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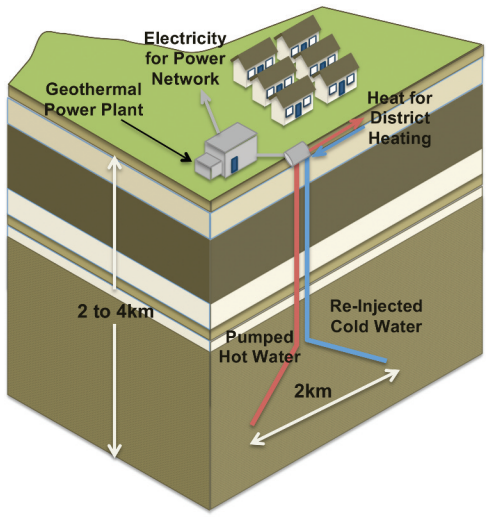

ABSTRACT BOOK

Potential UK Geothermal Targets

Convenors

Charlotte Adams (Durham University)
Guy Macpherson-Grant (EGS Energy)
David Townsend (Town Rock Energy)

Background image: Asgeir Eggertsson, Krafla geothermal power plant in Iceland, colour edited version (Creative Commons).

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Technical developments in geothermal systems in the Netherlands

Floris Veeger

Veegeo Energy

Abstract
14 deep geothermal doublets for direct heat use have been realised in the Netherlands since 2007 and two are being drilled at this moment. Due to a public available GEO-database, good subsidy schemes and a thriving greenhouse sector, many more projects are in development. The used reservoirs are the Lower Cretaceous / Upper Jura Delft and Rijswijk Sandstones, the Trias Bunter Sands, the Permian Rotliegend Sandstone and the Carboniferous Limestones. The deepest geothermal well is 2900 meters and the highest production temperature is 95 degrees Celsius. All projects use the heat directly.
Technically the approach of doublet design and realisation has changed. The four major learnings are:

1. Stable injectivity in sandstone reservoirs was a serious challenge in many projects. With a limit on injection pressures by the authorities, very fine filtering and scaling control are essential.
2. The co-production of dissolved gas and oil traces were first unexpected. With gas water ratio's exceeding 1 Sm^3 gas per m^3 brine it is uneconomic to keep this gas dissolved.
   All new wells are now being drilled and completed according oil and gas standards. The gas contains high methane levels and is therefore used in a CHP or boiler for additional energy recovery.
3. Corrosion and scaling is inevitable in the thermodynamic system of a high saline geothermal loop. Each project is different in terms of geochemistry, but in general CO_2 corrosion and carbonate scaling are the major challenges. Corrosion inhibitors are being used successfully and other methods are being tested at the moment.
4. The well test designs have been changed from initial gaslift to ESP lift with downhole pressure sensors in both wells in order to retrieve high quality data and proper analysis for the decision making processes.

Current developments in the Netherlands include the focus on deeper reservoirs with higher temperatures. Composite casings are being developed to eliminate the corrosion issues and to drill with lighter rigs. Synergies with the oil and gas industries are being developed further in order to re-use E&P infrastructure and to decrease exploration risks.

Biography

Floris Veeger has been involved in geothermal projects since 2009 while doing his Master at Delft University of Technology. He graduated on the synergy opportunities between the geothermal and hydrocarbon industries and won a Geo Energy Master Award and this work was picked up by the industry. As a project engineer he has been responsible for well test execution and design, completions, injectivity blockage solving, monitoring programmes and corrosion and scaling management. As a project manager he is now responsible for the entire doublet related works including geological studies, well designs and project realisation and workovers.

Floris is owner of Veegeo Energy, a geothermal project management and engineering company.

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Seeking a successful business model for low temperature geothermal in Denmark

David Simmons

GEOOP

Abstract
Denmark has a huge geothermal potential that remains largely unexploited. Investors remain shy due to the perception of high costs and risks principally associated with the drilling process. Investment decisions are currently based on the costs of expensive 'prototype' projects. By industrialising the process of drilling and production the economics of geothermal energy become favourable. However, the Danish industry remains structurally and technically immature. By creating a geothermal operating company (GEOOP) and opening a test facility we are beginning the process of addressing these issues.

Biography
After graduating from Imperial College in 1992 I spent my early career working on drilling sites as a geologist. Since then I have been working in geological operations planning and delivering wells in the oil and gas sector worldwide. I was asked to join GEOOP last year as subsurface manager to help develop a geothermal exploration strategy for Denmark and northern Europe.

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History of geothermal utilisation in India- Opportunities for future development

Ritesh Arya

International Sustainable Energy Organisation

Abstract

Geothermal development in India dates back to more than 7400BC when Saint Vashit teacher of Lord Rama discovered and used the hot waters in Vashist village in Manali Himachal Pradesh for bathing and washing clothes in his Institute. Old stone bathroom are still in existence. Similarly story of Lord Shiva and precious stones explored and utilized from hot springs of Mani Karan (precious stone for ears) Village in Himachal Pradesh dates further back. It is interesting to note that the 1st utilization of Hot springs for cooking food was also done in Mani Karan in India in 16th century when Guru Nanak ji cooked 1st Geothermal food from the hot boiling waters of Manikaran. This geothermal food is still cooked and distributed FREE of cost to anyone visiting his place. Use of geothermal waters for medicinal healing by Alchis and Amchis (Tibetan doctors) is known since time immemorial. Inspite of these early discoveries today these hot spots have become religious centers and not much has been done to improve the infrastructural facilities or its use for any other purpose.

