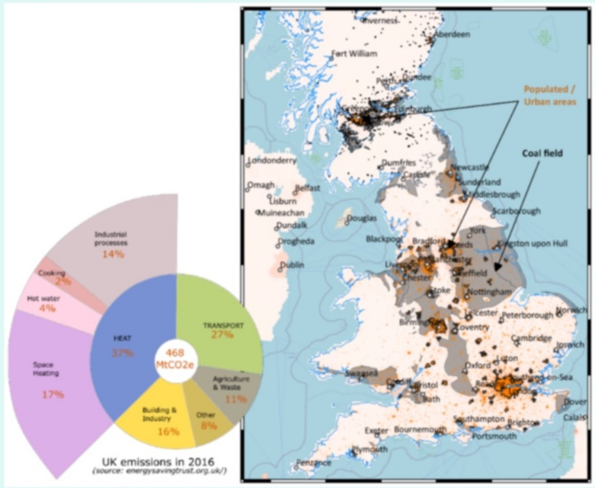



The challenges of Mine water heat extraction – PhD investigations

Mylene Receveur, Fiona Todd

With the growing need for new low-carbon energy sources, harnessing heat from abandoned and now flooded coal mines could be a very attractive solution. In the UK, about 47% of the energy consumption is used for space heating (source: 2018 GOV.UK), and around 70% of the heat demand is supplied by natural gas, largely contributing to the carbon emissions of the country.

A large proportion of the urban area in the UK was extensively mined for coal, and the resource that once contributed to harmful air pollution and climate change is now home to another valuable, renewable and easily accessible resource: a large volume of 12-20°C mine water. Using ground-source heat pump (GSHP) systems, heat energy can be extracted from this water and potentially be used for space heating. Mine water based GSHP schemes have already been implemented worldwide and one of the most successful projects, which has been running for over a decade, is located at Heerlen in the Netherlands. Earlier this year, the Coal Authority (the non-departmental government body with the responsibility for managing the legacy of abandoned coal mines) has launched the first large scale mine-energy district heating scheme in the UK in South Seaham, North-East England, where 18-20°C mine water will be used to provide heat to the 1500 residents of the new Garden Village.



UK coalfields (grey) with location of the main cities and urban areas (orange). In the UK, about 25 % of the population lives on former coalfields, where 17 billion tonnes of coal were extracted over the past 300 years.

A great opportunity, but what is its potential?

Mines have several benefits compared to conventional geothermal reservoirs. The existence of deep shafts, if not backfilled, might offer the possibility of direct access to the mine water without needing to drill new boreholes, which can often represent a large proportion of initial project investment costs. Geothermal projects can also have a high risk of tapping into an insufficient resource (i.e. limited by low water flow), and this is significantly reduced in mine systems as the network of mine galleries, generally well mapped and documented, creates high conductivity pathways able to flow large quantities of water. Additionally, there is usually little need to transport this energy as the mines are situated immediately beneath the consumers.

The schemes could, therefore, directly benefit the local population who often have a strong historical connection with former mines in their local area. The Coal Authority currently pumps and treats mine water at over 70 locations in the UK to control mine water discharge and it is envisioned that the operational costs of this could be offset by using the heat naturally contained within the water.

So if this is such a great opportunity, why has it not already been capitalised upon? Well, there are several questions to be answered to ensure that such project can be viable. Even if the resource is here and extensive, we don't want to risk depleting it too fast. There are great challenges in striking the right balance between the geological, technical and economic aspects - between what energy we need and what a geological system can realistically deliver. To make the heat extraction sustainable, we need to assess the full extent of its potential, and understand how fast the energy we take from the mine water to heat our houses will be replenished within the mine system, and this is the focus of my PhD: Where does the heat come from?

My research project is about trying to understand what the heat sources in mines are, their relative contribution to the total heat generation, and the heat recharge mechanisms that control mine water temperature over time.

