MERCIAN Geologist

VOLUME 19 PART 1 OCTOBER 2016

East Midlands Geological Society

Correspondence
Society Secretary, 100 Main Street,
Long Whatton, Loughborough LE12 5DG
01509 843297 secretary@emgs.org.uk

Mercian Geologist Editor,
11 Selby Road, Nottingham NG2 7BP
0115 981 3833 mercian@geophotos.co.uk

Mercian Geologist is printed by John Browns,
and published by the East Midlands Geological Society.

ISSN 0025 990X

Front cover: Ancholme Clay mudstones (dark grey) overlain by Carstone and Hunstanton Chalk (a.k.a. Red Chalk) and chalk (with Welton Chalk above Ferriby Chalk) at South Ferriby Quarry on the southern shore of the Humber estuary. The chalk and mudstones are worked for cement manufacture, while the Carstone and Red Chalk are set aside as waste. Photo: Peter Worsley.

Back cover: Geological map of Nottinghamshire.

Contents

PROFILE

Vanessa Banks

Our new president, Dr Vanessa Banks, has placed conceptual ground models for applied geological applications at the centre of her professional career. Her specialist fields include karst hydrogeology, ground investigation and contaminated land, and she has worked on difficult ground conditions that involved organic soils, glacial deposits and karst. Throughout her career, Vanessa has maintained an interest in professional societies and local geology groups, the latter to share and widen her geological experience. To this end she has served on the committees of the East Anglian and East Midlands Regional Groups, the Chartership Audit Panel, the Geological Society of Norfolk and our Society. She is generous in her support of younger geoscientists as visiting research students at the British Geological Survey, and is a Visiting Research Fellow at the University of Derby.

During the late 1970s Vanessa's early interest in geology saw her doing voluntary work on fossil collections at Norwich Castle Museum. Following a gap year, crewing on a yacht sailing to the Caribbean and returning via the Azores, Vanessa studied geology at the University of Manchester. She then obtained a post with M J Carter Associates, where she gained practical experience in hydrogeology and environmental geology, working in the waste disposal and mineral extractive industries. During the next three years she was responsible for environmental monitoring of a number of landfill sites across the country, and for hydrogeological assessment and site investigation of a number of former quarries, and made earth-balance calculations for low-level restoration schemes at former gravel pits. During 1987-88, she completed an MSc in Engineering Geology at Imperial College, with her research project on the stability of underground chalk workings. This proved to be the foundation for a recurring professional interest in the engineering geology of karst.

Armed with her MSc, and attracted towards work with geotextiles in a range of ground conditions, Vanessa joined C H Dobbie and Partners in Ipswich. Working directly with structural and civil engineers under the supervision of Robin Sanders, Vanessa gained experience in foundation design and then in the design and supervision of ground investigation. Site-based management of contracts for the Property Services Agency, largely focused on the American air bases in East Anglia and an investigation for an oil interceptor at BP Llandarcy in Wales, underpinned subsequent opportunities on larger projects.

Responding to family commitments in Norwich, Vanessa had a short period of logging and soil testing for May Gurney Technical Services, before joining A F Howland Associates as a Senior Geotechnical

Engineer in 1990. She was resident engineer for ground investigation for a section of the Jubilee Line extension, and then became clients' representative for the Isle of Dogs Northern Drainage scheme with opportunities to monitor the tunnel face during construction. These projects were designed to generate characterised ground models with the aim of minimising any claims for unforeseen ground conditions as a consequence of tunnelling and construction in the London Clay and adjacent strata.

At A F Howland Associates, and then at RSA Geotechnics, she worked on numerous projects involving housing, large warehouses, roads, bridges, pipelines and reservoirs. She prepared flood risk assessments and baseline reports on pollution prevention, worked on airborne gas monitoring and undertook investigations of contaminated land. Supported by RSA Geotechnics, Vanessa also studied for a Certificate in Field Archaeology and Landscape History at the University of East Anglia to facilitate participation in Archaeological Watching Briefs.