Till date more than 320 Hot springs have been reported by GSI in India with total 10000MWe known geothermal potential in peninsular and Himalayan regions sufficient to solve the energy problem of over 1 Billion population of **India**.. Exploration and drilling was carried out to develop these Pilot sites in early 1980's. Borax plant was set up in Puga and Cold storage plant and few bulbs were lit in Manikaran using energy generated from geothermal energy but source was subjected to landslide and that was the end of geothermal utilization for energy production in India.

In early part of 21st century interest in geothermal energy was rejuvenated and in 2010 Indo Norway Iceland INDNOR (Agneyodgara –Lava Energy) project was initiated which was supported by Research Council of Norway. Trial borewells drilled at Chumathang (hot Waters) by MOD yielded 130C temperatures at less than 100 meters depth. Small Hotel in Chumathang was heated using Geothermal hot waters. Closed loop system using Groundsource heat pumps were installed by SASE center in Manali and an open loop system of 300TR Geothermal Air conditioning system is successfully working in Indian School of Business Mohali, saving 30% on operating cost and 100% on water.. The historic **TATTAPANI (Tatta** means **hot** and **Pani** is **water**) geothermal site near **Shimla** in the Indian Himalaya was submerged in the KOL dam reservoir in 2015.

New geothermal policy has been prepared by Ministry of New and Renewable energy, government of India and this promises great leap in the geothermal development with sharing of revenues in exploration and drilling for deep geothermal development by the government as well as making GREEN laws to enhance the use of ground source heat pump for heating and cooling in almost all parts of the Nation. Geothermal utilization map of India was prepared and in next decade ambitious plan drawn to systematically develop geothermal as safe sustainable clean energy resource. New tenders have been floated for Tattapani and other sites for geothermal exploration and production. Rejuvenation of Puga geothermal field can provide green energy to civil and army in indo-China Border in the remote areas of Himalayas which are presently relying on fossil; fuel.

Concept of Agneyodgara (Lava Energy) developed by the author aims to tap Lava Energy at shallow depths in geologically favorable conditions using GEOCOGEN technology to produce upto GIGA watts of power from Single geothermal well. Gujarat, Delhi, Mumbai and Madras are favorable geothermal spots in India owing to their typical geological and tectonic conditions Andaman and Nicobar have the potential to become a future Geothermal energy centre like Iceland

Geothermal Energy with global potential of 200GW (UN) and projected installed capacity of 20GW by 2020(IGA) holds one of the golden keys to fulfill the objectives of "**Sustainable Energy for All"** by United Nations (besides ending nuclear power plants which are bombs for our future generation on one hand and on the other decrease the dependency on fossil fuel which is major source of pollution and revenue loss for non OIL producing nations. Kenya's geothermal plant has shown the way, today geothermal is even cheaper and more sustainable than hydropower. According to the International Sustainable Energy Organization ISEO geothermal solutions will not only provide sustainable, but also abundant economical and SAFE ***energy for all*** by 2050.

Biography

Dr Ritesh Arya Guinness World record holder is doctor in geology with interest in Water, Energy and Climate. His Mission is "Right to Free Safe Sustainable "Water & Energy" for All by 2050. He started his carrier as hydrogeologist to provide sustainable drinking water solutions based on groundwater development on NO WATER -.NO MONEY basis for civil uses and army. He worked with WaterAid to provide water solutions for Tibetans who migrated from Tibet in 1959 and settled in the Ladakh High altitude cold mountain deserts of the Himalaya. India Today this group has rightly titled Dr Ritesh Arya "The Incredible Waterman".

The Agneyodgara (Lava Energy) - GEOCOGEN concept developed by him to produce Giga Watts of green, clean, safe, FREE sustainable energy for all and was rated as "Top 10 Innovations" at the World Future Energy Summit in Abu Dhabi by The Guardian. Dr Arya is member of the National Institute of Hydrology (WG) Roorkee, Government of India. In 2013 he was appointed as Director of the Water and Geothermal Energy section of the International Sustainable Energy Organisation UNISEO in Geneva.

He presented Arya's C cycle in International Conference on Climate change in Himalayas based on paleo climatic signatures discovered by him to show Climate change is a natural cyclic process, but pollution is manmade and needs to be tackled by improving technology. Global warming can be enjoyed by building safe habitats in geologically favorable locations away from shores and river banks.

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Single well deep geothermal heat projects in the UK

Ryan Law

GEON Energy

Abstract
Deep geothermal heat projects have been very slow to take off in the UK. In fact, none have been drilled since the Southampton geothermal well (over 25 years ago). The slow development has been for a number of reasons, some technical, most financial. To help the industry to move forward in the UK, Geon Energy has been working on a relatively inexpensive, low risk deep geothermal single well system for heat extraction. Following a successful field trial of the system in 2014, Geon Energy is now embarking on two demonstrator projects in the UK to be drilled in 2017. This talk discusses the technology and the forthcoming projects at Jubilee Pool in Penzance and the Aberdeen Exhibition and Conference Centre.

Biography
Dr Ryan Law is Managing Director of Geothermal Engineering Ltd (GEL). He is also a Director of Geon Energy Ltd, a joint venture between GEL and Ove Arup and Partners Ltd Geon Energy is focused on the development of deep geothermal heat projects in the UK. GEL is developing a pilot deep geothermal electricity plant in the United Kingdom at the United Downs site in Cornwall. Ryan is a geologist specialising in shallow and deep geothermal systems. He has a degree in Geology from Oxford University, a Masters in Hydrogeology and a PhD on the transport and modelling of heat in fractured rocks.

