The Whirlygig of Hydrogeological Time

Lecture at Derby University, 8 October 2014

Our October meeting featured James Dodds, hydrogeologist at Envireauwater his consulting practice, who has worked across the globe in many different geological environments. He specialises in regulator negotiation and from his 30 year career he described a wide range of technical and regulatory approaches to hydrogeological risks and problems. These stretched from groundwater resources management and mine and quarry water management to landfill and contaminated land. Over the 30 year period there would appear to be a cyclical nature to the regulatory approach and the issues that need to be investigated and solved, and James discussed the nature of these cycles, what can be learned from them and, on that basis, what the new environmental geologists and hydrogeologists might encounter over the next 30 years.

Cliff Stability

Lecture at British Geological Survey, Keyworth, 18 November, 2014

Report by Geoffrey Jago

Mark Twain's advice to investors was to buy land because as he put it "they're not making it any more". England's land, by contrast and in particular on the Channel and North Sea coasts, is diminishing. Scientific study of the process of this loss is therefore of national importance.
On 18th November, 2014 at British Geological Survey, Keyworth, Pete Hobbs, Engineering Geologist at BGS, spoke on cliff stability and the processes of erosion.

Cliffs - by the Sea and Inland
Rocks are content to level out when left in peace but, where certain natural processes obtain, cliffs are formed. This can happen where there are any vertical or near-vertical slopes, where the sea erodes a coastline and when land is pushed to a higher level.

Landslides
Landslides feature prominently in cliff stability but they are not the whole picture. A BGS diagram showed us the many ways that rocks move: toppling, rotational sliding, planar sliding, wedge failure, spreading, flowing and sometimes complex combinations of these processes. Soft rocks are the most affected but competent ones are not immune. Flows are common but obey different laws from other failures and may result from liquefaction of debris from a rotational event.

Slope Stability Analysis
Where sufficient information can be gathered, mathematical methods may be applied to calculate stability factors relevant to potential safety or to evaluate data after a landslide.
In all rock failures rainfall has a major effect but on the coast sea storms play their part as well.

Investigation
Investigation begins with desk study where technology plays an increasing role. Aerial photos have long been available but are now increasingly supplemented by ground investigation by geotechnical and geophysical methods. These include satellite inSAR (Interferometric synthetic aperture radar) which recovers subsurface information from space and LiDAR (Light detection and ranging) which works similarly via crews on the ground.
Often surface features preclude ground work and here unmanned aerial devices show their mettle. They include remotely controlled devices such as gliders, hexakopters (model helicopters) and parafoils (pretentious kites).
We were shown interesting examples of data plots and animated 3D views of surveyed sites.

Case Studies
Several case studies were described, many accompanied by moving image footage, of which the following are a selection.
The village of Happisburgh on the Norfolk coast lies on soft glacial rocks from which, between 1991 and 2008, the sea greedily ate chunks at a rate of nine metres a year.

The renowned Beachy Head in East Sussex is a cliff made up of a succession of six chalk beds rising 160 metres above the English Channel. One night in January, 1999 about 200,000 tonnes, which included a feature called the Devil's Chimney, came down to form a temporary debris slope towards the offshore lighthouse. Smaller amounts spall off regularly in a process which often starts with a tension crack bottomed by a very steeply inclined narrower crack. Pressure from rain in this fissure pushes another load down. Those walking below any cliff should remember to stay well back.
Near Brotton, Cleveland, an aerial view showed how the sea cliff has approached closely to an active railway and at Penn's Weare, Portland, a diagram displayed a stepped landslide of tilted blocks.

We were shown the footage captured by two fortunate cinematographers when, in September 2011, a huge chunk of seemingly stable slatey cliff fell into the sea at Hell's Mouth on the north Cornish coast.

Aldbrough
On the Holderness coast at Aldbrough, north of Hull, BGS are monitoring the recession. Weak clays with sands are being eroded at nearly three metres a year. Cliff sectional diagrams were made showing the movement from 2001 to 2012 from which the cubic-metrages and tonnages of each fall have been calculated.