These factors are critical to establishing the long-term health of mine water heat schemes, which highly depends on the system's thermal dynamics. During the operation of the GSHP, groundwater might enter the system at a cooler temperature or abstracted mine water might be reinjected directly into the mined strata after being used for heat. From an economic perspective, the biggest issue would be that this cooler water reaches the production well before warming up, reducing the ability of the scheme to provide the required heat. Unfortunately, "short-circuiting" effect is a real possibility in mines, where the interconnection of shafts, tunnels and galleries tends to enhance the subsurface permeability at very large scale, and can result in insufficient time for water to be replenished in heat via energy transfers from the host rock. From a resource perspective, if the inflowing water were hotter than the rock, the heat recharge of the mine would be guaranteed, but if it is colder, then the water might deplete the host rock from of the heat needed to fulfil our low-carbon heating needs. The key question will therefore be to assess whether a sustainable heat extraction rate can be maintained over the long-term.

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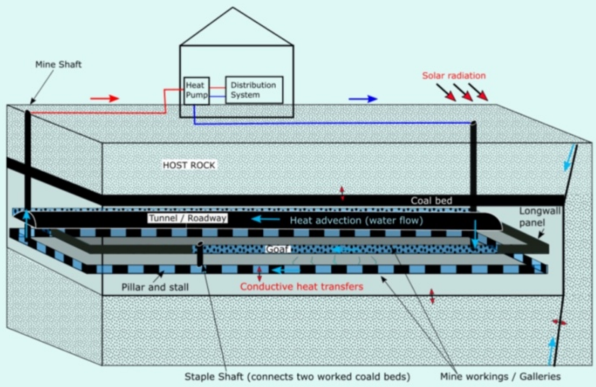
Mines, a complex geothermal system.

Unfortunately, disused mine reservoirs are not simple. Their complex geometry resulting from a long mining history make it difficult to predict mine water flow paths. Furthermore, no matter how detailed mine plans can be (and they really are!), the amount of collapse that occurred subsequent to mine closure and the current state of the galleries is unknown. As a result, we can only make broad estimates of the volume and the shape of the residual voids, and thus the volume of accessible water. More importantly, this might also indirectly affect our capacity to predict the nature of the heat fluxes in the mine, and the potential to recharge the heat resource. However, we don't actually know how important these factors are. One of the main points of my study will be to find a way to deal with those uncertainties, by assessing what parameter or geometrical feature is most important when it comes to understand the key heat transfer processes controlling the temperature distribution at the scale of the mine.

The complexity of the mines is not limited to their geometry, but also to temporal aspects. During mining activities, pumping and ventilation were implemented in deep galleries to ensure safe working conditions for the miners. Another line of investigation of my PhD will be to assess the possible long-term effect of such prolonged periods of cooling on the present-day temperature distribution in the mine and on the fluxes induced on the "disturbed" sub-surface. How do I plan to do that? Primarily by developing numerical models that will simulate change in the hydraulic and thermal states in the mine for different scenarios covering the mining, flooding and the geothermal production periods, using the open-source OpenGeoSys software. Models will be calibrated and validated using temperature data acquired by the Coal Authority, who partly fund this research. Looking at the big picture, developing a numerical tool that could be used to evaluate the full extent of the heat available over the long term in a mine would be a valuable outcome of this study. It could first support the dimensioning of GSHP systems and then, help defining the footprint area of heat extraction, providing a scientific support to guide the licensing of heat.



Simplified sketch of a coal mine with GSHP mine water heat system. The arrows show the induced heat transfer processes and the direction of water flow. Two mining approaches are represented. In the "pillar and stall" approach, pillars of coal were left unmined to support the roof of the mine. In the "longwall" mining approach, coal panels (about 100 to 250 m wide) were mined between two parallel roadways and the roof was allowed to collapse, filling the galleries with "goaf" material (see Younger et al., 2002).