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Mine Water Treatment Schemes; a Cost Effective Low Carbon Heat Source

Jeremy Crooks

The Coal Authority

Abstract
The Coal Authority operates and maintains over 70 mine water treatment schemes (MWTS) in the UK with a future build programme of between one and three new schemes per year.

Mine water treatment is required to remove minerals dissolved within mine water following operational pumping ceasing and avoid pollution of the environment. Mine water is intercepted before it reaches surface or captured at its point of discharge. MWTS process this water through active treatment using chemicals, or passively using settlement lagoons and reed beds. The Coal Authority treats in excess of 100billion litres of water per year. Aquifers with a value of £30.5million and 400km of rivers are protected annually.

Geothermal processes heat rising water within the mine with water temperatures at surface abstraction points ranging between 16 and 21 degrees Centigrade. There is in excess of 63MW of heat that could be cost effectively harnessed at surface. The Authority sees this heat as a potential income source to support the building and operational maintenance of new MWTS providing an ongoing positive benefit to the environment.

Historically most MWTS have been built away from urban areas, however; with urban expansion, developments are increasingly encroaching on schemes. 13 large developments are currently at planning stage immediately adjacent to existing MWTS, the largest opportunity to date being 6.7MW.

There are alternative means of accessing mine water through direct tapping. However MWTS present a cost effective advantage over this option from the following: costs of accessing mine water are an existing expense of treating the mine water so are not a direct cost attributed to a heat scheme. No second boreholes are required to reinject cooled water as the mine water treatment process renders this water suitable for discharge to environment. With no need to reinject water the risk of short-circuiting and cooling the feed water is avoided.

Heat exchanger trials have been successfully trialled showing that pollutants within the mine water can be managed without adversely affecting heat exchangers. The coefficient of performance (COP) for abstracting heat from mine water is anticipated to be between COP5 and COP7 meaning that for every 1kw of electrical power required 5-7kw of heat could be extracted. The Authority is seeking to use renewable energy sources as the source of

electrical power for heat exchangers and heat pumps, this would deliver a very low carbon sustainable heat source.

In designing all future MWTS, the Authority seeks to locate where there is the highest commercial and environmental benefit from the sale of heat, water and a range of other benefits to developers and environment such as sustainable urban drainage, grey water networks and amenity/biodiversity offsetting. This catchment management opportunity appraisal process is proving of interest to water companies, local authorities and developers.

The Authority is presently progressing two heat schemes in the north east and looking to advance three other schemes in 2017. Further opportunities for managed heat sumps within mines are being considered.

Biography

Jeremy is a serial innovator in his home life and at work. He has had considerable experience bringing innovation to the delivery of services; finding new ways to do things in a way that improves service provision while at the same time reducing costs or generating incomes Over the last two years he has been leading a team to find new ways of managing mine water treatment schemes in the UK for the Coal Authority.

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Well Recycling – making use of existing assets

Gareth Digges La Touche

Golder Associates

Abstract
The use of geothermal energy has not grown significantly as a proportion of world energy production since the 1970's. To date the majority of geothermal energy developments across the globe are developed specifically to develop a specific asset. Optimistic assessments of geothermal potential such as MIT's 2006 report often gloss over the potential difficulties of well installation and completion, equipment maintenance, the potential for geochemical clogging and thermal and pressure decline. While none of these issues are insolvable there are lower hanging fruit. The US National Science Foundation (2013) looked at an alternative approach for geothermal energy. The NSF review focused on the lower temperature resources that can be accessed through existing wells in mines and in oil and gas fields. This approach is particularly attractive in sedimentary basins, where significant inventories of wells are often available that can readily access heat resources. While these heat resources may be lower in quality (lower enthalpy) than those in, for example, volcanic settings, the lower cost and less complex geochemistry has associated economic advantages. This paper develops an approach to identifying potential wells for re-use, adapting those wells for geothermal energy production, and maintaining sustainable conditions of temperature and pressure in the geothermal reservoir. This approach builds on experience in repurposing wells for deep fluid injection, groundwater development, and mining applications.

Biography
Gareth Digges La Touche is a Chartered Geologist and a European Geologist with approximately 25 years of experience of research and consulting in hydrogeology and geoscience. He is employed as a Principal Hydrogeologist within Golder Associates' global mining business and specialises in hydrogeological issues relating primarily to fluid flow in bedrock aquifers for geothermal, , deep liquid waste injection, mining and unconventional hydrocarbon studies in Europe, Africa, Australia, North & South America and Central Asia. He has experience of undertaking baseline assessments for geothermal prospects in the UK and Europe as well as experience in the assessment of saline, high temperature groundwater regimes. Gareth has extensive experience in the assessment of the impact of natural resource development on water resources. His experience includes liquid waste injection, geothermal and water resource studies, the assessment of the impact of well development, dewatering, mine water management. Gareth has approximately 20 years of experience in the execution and management of analytical and numerical modelling (including MODFLOW, FEFLOW, SEEP/W and FracMan) of groundwater systems. He holds postgraduate qualifications in hydrogeology, computing in earth science and geotechnical

engineering and is the author of numerous papers and conference presentations on a variety of groundwater related issues.