The Future
Ongoing improvement of Cliff Stability Mapping continues, taking into account relevant variables such as failure mechanics, activity, sediment supply, height, and engineering materials. Ship borne LiDAR is being carried out all around the coast. We may soon see whole swarms of Unmanned Aerial Vehicles working in concert.
Sea level rise is carefully watched as are any effects of climate change. A map showed that a seven metre rise would flood much of Lincolnshire while ninety metres would convert Albion to an archipelago.

Public Benefit
Maintenance of land in this country is of vital importance, towards which the study of cliff stabilisation by BGS makes a major contribution. This work is made use of by most organisations that have any involvement with unstable land. Central and Local Government, construction firms, the European Union, English Heritage and the National Trust are only some of those interests.

Chairman John Black thanked Peter for this interesting and informative evening.

Forecasting Sea Level Rise by Reconstructing the British-Irish Ice Sheet

Our December, 2014 meeting at BGS, Keyworth featured Professor Chris D. Clark of the University of Sheffield who is Project Leader and Principal Investigator of BRITICE-CHRONO

In reporting this event we cannot add significantly to Professor Clark's published Introduction, as follows:

"Why all this sudden activity on the British-Irish Ice Sheet?
Ever since the discovery of ice ages there has been a quest to work out the extent, thickness and geometry of the ice sheet that once covered most of the British Isles. Archibald Geikie's map in 1894 was an inspired start and steady progress since then has added much detail. There is now a concerted effort to finish the job, doing many decades work in just 5 years with over 40 researchers on the BRITICE-CHRONO project currently blitzing the far corners of the ice sheet. It has never been so heavily investigated. Why the sudden rush?

A perfect storm of stimuli came together…
It was realised that, spread over numerous publications (over 1000!), fragments of the jigsaw puzzle that is – 'ice sheet information' – had never been assembled. This was put right in BRITICE, a previous project compiling over 20,000 landforms (e.g. moraines, drumlins) into a map and as downloadable data (GIS) layers.

This brought value to over 100 years of fieldwork, but what about the blanks on the map? Using satellite images and elevation models of the land and seafloor, the whole ice sheet bed was mapped afresh. The jigsaw pieces were now in one box and ready.

From this, and for the first time, a detailed map of the pattern of ice margin retreat was assembled based on, and traceable back, to the underlying landform evidence. Once assembled we started to wonder about the timing, what was the rate of retreat, how and why did it vary, did anything catastrophic happen when North Sea ice broke up?

Over the same time that curiosity-driven academic research on our palaeo ice sheet progressed over the last century, and beyond, humans continued with their uncontrolled Earth-warming

experiment. We now know this to be melting ice sheets in Antarctica and Greenland at a rate faster than can be replenished by snowfall, with losses exceeding 100 Gigatonnes per year (100 kilometre-sized ice cubes every year) with indications of acceleration.

The melted ice of course, ends up in the sea, contributing to our fast rise of sea level. Forecasting is difficult because our complexly-interacting Earth system has yet to be completely understood and because it is hard to know when idiot-humans will finally get round to properly reacting to the now-obvious signals. Both uncertainties make forecasting difficult, but the best current estimates place sea level rise by year 2100 as between half a metre and one metre.

The effect that such a rapid rise in sea level would have on people globally, and who have built their existence in a world of slow change, has dramatically focussed the minds of scientists who now need to improve understanding to make more precise forecasts. Just as our weather forecasters use a mix of data and computer models, our glaciologists do likewise with their ice sheet models, which track fallen snowflakes, on their journey of flow as ice, until they reach the sea, as water.

So, the reason that our team is so frantically busy, setting out to do 50 years work in 5, is because glaciologists urgently need a data-rich playground of information on the timing of a retreating ice sheet with which to improve and test their forecasting models – this is the focus of BRITICE-CHRONO . Remember that the weather forecasters get to know whether they were correct or not in a few days' time, which allows them to keep improving their models. We will do similar for ice sheet forecasters but who need data on timesteps of 1000s of years rather than daily, and we will do so by collecting samples of rock, sand and organics, analysed in our labs (e.g. radiocarbon) to provide dates on the pattern of retreat. So how fast did the British-Irish ice sheet retreat?"