Cyclical production and mine stability

Not only could mine systems be seen as a heat source, but also as a storage system; heat could be injected either seasonally by reversing the GSHP system, or from local buildings/infrastructures with excess heat (i.e. data centres, incinerators), in order to be used later in the year (i.e. winter time). Seasonal production/injection of heat and cold has been proven to increase the efficiency and the sustainability of GSHP system, by ensuring the artificial recharge of heat into the underground. However, the impact of such cooling-warming cycles on the stability of coal pillars, that have in some cases maintained structural stability of abandoned mines, is uncertain. If pillars collapse, subsidence of the ground, that generally occurred during or shortly after mining, could be resumed. This would have both a negative impact for the underground by reducing the rock permeability, but also for surface infrastructure. This is another area of research being undertaken at the University of Edinburgh by Fiona Todd whose PhD is aiming to evaluate the risk of pillar collapse through a full hydro-thermo-mechanical modelling study of cyclical mine water heat production.

To conclude... Reutilising old coal mines into a renewable energy source could significantly contribute to the decarbonization of residential heat, an area targeted by the UK to help reach Net Zero emissions. Diversifying the range of energy sources is the key to a reduction of our impact on the environment, and it is legitimate to put mine water heat in the mix. But for that, we need to find the right balance, in terms of what is available rather than what we need, which requires an understanding of its potential over the long term. A Final word? Be smart. Antoine Lavoisier said “nothing is lost, nothing is created, everything is transformed”. What if we could make it true at the scale of our energy consumption? A giant interconnected loop, where all wasted heat is recycled and converted into usable energy source. Let’s think big. And the more brains involved, the more possible it can become.

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Geology and 'the dark side'

Peter Ledingham & Suzie Doe

Representing the views of the author and not the company

A long time ago in a galaxy – well, this galaxy actually – it was commonplace for geology graduates to follow careers in the oil & gas and mining industries. And why not? They offered secure, interesting, technically challenging and financially rewarding jobs. But something has changed. Now a significant number of geology students regard these industries as the dark side. They are looking for more environmentally sensitive and sustainable career opportunities, some even choosing careers in totally different disciplines, as suggested by the falling numbers taking geology A-level.

As part of the outreach and education programmes at the **United Downs Deep Geothermal Power project**, we have visited lots of schools, hosted school visits and attended many careers events. When we ask geology students what they want to do after graduation there is a very clear bias towards industries like geothermal energy and environmental management and away from what they regard as more controversial and undesirable ones like hydrocarbons and mining.

A group of A-level geology students from Helston Community College visiting the UDDGP site in February, 2019.

The widespread reporting of catastrophic pollution events, mining operations that devastate the landscape and protests against 'fracking' projects has undoubtedly contributed to this negative perception of extractive industries. But is it really fair to paint the picture quite so black and white? The negative reporting is often actually about bad practice, not bad industries. There is lots of good practice too, carried out safety and in full compliance with environmental regulations.

And, whether we like it or not, these industries are going to be essential to support the move towards a low-carbon future and to provide gap fuels until it is achieved. Minerals and metals have to be mined to make batteries, wind turbines and solar panels, and provide the raw materials necessary for generation and transmission equipment for renewable energies. The phasing out of fossil fuels is clearly desirable but it isn't going to happen overnight, even if the necessary decisions were taken now. We probably face a transition period of at least two working lifetimes during which oil and gas will still be needed in significant amounts.

http://www.geothermalengineering.co.uk/UDowns.html

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Via Quartz
Image source: https://qz.com/916572/germanys-renewable-energy-boom-is-making-life-miserable-for-fossil-fuel-producers-like-rwe-and-eon/
EPA/Julian Stratenschulte