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What Geothermal means to investors

Nick Lyth

Green Angel Syndicate

Abstract
Angel and early stage investors in the UK have been investing in renewable energy installations extensively for the last 15 years or more. Fuelled by attractive Government incentives, the wind and solar sectors in particular have done very well. When investors have been given the opportunity to participate in schemes, they have tended to respond with alacrity. Generally, they have made money. This pattern is not reflected among larger scale investors, the infrastructure funds and other large investment organisations which have participated in the large on and offshore wind farms, for example, where planning difficulties, installation problems and technology challenges have all caused a disappointing performance in what has been called the “Cleantech” sector. So what does geothermal mean to investors? Geothermal is new in the UK. When first mentioned, many investors mistake it for ground source heat pumps. It seems to be another opportunity similar to the more familiar renewable technologies, but often assumed to be domestic in scale. However, this is not the reality. Investors discover that Geothermal is not only best designed to serve district heating schemes at scale, but also that it may be new to the UK, but is not new anywhere else in Europe. They realise it is a tried and tested technology. This makes Geothermal a different and much more attractive proposition for investors.

Biography
Nick Lyth is co-founder and manager of Green Angel Syndicate (GAS), the first business angel syndicate in the UK to specialise in investments in energy and water sectors. He is responsible for finding and selecting the companies in which the syndicate invests, as well as business development for the syndicate. Prior to GAS, Nick founded, developed and managed International Resources and Recycling Institute, which specialised in applied research, working in European partnership projects exploring innovations in renewable energy, water management, sustainable transport, waste and recycling, and other areas of resource use. Nick has contributed to forums advising Scottish Government on water policy, and renewable energy policy; the Northern Irish Government - advising on the development of community renewable energy; has hosted presentations on renewable energy policy to the European Parliament in Brussels and has been invited to assess innovation competitions in the UK run by the Technology Strategy Board (now Innovate UK) and Scottish Government. He has also served on charitable Boards for the Big Issue Scotland, and Dundee Cyrenians, as well as many commercial Boards ranging from sectors as varied as Denholm Ship Management and Drambuie Liqueur Company. Nick is married, has three children and lives in Edinburgh.

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Achieving SDG7 – Application of UNFC-2009 to geothermal energy resources

Gioia Falcone

Cranfield University

Abstract

Geothermal energy has a significant role to play in ensuring access to affordable, reliable, sustainable, and modern energy for all as called for in Sustainable Development Goal (SDG) number 7. However, a lack of clear global guidelines and standards is holding back the assessment of geothermal energy as a viable energy option at a global scale. Having an international system and a standardized terminology for reporting geothermal resources will help build the trust and understanding of the geothermal industry with investors, regulators and the general public alike. The UN Economic Commission for Europe (UNECE) in cooperation with the International Geothermal Association (IGA) has been working to address this.

At the fifth session of the UNECE Expert Group on Resource Classification in April 2014, the Task Force on Application of the United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009 (UNFC-2009) incorporating Specifications for its Application (as set out in United Nations Economic Commission for Europe Energy Series No. 42, ECE/ENERGY/94) to Renewable Energy was requested to provide at least one draft renewable commodity-specific specification for review at the sixth session. To this end, the Task Force called upon the expertise of the International Geothermal Association (IGA) to provide specifications for the application of UNFC-2009 to geothermal energy resources using the full granularity of UNFC-2009.

Through a Memorandum of Understanding that was signed in September 2014, the UNECE and IGA agreed that their goals in the area of geothermal resources were mutually supportive. It was also agreed that the IGA represented the best platform and international umbrella to develop specifications and guidelines for the application of UNFC-2009 to geothermal energy, and to maintain evergreen the texts in a manner consistent with their proper application through regular and periodic review, under the aegis of the EGRC.

Following the Memorandum of Understanding, on 15 October 2014, IGA issued a call for volunteers interested in joining a Working Group to draft the geothermal specifications for the UNFC-2009. A twelve member Working Group was appointed on 15 January 2015.

The Geothermal Working Group developed a set of draft specifications for the application of UNFC-2009 to geothermal energy resources which were presented to the Expert Group on Resource Classification at its seventh session, 26–29 April 2016, for review. The draft specifications were then issued for public comment on the ECE website from 6 June 2016 –

4 August 2016. The Geothermal Working Group reviewed all the comments received and produced a revised set of specifications in response, which will be presented at this event.

With no globally agreed geothermal standards, guidelines or codes existing prior to the development of this document, it is hoped that the inclusion of geothermal energy within UNFC-2009 will help to attain SDG7 by improving global communication in the geothermal sector as part of the larger energy sector.

Biography

Gioia Falcone is Professor and Head of the Oil and Gas Engineering Centre at Cranfield University. Until early 2016, she held the Endowed Chair and Professorship in Geothermal Energy Systems at TU Clausthal, where she was also the Director of the Institute of Petroleum Engineering. She was formerly an assistant and then associate professor in petroleum engineering at Texas A&M University, Chevron Corporation Faculty Fellow and faculty member of the ODASES partnership. Prior to joining Texas A&M, she worked with ENI-Agip, Enterprise Oil UK, Shell E&P UK and TOTAL E&P UK, covering both offshore and onshore assignments.

Gioia holds a Laurea Summa Cum Laude in environmental/geo-resources engineering from the University Sapienza of Rome, an M.Sc. degree in petroleum engineering from Imperial College London and a Ph.D. in chemical engineering from Imperial College London.