Completing the meeting, John Black thanked Professor Clark for this stimulating evening

For further reading, see the britice-chrono website

Field Excursion: Vale of Belvoir Building Stones

Tour Guide: Dr. Graham Lott
8 July, 2014

Report by Geoffrey Jago

Lumpers and Splitters

Lumpers and splitters are local quarryman's apt terms to classify stone used for building and construction work. During our well attended July Field Trip we were introduced to these graphic terms to add to the wide vocabulary of rock classifications.

With his wide experience of building stones in the Midlands and elsewhere, we welcomed a return visit of Dr. Graham Lott to learn more of the history of local building in the landscape to the east of Nottingham named after Belvoir Castle.

Meeting Up

East Bridgford is an attractive village overlooking the river to the northwest from the high ground of the Trent Valley bluffs. We met in the Royal Oak which provided good refreshment and a meeting room where Graham gave his presentation under comfortable cover while a thunderstorm cleared away.

Local Rocks

The rocks in the Vale are of the Triassic Penarth group (Mercia Mudstone) overlain to the east by Lower Jurassic, with the Triassic providing the most important stones. Sandstone of the Triassic Sneinton Member provides square-cut ashlar blocks such as those used to rebuild the tower of East Bridgford Church in the fifteenth century. Less durable than, say, the older Millstone Grit, this stone has lasted well in block form although carved sections show more weathering.

Skerry Bands

Many local buildings have been built, at least partially, with rocks known as skerry bands which are hard strata in the Triassic Gunthorpe member. Skerries are greenish-grey muddy sandstones strengthened by dolomitic cement. The higher ground topography in the Mapperley district of Nottingham owes its shape to the superior hardness of a skerry band interbedded with softer mudstone.

The flaggy skerry has been used from Roman times or earlier for walling and flooring. Most building in East Bridgford and surrounding villages is partly of skerry, often requiring to be surmounted by more competent material such as brick or harder sandstone, sometimes with cornering of imported limestone. The Romans used it at Margidunum, a crossroads station on the Fosseway a mile south of East Bridgford.

Local Brickmaking

Three brickworks formerly flourished near the village, run respectively by the Herod, Levers and Poole families. The mudstone below the skerry band has been widely exploited for brickmaking close to and on the northeast side of Nottingham and similar mudstone allowed the three families to prosper. In estimating their reserves, the old brickmakers knew that three cubic yards of clay will make a thousand bricks and that a million can be made for every two feet of clay over an area of an acre.

Gypsum

Thin bands of the soft evaporite gypsum are common on many horizons of the Mercia Mudstone and they found uses locally. A mixture of gypsum, sand and coal ash pounded to form a floor

will set like concrete and last for many years. Ceilings were constructed with gypsum and lime on a base of Norfolk reeds. Walls could be made from a fine mix of lime, gypsum and horsehair.

Alabaster, the finer brother of gypsum, was used in some local tombs, notably the Whalley memorial in Screveton Church but it was imported from Derbyshire or Staffordshire deposits many miles away up the Trent which must have provided its transport route.

Cob Walls

Sound walls can be made from a mixture of pounded wet clay and sand with some fibrous material like straw to bind it together. Known as cob, buildings of this stuff are common in parts of Devon but much less so in Nottinghamshire. An exception is Dove Cottage, near East Bridgford Church. Cob buildings last for centuries but the walls must be sealed with waterproof rendering because cob can be rapidly eroded if the rain gets in.

Street Level

Curb stones and square cobbles made from granodiorite from Charnwood in Leicestershire are widespread in Nottinghamshire towns and some exist in East Bridgford. Many have however been replaced with concrete and, more recently, with plastic curbs which appear to be very serviceable.

The Strategic Stone Study

Graham concluded his presentation by commending us to the Strategic Stone Study, a preliminary study by English Heritage, BGS and local experts into vernacular stone in England in forty-four English counties. County by county, thirty-seven studies are complete with seven, in London and the southeast, to go.