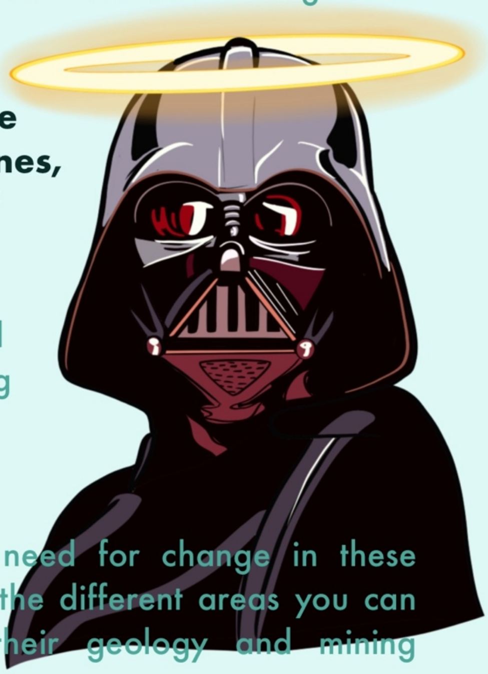
If the hydrocarbon and mining industries are unable to recruit good quality graduate geologists, and other earth scientists, the situation will get worse, not better. Now, more than ever, there is a need for a workforce with the skills to manage the transition period in the best way possible, both from a technical and an environmental standpoint. Better to enter the industry and help steer it towards best practice than to stay out of it and dismiss it as antisocial, or worse.

The management of radioactive waste is sometimes overlooked these days, but has no less stigma attached to it. The UK has a significant amount of waste which is currently stored at surface. Other countries have similar stores. The international consensus, arrived at after decades of research and experimentation, is that geological disposal or storage is the best long term solution. The identification of sites, construction, monitoring and management of such facilities is a complex and challenging exercise but earth science graduate noses are likely to turn up even more at the suggestion that they enter this field than at the idea of working in oil and gas. Yet a lack of expertise in this area could soon become a serious problem, and the waste won't go away.

Image via Sandford Underground Research Facility
Image source: https://www.sanfordlab.org/article/listening-earth-harness-geothermal-energy

Perhaps graduate earth scientists with a social and environmental conscience shouldn't dismiss working in these 'contentious geoscience' industries out of hand. It isn't going over to the dark side; it can be a force for positive change.

Luke always knew there was some good in Darth Vader.



The **Camborne School of Mines, University of Exeter** offer some world renowned local geology/mining courses, their promotional video below highlights the need for change in these industries and the different areas you can study within their geology and mining degrees.
https://www.facebook.com/watch/?v=575549289683374

http://emps.exeter.ac.uk/csm/

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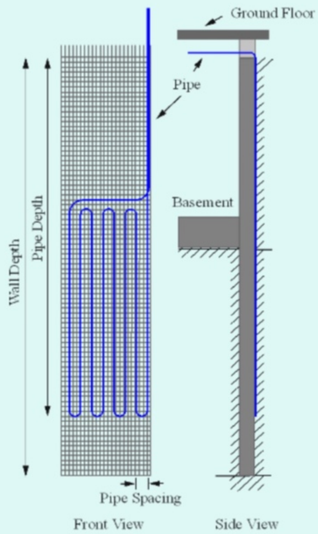
Thermal Energy from Buried Infrastructures

Dr Ida Shafagh, University of Leeds

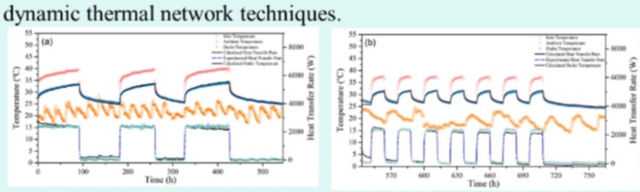
One of the grand challenges confronting the world today is to meet the growing demand for energy while addressing the environmental and climate impacts of fossil fuel consumption. A large portion of energy consumption in developed countries corresponds to heating and cooling of residential and commercial buildings and so reduction in such demands is a key element of most national emission reduction strategies. Ground-coupled heat exchange systems are infrastructures that have the potential to be the most efficient and sustainable thermal resources to meet this need. These thermal energy sources include: (i) open and closed-loop borehole heat exchange systems; (ii) water sources such as rivers, canals and port facilities; (iii) foundation elements such as piles and diaphragm walls; tunnels; embankments and cuttings; (iv) mine workings; and (v) waste water infrastructure systems. Successful exploitation of these resources requires robust assessment, investigation, design and simulation methods. Achieving successful exploitation requires that user needs and social concerns are addressed, and that suitable business and regulatory models can be found and implemented. Here at the University of Leeds, our research in "Energy Geotechnics" seeks to address these challenges. Our vision is to advance the state-of-the-art of geothermal energy exploitation through inter-disciplinary research in energy geotechnics applications in order to achieve sustainable heating and cooling energy infrastructures suitable for the twenty first century.