Along with being actively engaged with the Society of Petroleum Engineers (SPE), she is one of the 21 members of the United Nations Economic Commission for Europe (UNECE) Bureau of the Expert Group on Resource Classification, and of its Renewable Reserves Taskforce. She is also the appointed Leader of the International Geothermal Association (IGA)/UNECE working group for the development of geothermal specifications for the UNFC-2009.

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Minewater and HSA geothermal business opportunities

David Townsend

Town Rock Energy

Abstract
In the past year Town Rock Energy have been heavily involved in the creation of four deep geothermal energy feasibility studies for sites in Scotland. Some of these projects are going ahead, others have been put on pause, and in addition several more sites are now in the pipeline for feasibility evaluation.

David's presentation will describe some of the lessons learned, including the key economic sensitivities for minewater and HSA projects, and some headline figures outlining the business case for developing geothermal energy projects in Scotland and the wider UK.

Biography
Having specialised in deep geothermal energy whilst studying geology at the University of St Andrews, David gained an understanding for the business opportunity in harnessing the vast heat resource under our feet, and shortly after graduating incorporated Town Rock Energy. Three years later, Town Rock Energy is at the forefront of geothermal energy in Scotland, working on multiple feasibility studies whilst evolving the business model and risk mitigation strategy to attract commercial and industrial clients.

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Surface Exploration in the Fantale Geothermal Licence Area, Ethiopia

Tom Elliott

Cluff Geothermal

Abstract

Cluff Geothermal was awarded the Fantale Geothermal Exploration Licence in July 2015. The licence area is principally sited to take advantage of suspected resources to the west of Mount Fantale, a prominent stratovolcano situated within the Main Ethiopian Rift near the town of Metehara. Following the award of the licence, the company has carried out extensive exploration works building on initial data collected by the Geological Survey of Ethiopia, amongst others. Most significant has been the successful completion of a $1M magnetotelluric (MT) survey, supported by geochemical and geological mapping. Findings of these surveys have enabled identification of exploratory drilling targets. The project has been significantly funded by the Geothermal Risk Mitigation Facility (GRMF), a body supported by the UK Government's Department for International Development (DFID), the German Government and the European Union. The purpose of the exploratory drilling campaign at Fantale is to enable the phased development of geothermal power, culminating in full scale production drilling and electricity generation. Exploratory drilling will commence subject to successful conclusion of a power purchase agreement with Ethiopian Electric Power, the energy utility owned by the Ethiopian Government. Subsequent production drilling is expected to support electricity generation at the scale of hundreds of megawatts. This will make a substantial contribution to the expansion of sustainable power generation in Ethiopia, in line with the Growth and Transformation Plan II.

Biography

Tom joined Cluff Geothermal in 2013. Initial focus was on developing the UK's deep geothermal industry, with projects targeting the elevated temperature gradient associated with the North Pennine batholith. Meanwhile, the company was increasing operations overseas, most notably in Ethiopia and Kenya where the East African Rift System hosts many regions suitable for geothermal exploration. Tom has been heavily involved in the Fantale project, Ethiopia since licence award in 2015.

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De-risking geothermal energy in the Cheshire Basin

Councillor David Brown & Mike Smith

Cheshire East Council & Engie

Abstract

The Cheshire Basin is one of four Mesozoic Basins in England, where deep geothermal energy is targeted from hot sedimentary aquifers. Geothermal energy is an untapped, clean, renewable energy source, exploited from either shallow or deep sources.

At present, the council is focusing on exploring the low-enthalpy resource from deep Permo-Triassic sandstones within the Cheshire Basin. Current estimates suggest the total resource identified in the basin is the equivalent to the energy produced from 3 billion barrels of oil.

Cheshire East Council (CEC) is committed to changing from non-renewable to renewable energy sources, and is exploring new routes to deliver stable energy across the borough. Geothermal is of particular interest due to the huge resource, sustainability and scalability across the country. In pursuit of clean energy the council has:

- May 2013 – commissioned Arup to undertake a Cheshire East Ennergy Planning Review.
- January 2014 – secured £198,000 of grant funding from Heat Network Delivery Unit (HNDU) to commission a feasibility study for the Crewe area.
- July 2014 – persuaded the Cabinet to make the decision to pursue deep geothermal energy.
- January 2015 – produced an Energy framework that identified Geothermal energy as an opportunity to deliver affordable, sustainable energy.

CEC has continued to seek funding of a deep, exploratory, geothermal well in the Crewe area, currently mid application for European funding. Funding is being sought for a geothermal well drilled to 4 – 5km in the Crewe area to de-risk geothermal energy in the Cheshire Basin if successful, stimulating commercial investments across the county to further develop the resource.

To further these ambitions a new company – Cheshire Energy Ltd – has been created through a joint venture with Engie. The partnership will install infrastructure for geothermal projects and stimulate commercial investments across the county.

Biographies

Councillor David Brown

Councillor David Brown is the Deputy Leader of Cheshire East Council, and Highways Infrastructure & Leisure Portfolio Holder. He is town mayor and deputy leader for Congleton Town Council, and sits as Chair of Cheshire Energy Networks Ltd, and Cheshire East Residents First. Board Member of Cheshire East Energy Limited, Plus Dane Housing, IESE,

and Groundwork Merseyside. He has led carbon reduction projects across the Council, including innovative street-lighting and highways measures.