Field Studies

The skies having cleared, the company walked the short distance to East Bridgford's St Peter's Church where Graham was able to point out various examples of the rocks he had described, with skerry and Triassic sandstone predominating.

The party then went on to Bingham, two miles to the south. The buildings studied included the Butter Cross the pillars of which included the widely used Ancaster limestone (Middle Jurassic) and Mansfield Red.Sandstone (Permian).

The well maintained graveyard at East Bridgford Church contained many upright headstones, mostly of slate, and although they were of a similar, slight;y purplish grey, colour two very different rocks were identified. Some headstones were seen to be smooth on both sides and these were of the neatly splitable North Wales slate. Others were of Swithland slate from Charnwood which have a much less smooth surface when mined and this was evident on the backs of the stones. The inscribed faces of the stones had been smoothed laboriously by being ground on sturdy grinding tables. One can only wonder at the tedious labour suffered by those workmen of 1800.

At the conclusion of the trip John Black, who chaired the meeting, thanked Graham for this very interesting and successful evening.

The Geological Survey at War 1914 - 1918

Lecture at British Geological Survey, Keyworth, 19 June, 2014

Report by Geoffrey Jago

To commemorate the centenary of the outbreak of First World War, our June meeting concerned the contribution that British Geological Survey made to that war effort. Our speaker was Andrew Morrison, Archivist at BGS.

BGS Archives, part of the National Geological Repository Records Service, holds approximately 30,000 items and acts as an object museum with over 100 objects so far. In 1914 Britain had anticipated a major war to a lesser extent than in 1939 and it took some time to assemble information resources or indeed, in respect of our own discipline, to realise how many matters lay within the scope of geoscience to help.

Geological maps are the most obvious and there were soon maps for many battle areas. Both sides tried tunnelling in the French and Belgian chalk bedrock but the British found an overlying clay bed the better horizon. Hydrogeology was vitally important in finding sufficient water, not only for personnel but for the many horses that WW 1 needed - and horses drink more than men.

The list of subjects and activities where BGS was able to help, the history of which remains recorded, is long. They include sources of road metal, sand for concrete, the nature of German cement and concrete, aero compass materials, quartz crystals used for antisubmarine detectors and research into why the Germans used hexahedric crystals of pyrite.

Topographic studies helped with finding sites for aerodromes, valleys suitable for airships and caves for storage of food, munitions and other valuables.

Of BGS employees, 29 served in the war and Andrew gave brief biographies of seven of them which included two who became Directors of BGS, both receiving knighthoods, and a further two who became Assistant Directors. W.B.R. King, given the accolade of the "first British military hydrogeologist", was appointed to assist the Chief Engineer at the Western Front and was awarded the Military Cross. After the war he served as a university professor until his retirement in 1955.

That geologists could face wartime hazards nearer to home was demonstrated in 1914 when C. B. Wedd, quietly mapping the area around an army camp near Oswestry, Shropshire, was twice thought to be a German spy making sketches of the tented accommodation. A summary proposal by the occupants for a lynching was fortunately rescinded in time. Letters of complaint to the

War Office by BGS for thus unduly delaying its work remain in the archives.

Jo Thompson thanked Andrew for this interesting evening.

The Caves of Nottingham – Engineering Characteristics of the Castle Sandstone

Lecture by Dr. Tony Waltham at British Geological Survey, Keyworth on 13 May, 2014

Report by Geoffrey Jago

Could we humans owe our fascination for caves and caverns to an ancient folk memory from our primordial dwelling places?

On the subject of caves, at our May meeting we were glad to welcome the knowledgeable and entertaining speaker Dr. Tony Waltham. In the several times that Tony has spoken to us and assisted on our field trips since 1993 his subjects have been as diverse as the geology of Alaska, the Faulds Crater in Staffordshire and sulphur mining and caves in China. This evening his subject was the man-made caves of Nottingham, on which topic he is the leading expert.