Highlights of our research in Leeds University include:

➢ **Diaphragm Wall Heat Exchangers**



The research is focused on development and validation of a state-of-the-art modelling tool to assess the performance of diaphragm wall heat exchangers using a novel combination of finite volume and dynamic thermal network techniques.



Examples of model validation with experimental diaphragm wall heat exchanger outlet temperature;

In addition, novel analytical models to assess the steady state thermal resistance of such substructure heat exchangers are developed [1,2,8].

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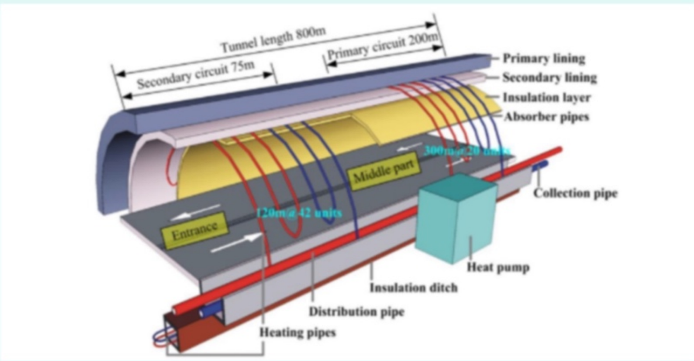
➢ Energy Piles

The research considers analysis of foundation piles with the aim to fill significant gaps in our understanding of their behaviour. Current work includes instrumentation of operational piles that is essential to allow validation of new design methods as a lack of high-quality field datasets has inhibited design development. Initial data from site monitoring is confirming the importance of the pile concrete in controlling large diameter pile behaviour [3-6].

➢ Tunnel Lining Heat Exchangers



Typical example of a tunnel lining heat exchanger, Source: Wiik, 2015;

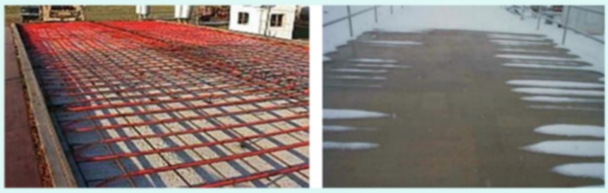
The research investigates thermal resistance of tunnel lining heat exchangers, which is an important factor in exploring their thermal performances, using combinations of analytical and numerical methods. Moreover, it focuses on developing a unique tool to accurately estimate thermal performance of such substructure heat exchangers using their key design parameters without the need for computationally burdensome numerical analysis.

➢ Improved Transport Infrastructure Resilience

Ice and snow weather events provide challenges to safety, management and durability of transport infrastructures. Failures to manage snow at UK airports has proved to be extremely disruptive and economically damaging, for example. Using geothermal energy to protect infrastructure from ice/snow by heating pavement and rail surfaces has been proved to be feasible. We aim to advance this technology for UK application. Such systems consist of:

- Pavement surfaces with embedded pipes – for use as solar collectors in summer and heating surfaces during storms.
- Ground thermal stores – boreholes, piles or embankments.
- Heat sources – including heat pumps;
- Smart sensing and automatic control systems.

Work has focused on modelling surface conditions and assessment of energy demands [7].