Mike Smith
Mike is Director – Cities, Urban Energy, ENGIE UK, and President of ENGIE's UK Urban Development Fortissimo. Mike has been associated with low carbon and sustainable energy for 35 years. He initiated and led the Southampton deep geothermal scheme. Mike is a Board Member of Business South. He sits on the Board of the Veolia Environmental Trust and is Chair of the trustees of the newly formed Southern Policy Forum. He is also a Board Member of the Mayflower Theatre in Southampton and is a visiting lecturer at Southampton University.

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District Heating Network with a Deep Geothermal heat source (Hot Sedimentary Aquifer) in Stoke-on-Trent

Andrew Briggs

City of Stoke-on-Trent

Abstract
The presentation will provide an update on progress and development of the scheme in Stoke-on-Trent as it moves from theoretical discussions and feasibility work to a project that will soon be in delivery.

On 19th March 2015, Council approved the investment of £23.15m as a part of a £53.00m package for the implementation of the first phase of a citywide District Heat Network (DHN) in Stoke-on-Trent. The preferred heat source identified in the Outline Business Case (OBC), one of three proposed potential heat options for the DHN scheme was a deep geothermal well.

The main objective of the DHN scheme is in supporting the City Council's Stronger Together Strategic Plan by providing a secure, stable, local source of energy. The deep geothermal option provides the possibility of an ultra-low carbon heat source which has the potential to provide secure price stable energy and retain maximum value in the city. By investigating the geology, the City Council have completed sufficient due diligence to ensure that there is a viable option to unlock this potential and secure private sector investment in the scheme. The deep geothermal heat source will be delivered by the private sector. The City Council has carried out the geology work to ascertain that such activities would be of benefit to the city and to enable private sector investment.

In evaluating the viability of the deep geothermal option, geology desktop studies were completed last year, using existing seismic data from across the city acquired through seismic surveys undertaken in the mid 80's.

The geological conditions were successfully characterised using existing this vintage data showing very good potential for a deep geothermal heat source. The resolution of the data was however, insufficient to undertake a final detailed target selection and for the generation of a specific localised geological model to be produced. This is required to enable the completion of a full business case and ultimately the development of a well by a commercial developer.

The work was undertaken across two areas of the city along routes that had been designed to optimise the capture of data and to minimise disruption and cost. A detailed design and development exercise was undertaken with site visits and survey undertaken and

consultation with key stakeholders throughout the process. Simulations were undertaken to establish the viability of the route and to ensure risks were mitigated.

Having concluded this and further technical development work for the heat network alongside commercial modelling the scheme is now moving towards delivery phase. A council decision to adopt a commercial structure and operating company vehicles takes place in October with the companies to be established by Q1 2017 and financial closure occurring Q2 2017. Procurement and practical delivery will directly follow with the anticipation of commencement of network installation in early 2018 and first customers connected shortly after.

Biography

Originally coming from the commercial sector having established and developed design and manufacturing businesses, Andrew moved to work for local government in the creation and the successful delivery of a 3D design technology transfer and business centre. The role developed to take on the portfolio of enterprise and business development functions leading to the sector based approach adopted by the city. More recently his work has featured on broader economic development including helping to establish the Local Enterprise Partnership where he took an active role in the securing the successful Wave 2 City Deal 'Powerhouse Central', taking the lead on the key energy proposals at the heart of the bid. He is now leading a team looking to deliver an integrated energy approach driving the development of a district heat network as part of a suite of projects and proposals across the city.

NOTES

Using surface geochemistry to identify and map fluid and gas conduits in deep geothermal systems

Helen Robinson

University of Glasgow

Abstract
Large sections of the East African Rift Valley are thought to have formed along basement structures, sutures and transform faults of the ~3.5 Myr Pan African Orogeny, now reactivated in extension. Recent work on this incipient continental break up suggests that the oblique nature of maximum horizontal stress versus the direction of extension will result in the destruction of the African continent as we know it today. In the meantime, the resultant thinning of the continental crust of the East African Rift Valley has resulted in the upwelling of magma and the growth of over 120 active volcanoes, and with them the potential for a vast renewable energy resource.

The accumulation chamber method and the analysis of soil gas isotopes, a comparatively quick and low cost technique normally linked with the monitoring of volcanic activity levels has recently been applied to the Menengai volcano summit caldera, where the development of 3 x 35MW power plants by Kenya's Geothermal Development Company (GDC) is almost complete. Using an area already developed has allowed for these techniques to be tested and a compare and contrast of the results with those collected by GDC to establish the reliability of the methods.

The detectors used in the accumulation chamber method in this example are set up for CO_2. However detectors for other gases such as CH_4 and Rn can be acquired. Might it be possible to apply similar surface exploration techniques to non-volcanic environments?

Biography
Helen Robinson, PhD candidate at the University of Glasgow and UK ambassador to WING (Women in Geothermal).

My PhD involves working on geochemical surface exploration techniques used to identify and map the location of faults and fractures used as fluid and gas conduits in deep geothermal systems. This research concentrates on methods that can be used to target specifically buried features and therefore guide future drilling programs and engineering designs.