In 2001 Vanessa embarked on a PhD in karst hydrogeology at the University of Huddersfield. This led into a research career, firstly as a Senior Contaminant Hydrogeologist at the British Geological Survey, where she worked with Dr Barbara Palumbo Roe on the environmental impact of abandoned non-coal mines, specialising in the unsaturated zone of mine tailings. Since February 2012 Vanessa has been the Team Leader for Shallow Geohazards and Risk at the BGS. Vanessa's breadth of experience enables her to contribute to a wide range of activities, primarily in the Engineering Geology Directorate. She has a mixed portfolio of NERC-funded and commissioned research in multiple aspects of geohazards, and recently taught a short course in Urban Geoscience in South Korea.

GEOBROWSER

Is global warming a long-term option?

The latest published Climate Change Synthesis Report (2014) reinforces the majority view that climate change is proceeding apace, stating that: *Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, and sea level has risen.* For Britain, obvious impacts over the last 20 years were the destructive storms that flooded coastal and inland areas. Their increased frequency and intensity reflect the greater energy and water content of weather systems in a warmer globe, exacerbated by a complex interplay of natural factors such as El Niño and jetstream configuration. Only a few climate researchers would now argue with the report's conclusion that … *Human influence on the climate system is clear, and recent anthropogenic emissions of green-house gases are the highest in history.*

Climate change *per se* has been occurring throughout the planet's history, however, and fluctuations of the current ice age did not prevent, and may even have accelerated, the evolution of anatomically modern humans about 200,000 years ago (*www.sciencebasedlife.the-timeline-of-human-evolution)*. Through adaptation and migration, *Homo sapiens* ('wise man') lived through two major Quaternary glaciations that rendered much of Eurasia and North America partially ice-covered or as a tundra terrain. Conditions are relatively benign in the current, interglacial times, but looking far into the future, at least on the human scale of perception, our climate will naturally cool once again due to orbital forcing (Milankovitch cycles). Thus, by drastically curtailing anthropogenic greenhouse gas emissions, another glaciation may result, and even allowing for technological advances this would pose massive geopolitical problems as whole nations could be threatened by advancing ice sheets.

Given a future that potentially involves natural global cooling, a better emphasis might be to regard greenhouse gases as a valuable resource for regulating the planet's climate. To achieve this, accurate global emission-control models will be needed to give an optimum climatic balance that attempts to maintain the current environmental, demographic and political *status quo*, undesirable as that may be to some communities. Researchers are just beginning to think in that way; for example, the Potsdam Institute for Climate Impact Research (*Nature, 2016: 10.1038/nature16494*) finds that…'*relatively moderate additional anthropogenic CO_2 emissions from burning oil, coal and gas are already sufficient to postpone the next ice age* (ie glacial interval) *for another 50.000 years. The bottom line is that we are basically skipping a whole glacial cycle, which is unprecedented. It is mind-boggling that humankind is able to interfere with a mechanism that shaped the world as we know it.'* It also concludes that even …'*moderate future anthropogenic CO_2 emissions of 1000 to 1500 gigatonnes of carbon are bound to postpone the next ice age by at least 100,000 years.'*

So perhaps a nuanced greenhouse gas strategy would be more appropriate, taking into account oft-neglected factors such as emissions from livestock, already 14.5% of total, anthropogenic, greenhouse gas according to a UN FAO study (*www.fao.org/news/story/en/item/197608/icode*), as well as natural sources, such as methane emitted from decomposing vegetation (*e.g. http://www.wetlands.org/Carbonemissionsfrompeatland*). In this complex equation other emissions that cause climate cooling, such as dust from volcanic eruptions, and man-made industrial aerosols (*www.metoffice.gov.uk/aerosols factors*), also need to be factored in. Current estimates suggest that 'fairly dramatic' cuts to anthropogenic greenhouse gas emissions, mainly from the burning of fossil fuels, would be needed in order to stabilise current global CO_2 concentrations of around 400 ppm (*NOAA, 2016*). If we fail to do this, then not only will anthropogenic global warming proceed apace, destroying environments, rendering many countries uninhabitable and drowning coastal cities (*Nature Climate Change, 2012: 10.1038/nclimate158*), but we will also have exhausted the planet's strategic supplies of fossil fuels, the very materials that could stave off the more gradual catastrophe of a future glaciation.