The Lower Triassic Castle Sandstone on which most of Nottingham stands has the curious attributes of being easily dug with hand tools and, once excavated into a cellar or cave, of standing for centuries without support.

Flash floods in desert conditions deposited the sand leaving little evident layering other than stream bedding, while jointing or fracturing is present but at four to five metre spacing. Small subangular rounded pebbles, clay flakes and nodules, washed in by the river, add to the mix. Layering only becomes evident if water seeps in. This greatly weakens the rock and causes the roof of an excavation to spall off in layers about a centimetre thick.

Over 500 caves and cellars exist over a wide area of Nottingham but any use as dwellings ceased long ago. In recent centuries and modern times they are used mainly for private storage beneath existing buildings, an exception being access tunnels beneath Nottingham castle, Past times saw some caves used for trades including tanning and malting, while the more extensive caves are mines from the days when sand was a saleable commodity for scrubbing and floor covering. A few have grander provenance as garden rooms or curious adjuncts to large houses. Interconnection is rare, almost all the excavations being autonomous.

For anyone erecting a new building or modifying an existing one in the City it is therefore vital to know whether a previous owner has replaced rock with air. The sandstone is relatively easy to drill to probe the three to five metres that must be proven to provide sound footing to support a building. New cavities are inspected to decide whether they are of sufficient interest to be retained. Important caves can usually be preserved by bridging or by penetrating with narrow piles. Uninteresting holes can be filled with concrete after appropriate recording and

documentation. Nottingham offers ample opportunities to visit many of the caves including those under the Castle, the Broadmarsh shopping centre and a number of historic pubs.

Tony's book "Sandstone Caves of Nottingham", published by the East Midlands Geological Society and now in its third edition is recommended for informative and absorbing reading.

At the end of this interesting, informative and well attended meeting Tony was thanked by Andrew Brown

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Tales of the Unexpected: Human Fallibility and Geotechnical Design

Lecture at British Geological Survey, Keyworth on 15 April 2014 by Keith Nicholls, Principal Geotechnical Engineer at Opus International Consultants Ltd.

Report by Geoffrey Jago

The geological aspects of civil works are wide ranging. When all does not go well diagnosis of the reasons and assessing remediation or compensation requires especial knowledge.

Keith Nicholls described six disputes where he had advised or served as expert witness when parties were in dispute over problem ground conditions in civil engineering work. Experts have the demanding task of dealing with three responsible parties: their client, the opposition's expert and the Court, and need to be careful not to stray into advocacy (that is for the barrister).

Of the cases Keith described, all were successfully resolved without resource to Court although one was resolved "on the steps".

Two cases concerned tipped material in coal measure country which had slipped in complex conditions. A further case lay in regard of an application for Outline Planning Permission in potentially "contaminated" land. Outline Consent was initially refused on the basis that a Phase 2 Report (which rarely forms part of an Outline Application) had not been supplied. On appeal the local authority withdrew its contamination related objection.

In a case where a retaining wall had failed, many were involved including more than one contractor, their solicitors and barristers, insurers, loss adjusters and several householders, few of whom held off blaming other parties. The reality of the problem was clearly shown in photographs, an eventual solution (of sorts) being found by building a second wall behind the first. Some years after the builder's dust had settled, the contenders followed suit.

A culvert tunnel was planned through glacial materials. The ground comprised waterlogged sand over glacial till although the original tender design was based on an open cut option. Not a tunneller's dream, and changes of plan and sewer level were proposed in addition. The case was eventually settled out of court. The final case embraced a dispute over drainage design, this time

in soft rocks, and the problem seen here was a repeated simple arithmetic error uncovered after issue of supposed "Expert's" Reports.

Keith illustrated all the cases with detailed diagrams, plans, graphs and photographs. The evening was revealing and educationally useful to all in active work. Keith's subtitle, "Tales of the Unexpected" recalled Roald Dahl's tales of suspense and horror of the same title. Retired professionals in the audience may have experienced a sense of relief that such divertissement lay in the past.

Afterwards Andrew Brown thanked Keith for his interesting and instructive talk.