A geothermally heated bridge deck during construction and pilot testing (https://hvac.okstate.edu/facilities/medium-scale-bridge-deck);

➢ Thermal Network Integration

Harvested thermal energy is best utilized at large-scale by successful integration with networks such as district heating. This also requires application of heat pump technology and development of heat trading business models. Integration with low-temperature systems also brings opportunities for recovery of waste heat from sources such as datacentres. Research has focused on modelling of the dynamic performance of such networks and enhancing the predictions of ground heat losses and improving computational efficiency.

Examples of district heating pipelines;

https://www.womeningeothermal.com

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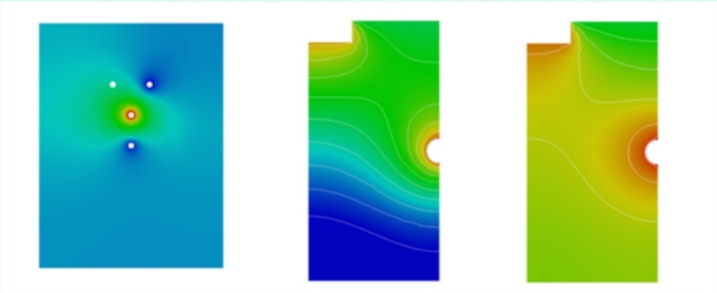
➢ PLEXUS: Priming Laboratory Experiments on Infrastructure and Urban Systems

PLEXUS (EP/R013535/1) aims to formulate (1) a first draft of UKCRIC's Common Vision, Strategic Research Agenda and Implementation Action Plan, and (2) facilitate an unfolding research and development route map for UKCRICs' Laboratory Strand. Work in collaboration with the Universities of Cambridge, Cranfield, Newcastle and Sheffield focusses on modelling ground heat transfer processes in tunnels and sewer infrastructure systems (Research Challenge 2: Harvesting Energy from Buried Infrastructure Systems).



Numerical modelling of buried sewer and tunnel infrastructure;

References: (1) Shafagh I; Rees SJ (2019) Analytical Investigations into Thermal Resistance of Diaphragm Wall Heat Exchangers, EGC 2019. (2) Shafagh I; Rees S (2018) A Foundation Wall Heat Exchanger Model and Validation, IGSHPA Sweden. (3) Loveridge F; Powrie W; (2013) Pile Heat Exchangers: Thermal Behaviour and Interactions Proceedings of the Ins of Civil Eng Geotech Eng 166(2). (4) Loveridge FA; Powrie W; Amis T; Wischy M; Kiauk J (2016) Long Term Monitoring of CFA Energy Pile Schemes in the UK In Wuttke, et al (Eds) Energy Geotechnics, Proceedings ICEGT 2016. (5) Loveridge F; Powrie W (2013) Temperature Response Functions (G-functions) for Single Pile Heat Exchangers Energy, 57. (6) Loveridge F; Powrie W (2014) 2D Thermal Resistance of Pile Heat Exchangers Geothermics 50. (7) Xiaobing L; Rees SJ; Spitler JD (2007) Modelling Snow Melting on Heated Pavement Surfaces. Part I: Model Development Applied Thermal Engineering 27 (5–6). (8)) Shafagh I; Rees SJ; Urra Mardaras I; Curto Janó M; Polo Carbayo M (2020) A Model of a Diaphragm Wall Ground Heat Exchanger, Energies 13(2).

Centre for Infrastructure Materials Geo-Energy Laboratory

The lab and field test site provides a unique facility for investigation of ground material properties and environmental heat exchange behaviours. Facilities include:

- lab-scale thermal properties test equipment (TLSM);
- flexible heating and cooling sources for pilot-scale excitation of heat exchangers;
- a field site for installation, testing and long-term monitoring of pilot-scale ground heat exchangers;
- a full-scale energy pile instrumented for detailed temperature and heat transfer measurements;
- an advanced fibre optic Distributed Temperature Sensing (DTS) instrumentation system (fixed and mobile);
- an enhanced meteorological station with advanced ground heat exchange instrumentation.

The facilities are intended for fundamental research in ground heat exchange, materials properties and testing of innovations in ground heat exchange technology with industry partners.