Record Atlantic tsunami recorded

Last year's *Mercian Geologist* (*pp 243-251*) described in lavish detail the volcanic geology of Fogo Island, in the Cape Verde archipelago. Another fascinating aspect of Fogo is that all of the recent activity is confined by an arcuate cliff, the Bordeira, up to 1000 m in height. This is not simply an old caldera rim: it has long been recognised as the scar of a massive landslide that, given the volcanic context in which it occurred, would be classified as a flank collapse. A vast amount of material must have suddenly entered the sea, inevitably creating an east-directed tsunami, but the question is: how extensive or devastating would this have been?

As recounted by Emma Brown in *Nature News* of October 2015 *(10.1038/nature.2015.18485)*, the first clues came in 2011 when a team of European scientists found evidence for tsunami-type deposits on Santiago Island, about 55 km east of Fogo (*Sedimentary Geology 239, 129–145*). This article triggered a recollection by Ricardo Ramalho, who while working there in 2007 had noticed extremely large boulders scattered across a wide plateau about 200 m above sea level. The boulders were derived from the cliffs below, and marine fossils


source: Ricardo Ramalho, Bristol University

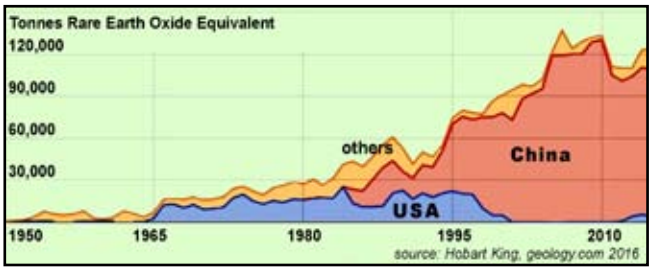
were also present among the debris. Putting two and two together, the most plausible causative event would have been the tsunami generated by the flank collapse on Fogo Island. Calculations showed that a wave powerful enough to carry the largest boulder would have been at least 170 m high when it hit the island, before reaching elevations up to 270 m above its coastline. To date this event more precisely, collaborators at Columbia University's Lamont–Doherty Earth Observatory in Palisades, New York, measured the amount of helium-3 on the boulder surfaces that have been exposed since the wave hit, pinpointing the tsunami, and thereby the Fogo flank-collapse, at roughly 73,000 years ago (*Science Advances* 2015: *10.1126/sciadv.1500456)*.

This evidence recalls the alarm raised by a paper (*American Geophysical Union, 2001*) suggesting that a giant west-facing flank collapse of the Cumbre Vieja volcano on La Palma Island, in the Canaries, could generate a tsunami large enough to travel across the North Atlantic and devastate cities such as New York. Subsequently however, many scientific bodies, including the Tsunami Society (*http://www.lapalma-tsunami.com/),* pointed out that that the power of such an event has been wildly exaggerated, and even the BBC published a partial retraction saying that this 'tidal wave threat', the subject of its *Horizon* program, was '…. over-hyped'. Nevertheless, submarine debris fields resulting from flank collapses have been found in many archipelagos with steep-sided volcanoes (*www.earth.ox.ac.uk/~tony/watts/downloads/Masson_Gee_Landslides.pdf),* the Canaries being a classic example (*Geobrowser, 2000)*. As yet there is no eye-witness account of an ocean-island flank collapse, but the Santiago Island example gives some indication of the damage to coastal settlements and tourist resorts that such events could cause in the future.

Coal: a new mineral resource?