NOTES

Britain's Geothermal Revolution: The Search for Deep Karst

Nadia Narayan1 supervised by Prof Jon Gluyas1, Dr Charlotte Adams2, Dr Jonny Imber1 and Dr Malcolm Butler3

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2 Durham University, Department of Geography, Lower Mountjoy, Science Site, South Road, Durham, DH1 3L (UK)
3 UK Onshore Geophysical Library, 93-99 upper Richmond Road, Putney, London, SW15 2TG (UK)

Abstract
There is a significant deficit in our knowledge-base regarding geothermal resources in UK Palaeozoic strata. Specifically, the deficit extends to a lack of expertise in prospecting deep karst for geothermal energy. Having located several resources in deep Mesozoic sedimentary basins and deep radiothermal granites (as detailed in the last UK geothermal assessment, 1970s-1980s), this research recognises buried Carboniferous Limestone karst systems as an overlooked and undervalued prospect. The vulnerability of the limestone unit to karstification is reflected by its ability to host some of the longest, interconnected cave systems in Britain (Ogof Ffynnon Ddu in Southern Wales and the Three Counties System in the North Dales, for example). At depth, potential karstification is identified by unconformable surfaces currently found to be exposed primarily in the Namurian and Westphalian A, surfaces which provide ample opportunity for meteoric infiltration and dissolution. The unit's remarkable capacity to accommodate fluid flow at high temperatures is reflected prominently by the thermal spring waters sourced from this reservoir across Britain. The UNESCO world heritage site of Bath City, for example, is renowned for its 47°C spring waters, which emanate from karst limestone at a combined flow rate of 1440m³, after descending to at least 2.5km. The unmistakeable potential for fractured and karstified limestones to develop sufficient porosity and permeability to transmit warm waters at significant depths is further evidenced by the Ridgeway borehole in Sheffield. Here, 48.9°C waters at the top of the Carboniferous Limestone are recorded at an 883m depth, with a flow rate of 100,000 gallons per day or 454.6m³/d (when converted from the imperial unit). This research confronts the challenge of locating deep Carboniferous Limestone karst resources nationwide through 2D seismic data analysis of unconformable karst surfaces, analysis of deep drill-core, a compilation of existing porosity and permeability data analyses from literature and well data and geothermometry investigations using spring water data. The resultant resource inventory of karst resources will complement the last national geothermal assessment conducted following the 1973 oil crisis. With a net energy importer status and a 48% energy consumption due to heat, it would be frivolous to not pursue such resources. It is time for us to be the pioneers, the explorers, the adventurers and advance towards new frontiers with great force.

Biography

Nadia Narayan is a PhD student from Durham University working under the primary supervision of Prof. Jon Gluyas and Dr Charlotte Adams. Prior to commencement of her PhD studies, she graduated with a 1st Class Mgeol Geology degree from Plymouth University. Her current research involves investigating the geothermal potential of deep karst systems in the Carboniferous Limestone across Britain.

NOTES

Rob Westaway and Paul L. Younger FREng, FRSE

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Abstract

The Science Central borehole, drilled in 2011 for geothermal exploration, is the first deep borehole in the urban area of Newcastle upon Tyne. Along with shallower boreholes in neighbouring Gateshead, it provides a key record of the geothermal gradient in a region that is heavily urbanized and was formerly intensively mined for coal, making it possible to assess the relative contributions of these two factors to the subsurface thermal state. Significant subsurface urban heat islands (UHIs) are evident in both urban centres, estimated as 2.0 °C in Newcastle and 4.5 °C in Gateshead, the former value being comparable to the 1.9 °C atmospheric UHI previously measured for the Tyneside conurbation as a whole. We interpret these substantial subsurface UHIs as a consequence of the region's long history of urban and industrial development and associated surface energy use. We also show that a large proportion of the expected conductive heat flux from the Earth's interior beneath both Gateshead and Newcastle becomes entrained by groundwater flow and transported elsewhere, through former mineworkings in which the rocks have become 'permeabilised' during the region's long history of coal mining. Discharge of groundwater at a nearby minewater pumping station, Kibblesworth, has a heat flux that we estimate as ~7.5 MW; it thus 'captures' the equivalent of the entire geothermal heat flux through a ~70 km^2 surrounding region. Modelling of the associated groundwater flow regime provides first-order estimates of the hydraulic transport properties of 'permeabilised' Carboniferous Coal Measures rocks, which are comparable to what values for karstified Carboniferous limestone. Furthermore, the large-magnitude subsurface UHIs create significant downward components of conductive heat flow in the shallow subsurface, which are supplemented by downward heat transport by groundwater movement towards the flow network through the former mineworkings. The warm water in these workings has thus been heated, in part, by heat drawn from the shallow subsurface, as well as by heat flowing from the Earth's interior. Similar conductive heat flow and groundwater flow responses are expected in other urban former coalfield regions of Britain; knowledge of the processes involved may facilitate their use as heat stores and may also contribute to UHI mitigation.

Biography

Dr Westaway's qualifications include a degree in physics and a Ph.D. in geophysics, both from Cambridge University. He has subsequently held research and teaching posts at Reading, Liverpool and Durham universities and the Open University, as well as running his own consultancy company, before joining the energy engineering group in the School of Engineering of the University of Glasgow (the 'Go To' group for geothermal energy research in the UK) as Senior Research Fellow in 2012. He has authored more than 200 publications and numerous unpublished technical reports, has a current personal citation index of 40, and has won many awards for research output.

NOTES

Burlington House Fire Safety Information

If you hear the Alarm

Alarm Bells are situated throughout the building and will ring continuously for an evacuation. Do not stop to collect your personal belongings.
Leave the building via the nearest and safest exit or the exit that you are advised to by the Fire Marshall on that floor.