Early Career Geologist Award - Presentations by Three Finalists

Meeting at British Geological Survey, Keyworth, on 18 February, 2014

Report by Geoffrey Jago

Our February meeting featured presentations by the three young men who had reached the final in our Early Geologist program.

1. "Karst Landscapes: How and why are they individually unique?"

by Michael Underwood, Hydrologist, Envireau Water

Those landscapes underlain by eroded rock, primarily limestone, known as karst were the subject of our first presentation. The talk covered a description of how the surfaces were moulded by solution and dissolution and how climate, rock types, hydrogeology and structure all played their part.

Sorbas, Almeria in Spain was a specific area described with its caverns in interbedded marls, rich in gypsum. Several caverns were illustrated, with an explanation of how they were formed and how lateral solution along bedding planes affected their shape.

Michael's talk went on to describe the karst of Gran Sabana, Venezuela where a sandstone and quartzite bedrock has been eroded to a varied subdued to extreme topography by the weathering of a wet temperate climate. A major fault is responsible for 1000m overhanging cliffs and spectacular sink holes. Even more spectacular are the Angel Falls, the waters of which descend from a height nineteen times higher than Niagara.

2. "Defogging the filters of death and decay in the fossil record"

by Duncan Murdock, Leicester University

Our second speaker's topic was his work into developing improved methods of reconstructing what obscure fossils looked like when alive. In most cases only the hard parts of a fossil remain for us to see, its soft parts having quickly decomposed after its demise. However, in the case of some specimens, changes in its environment soon after death have preserved traces of some soft tissue at different stages of decomposition.

If one could learn how decomposition progresses in modern descendants similar to the fossils, can one use this knowledge to infer the live form of a partly rotted fossil? This is the basis of our speaker's work.

Worms and forest dwellers of various shapes and sizes were allowed to decay and the process recorded until little remained, a study lasting in some cases as long as 220 days. Suitable candidates comprise Onychophora (velvet worms), Tardigrada (water bears) and arthropods (invertebrates with segmented bodies). Hence, this study of how decay occurs points the way to produce a model of the lifelike form of a partially decayed fossil.

3. "A Guide to the Numerical Modelling of Underground Excavations in Hard Rock"

by Anastasios Stavrou, Engineering Geologist, URS Corporation, Chesterfield

Our third speaker's topic concerned rock mechanics in underground mining, and how studying the way that rock fractures can lead to improved roof support and safety. The key lies in analysis and mathematical modelling of joint spacing between blocks and an understanding of failure mechanisms.

Two methods of modelling (continuum and discontinuum) have been applied and the indications compared with observed results, the better to select the more useful method.

Plotting of stress / strain graphs lead to a better understanding of how rock behaves when invaded by tunnels and extractive voids. An example of how practice may be improved is the judicious placing of rock bolts in elastic zones.

Judges' Decision and Award

Committee Chairman John Black praised all three speakers for the excellence of their presentations and the high standard of their projected illustrations. He said that he and his two colleagues, in making their judgement, had based it on content and presentation. The high standard of all three presentations made theirs a difficult task but they had all agreed that the winner was Duncan Murdock. John thanked all three speakers and duly presented Duncan with the award.

Landslides

Lecture by Professor Edward Bromehead at Loughborough University on 10 February, 2014

Joint Meeting of East Midlands Geotechnical Group and East Midlands Regional Group

Students predominated at our large audience at Loughborough to hear eminent civil engineer Professor Bromehead repeat his Glossop Lecture on the subject of the scientific analysis of landslides in clay sedimentary rocks.

Packed with interesting detail, Professor Bromehead's address was as entertaining and stimulating as it was understandable, delivered in a style that held the interest of his audience. As to its content, it is impossible to improve on Professor Bromehead's published abstract which is repeated below.

"This talk is about landslides and their slip surfaces at residual strength in clays. Particularly in southern England, but also elsewhere, landslides in infrastructure cuttings and many natural slopes are commonly found to be slowly-moving compound landslides with a component of their basal shear surfaces following a particular bed (or 'slide-prone horizon'). A selection of both historical and modern case records of this type of landslide are presented briefly.