As technology becomes increasingly sophisticated, so too is our reliance upon rare-earth elements (REE), such as scandium, yttrium, lanthanum and cerium, for producing both necessity and luxury items, such as computers, smart phones, rechargeable batteries, electric vehicles, magnets and chemical catalysts. However, rare earths are seldom concentrated in mineable amounts, accounting for the scarcity of prospects worldwide. Moreover, the graph shows that China has controlled the market in recent times, with more than 85% of world production. So it was able to sell rare earths at very low prices in the late-1980s and early-1990s, forcing mines to close in the United States, the next-largest producer. But when it cut exports in 2010, rare earth prices skyrocketed, stimulating new exploration in the USA and several other countries (*Geology.com,* May 2016).

It has long been known that rare earths are found in coal seams, but it was always costly to extract them. The current burgeoning market, however, has stimulated the search for readily accessible sources, and some of this research has been highly innovative. In the USA, the West Virginia Water Research Institute has already identified treated acid mine drainage from coal mines as an enriched



source of rare earths, particularly the more valuable, heavy elements (*www.sciencedaily.com/releases/2015*). In Britain we may have missed the boat here because, although some abandoned mines continue to be pumped out, the last, deep-working mine (Kellingley) closed in 2015. However, there are still eight mines supplying the remaining coal-fired power stations, and the ashy waste produced from these could yet be investigated as a further source of rare earths. Again the USA leads the way, with a team from Penn State University reporting cost-effective and environmentally friendly ways to extract these metals from coal-burning waste using ion-exchange techniques. Up to 0.5% of rare earths were extracted in a preliminary study, but the team are confident that this can be increased to a commercially viable 2% (*Metallurgical Materials Transactions E, 2016*). The Penn State team also investigated *in situ* coal deposits and found that coaly shales, at the very tops of some seams, contained the largest amounts of rare earths. This is currently a growth area for research in the USA and worldwide, so perhaps it is not too late to test it out in the 20–30 opencast coal sites that are still working in Britain.

Fracking does not contaminate aquifers

Few things are predictable in local politics, but one issue that is bound to heat up the East Midlands within the next few years revolves around the potential impacts of hydraulic fracturing (fracking) for shale gas. We raised this spectre in *Geobrowser* for 2010 and 2012, and this year in Nottinghamshire a start has been made at a site near Blyth, which has received planning permission for a single exploratory well. There are many objections to fracking, but one that usually receives prominence is the possibility of contamination by leakage of natural gases into aquifers supplying local drinking water.

This concern has been addressed in the USA, where large-scale fracking was pioneered and where its side-effects have been monitored over the past three decades. A team from Ohio State University has used noble gases, such as helium and neon, which leak out along with the methane, to identify a key source of groundwater contamination (*Proc. National Academy of Sciences*, *2014)*. After analysing eight clusters of contaminated drinking-water wells in Pennsylvania and Texas, the team found that neither horizontal drilling nor the fracking of shales were involved. Instead, it appears that poor casing and cementing in the parent wells caused natural gas to travel up the outside of the borehole and into any adjacent aquifers. This is good news because it means that any methane contamination should be strictly localized, and can be easily addressed by a few simple improvements to well integrity.

Green on Greenstone

Alexander Henry Green was born at Maidstone in 1832, the son of the Rev. T. S. Green, a classical scholar and Master of Ashby-de-la Zouch Grammar School, where A. H. Green received his initial education before entering Gonville and Caius College, Cambridge. In 1861 he was appointed Assistant Geologist at the Geological Survey of England and Wales, attaining the rank of Geologist in 1867.

During his time with the Survey he worked initially in Oxfordshire and Buckinghamshire before transferring to the Yorkshire and north Derbyshire coalfield. He was sole or joint author of a number of Geological Survey one-inch-to-the-mile sheet memoirs, including those for Banbury (1864), Stockport (1866), Tadcaster (1870), Dewsbury (1871), Barnsley (1878), and Wakefield (1879). He jointly authored a district memoir on *The geology of the Carboniferous Limestone, Yoredale rocks, and Millstone Grit of north Derbyshire* (1869, second edition 1887). His most substantial contribution for the Survey was as principal author of *Geology of the Yorkshire Coalfield* (1878, 823 pp).