Fire Exits from the Geological Society Conference Rooms

Lower Library:
Exit via main reception onto Piccadilly, or via staff entrance onto the courtyard.

Lecture Theatre:
Exit at front of theatre (by screen) onto Courtyard or via side door out to Piccadilly entrance or via the doors that link to the Lower Library and to the staff entrance.

Main Piccadilly Entrance:
Straight out door and walk around to the Courtyard.

Close the doors when leaving a room. **DO NOT SWITCH OFF THE LIGHTS**.

Assemble in the Courtyard in front of the Royal Academy, outside the Royal Astronomical Society.

Please do not re-enter the building except when you are advised that it is safe to do so by the Fire Brigade.

First Aid

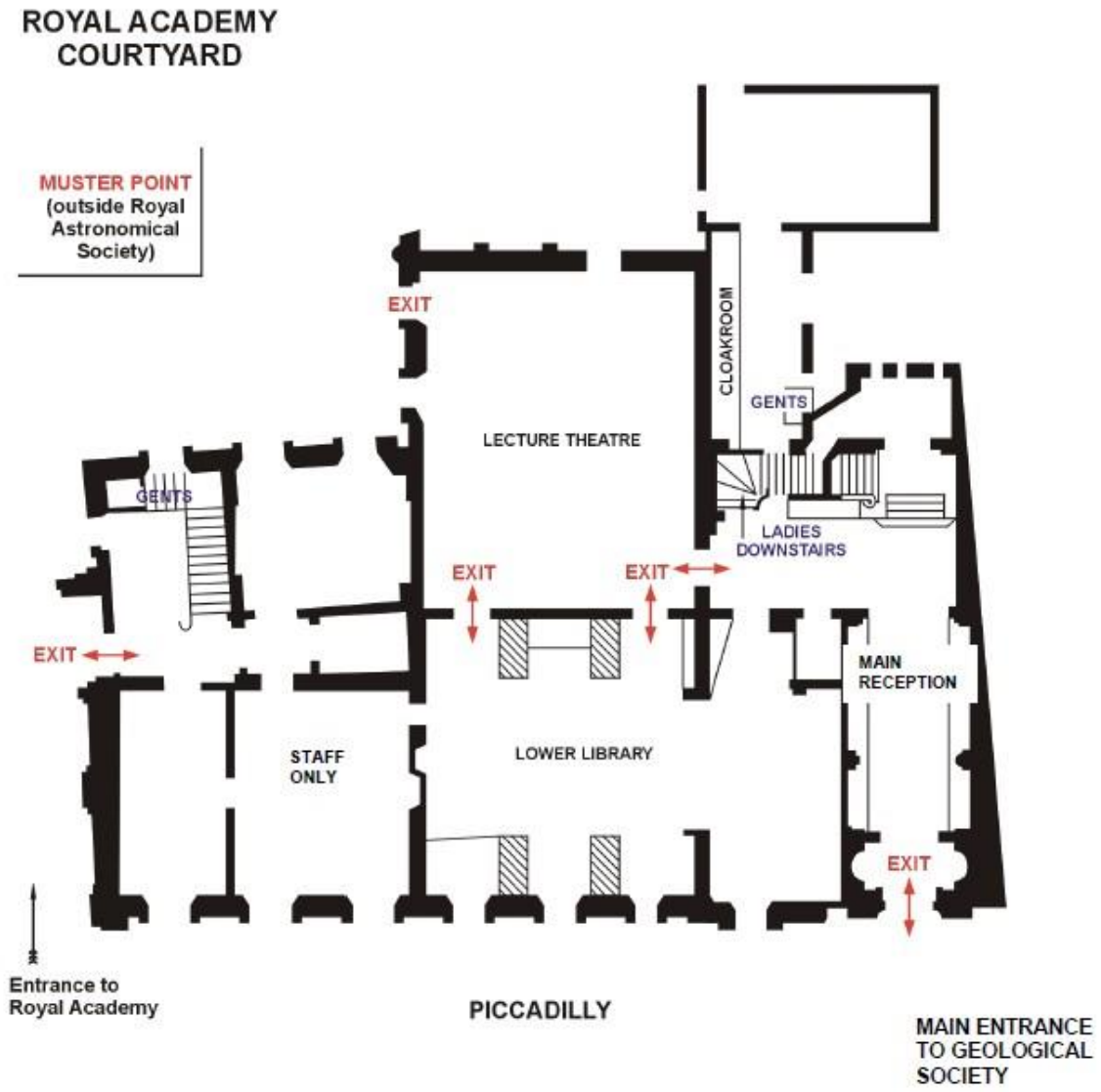
All accidents should be reported to Reception and First Aid assistance will be provided if necessary.

Facilities

The ladies toilets are situated in the basement at the bottom of the staircase outside the Lecture Theatre.

The Gents toilets are situated on the ground floor in the corridor leading to the Arthur Holmes Room.

The cloakroom is located along the corridor to the Arthur Holmes Room.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COURTYARD
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Astronomical
Society)
EXIT
CLOAKROOM
GENTS
LECTURE THEATRE
GENTS
LADIES
DOWNSTAIRS
EXIT
EXIT
EXIT
MAIN
RECEPTION
STAFF
ONLY
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EXIT
Entrance to
Royal Academy
PICCADILLY
MAIN ENTRANCE
TO GEOLOGICAL
SOCIETY