The geotechnical conditions that give rise to this occurrence are discussed in the paper, and the dominant factor relates to the dip of the strata, which must be of low inclination for the landslide mass to remain in place over the critical clay bed in the geological sequence after sliding has been initiated

Observations of the slip surfaces in the field lead to the conclusion that the bedding-controlled elements of this type of landslide develop along thin, slide-prone or slide-susceptible, horizons in the bedding. The question of what caused the formation of those horizons in the first place is answered by putting forward two hypotheses to explain why bedding-controlled slip surfaces form where they do, and considering the evidence for or against each of them. The conclusion is reached that despite the attractiveness of the concept that these slip surfaces form by a progressive failure mechanism at the junction of two materials with dissimilar properties, the alternative concept that they occur where there is a bed of slightly enhanced smectite content better fits the observations. The mechanisms for such local changes in clay mineralogy are linked to inputs of volcanic ash at the time of deposition. Definitive proof of concept is, however, lacking – but taking into account how clay sediments are deposited in sedimentary basins, this paper makes suggestions for future lines of enquiry.

Even now, nearly a half-century after Skempton's seminal Rankine Lecture that introduced the concept of residual strength of clays to the wider geotechnical profession, the corpus of data is rather limited. Some of the data sets are shown to exhibit remarkable similarities, and the implications of this tend to support the preferred explanation of the origin of slide-prone horizons."

Andrew Brown completed the session with a speech of thanks for an invigorating evening,

The Strange World of Underground Laboratories

Lecture by John Black of In Situ Hydro at British Geological Survey, Keyworth, on 21 January, 2014

Report by Geoffrey Jago

Following our Group's Annual General Meeting,where popular Chairman John Black had agreed to extend his leadership into the new year, he pressed on to open 2014 with a talk on the curious workplaces, of which he has extensive past experience, in manmade vaults known as Underground Research Laboratories (URLs) where scientists work (or worked in the past) deep in Mother Earth.

URLs are very commonly associated with the disposal of waste from the nuclear industry but not exclusively so. A few are devoted to pure science while rock mechanics, hydrogeology and transport of nuclides all feature in the research. URLs exist in all rock types. Some are freshly excavated but many are extensions of existing mines. By study of Rock Characterisation Facilities (RCF), most are devoted to proving or demonstrating that the site is safe for nuclear waste disposal but work associated with engineering, tunnelling and rock mechanics is undertaken as well.

Of URLs world-wide, only a minority remain in use. The US has seven, five closed, but one is used for defence waste as a repository in bedded salt and another remains in use for science. Japan has several disused URLs in its main island and one in use in its northern island. Britain has an active URL in the Boulby potash mine at Cleveland, north Yorkshire, and an RCF was proposed in Cumbria. Switzerland's URL is at Grimsel in the Alps.

At Aspo on the island of Forsmark, Sweden hosts the Rolls Royce of URLs: an international project, already having cost around 400 million dollars including running costs for 20 years. Situated beside a nuclear power station, it is 400m deep and hosts a number of experiments.

Not far across the Gulf of Bosnia, also near a nuclear plant, Finland began the Onkalo (Finnish for cavity) rock characterisation facility at Olkiluoto in 2002. Here you can drive down via a spiral tunnel to 420 m - it takes an hour. Their experiments include those in excavation damage zones (EDZ) seeking to assess the safety of storing containers of radioactive waste.

The Boulby potash mine at Cleveland is sufficiently deep at 1,100 m to make it a suitable place to study anomalous atomic particles which cannot be sought in the open air. It houses the ZEPLIN-III dark matter detector and the UK Dark Matter Collaboration, and also hosts research into extremophile organisms that can survive in a very salty environment.

In summing up, John said that this research field has made a vast supply of information, embodying much state of the art geoscience, freely available. Finally he noted that, should a

repository programme materialise in the UK, very many geoscientists would be required.

Helen Burke thanked John for this interesting talk.