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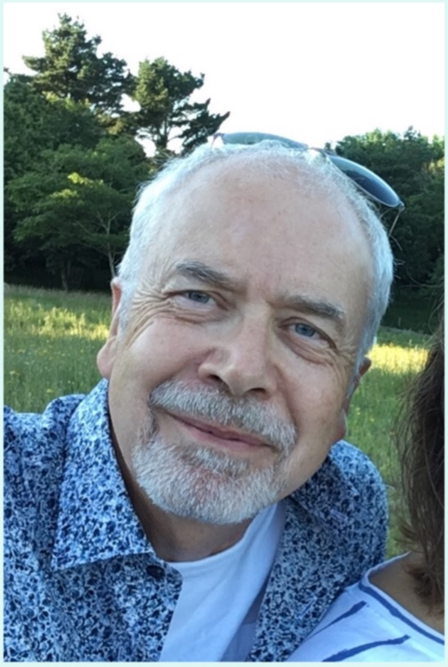
WING UK COMMUNITY

In each newsletter we want to share something about our WING members to let us get to know each other. If you'd like to share a bit about yourself please send through a photo and a blurb about yourself - womeningeothermal.uk@gmail.com

Peter Ledingham

I have been working in the geothermal industry on and off for 40 years. My first job after graduating from Camborne School of Mines was on the UK's Hot Dry Rock research programme in Cornwall where I cut my teeth on well testing, reservoir engineering and stress measurement. I joined GeoScience Limited in 1986 and spent the next few years working on its parent company's power developments in California and Oregon. Even though GeoScience's main business moved into other sectors, it has always provided geothermal services and I have been involved in projects in Europe, Asia-Pacific and the Americas, mostly carrying out due diligence, feasibility and project oversight for investors, potential developers and the European Union. For many years it has been our ambition to develop the geothermal resources in Cornwall and I was proud to be the Project Manager for the United Downs Deep Geothermal Power project from its inception until May this year. I am now looking forward to helping develop other geothermal resources in Cornwall and elsewhere in the UK with my colleagues in GeoScience and in partnership with other like-minded organisations. I joined WING in 2017 and am committed to furthering its aims whenever and wherever I can.



Hester Claridge

Having been raised in Cornwall I have always been surrounded by dynamic rocks and georesource industries which lead me to want to study geology. Since graduating I have been working for Cornish Lithium as an exploration geologist exploring for lithium in geothermal fluids which circulate through Cornwall's sub-surface. Working for a company with a sustainable and innovative georesource extraction has lead me to want to study sustainable georesource extraction and harnessing further, and I shall be starting an MSc in Subsurface Energy Systems at Heriot-Watt this September.

Mylene Receveur

Currently a PhD student at the University of Edinburgh, I am a geologist passionate about the Earth and its energy resources. Convinced that a universal access to energy through a rational use of renewable resource is a key to a sustainable future, I understood very soon that a career in geothermal was the best way to combine my personal convictions and scientific interests. After having obtained a Master in petroleum geology in France, I completed a Master in geothermal energy in Iceland, allowing to acquire diverse knowledge in geological and geophysical reservoir exploration methods, resource evaluation, and heat transfer processes. Last year, I participated to diverse projects related to the geothermal operations in Paris Basin as a geothermal reservoir engineer at the French GeoSurvey (BRGM). I have now left the deep and hot water resources to study the geothermal potential of flooded coal mines in the UK through numerical modelling, and hopefully contribute to show that shallow low temperature geothermal resources also have great role to play in our goal to tackle climate change.

Fiona Todd

I am a hydrogeologist currently undertaking a PhD at the University of Edinburgh. My project is researching the sustainable extraction of low temperature heat from abandoned mine workings. Specifically I am focussing on using computer models to determine the potential of geomechanical failure in shallow mine systems.

This complements her previous role at the Coal Authority where I managed polluting discharges from abandoned coal and metal mines. Prior to this I worked as a consultant in the wider water resources sector, predominantly in the development and management of new and existing sources.

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