Green resigned from the Survey in 1874 on his appointment as Professor of Geology (and later of Mathematics) at the newly founded Yorkshire College in Leeds, and while there he continued to undertake some official Survey work. The British Geological Survey has more than fifty of his field notebooks, section books and sketch books, dating from between 1853 and 1895. His careful and meticulous notes are embellished with pencil sketches and watercolours of exceptional artistic merit. Some of these sketches (such as that illustrated here) demonstrate a whimsical sense of humour, an attribute confirmed by one of his contemporaries at the Survey, Edward Greenly.

The following incident related by A. H. Green is fairly typical of that experienced by many a Survey mapping geologist in the 19th century and comes from Greenly's autobiographical *A hand through time* (1938): One day, he [Green] became aware that a farmer was watching him with suspicion. Wherever he went, the farmer went. Presently, the man came up, asked him what he was doing, and went away, but returned and invited him in to tea. "I really must apologize, Sir, for watching you like I did. But you see, it was this way. The constable he come and sez: "Farmer Long, you remember them ricks as was burnt, and how we couldn't never find out who it was 'as done it. Well, there's a chap about here now as I can't make out. He don't go along the road like an honest man: he's always pokin' about into all sorts of holes and corners. And if I were you, Farmer Long, I should keep an eye on that there chap."

The value of Green's notebooks came to prominence in 1973 in consequence of the Lofthouse Colliery disaster near Wakefield, where an inrush of water claimed the lives of seven miners. A Public Inquiry disclosed that the accident could have been avoided had a vital piece of information contained in one of Green's notebooks been consulted prior to the commencement of coal extraction beneath the abandoned Old Low Laithes Colliery. Following the publication of a Parliamentary Report in September 1973, a detailed, geographically index was prepared to register the contents of all Geological Survey field notebooks up to that time.

David G. Bate, British Geological Survey

A. H. Green, furnished with accoutrements necessary for a Survey Geologist working in the north of England: mapping case, hat and umbrella (undated, from Edward Greenly's 'A hand through time', 1938).

'A. H. Green on Greenstone blocks': self-caricature from one of Green's field notebooks (BGS Archives GSM/GL/Gr/25).

THE RECORD

The 2015-16 winter programme had 7 indoor meetings.

Ekbal Hussain spoke of the challenges created by the North Anatolian Fault, which extends for 1300 km across the length of northern Turkey as a right lateral strike-slip fault. Being one of the most active strike slip faults in the world, it has a long history of earthquakes.

Lively stories were told by modern-day flint knapper and archaeologist, Phil Harding, who demonstrated that evidence from the excavation of short-term knapping sites increases knowledge of stone working in the past.

David Harper talked about the new and often bizarre body structures of the Cambrian Explosion and the Great Ordovician Biodiversification Event, leading to increased numbers of families, genera and species. With modern marine ecosystems in place by the end of the Ordovician, abundant and diverse metazoans were set to dominate the next 450 million years with increasingly complex and diverse community structure.

Engineering and environmental geology in Cyprus was reported by Paul Nathanail. Its sheeted dykes and pillow lavas present challenges to road builders, and soils can be sources of potential harmful elements. The Troodos hydrogeology defines where and how deep groundwater wells can be to provide secure water supplies. Over-abstraction of groundwater causes ground instability in areas underlain by soluble gypsum.

Richard Hawkes described the preparation of geological specimens by removing the rock matrix to reveal the natural beauty of fossils and minerals. He brought with him many fine examples of ammonites, dinosaur bones, fossil wood, crinoids, trilobites and echinoids.

The lava fields of the Inner Hebrides were shown to be more than just monotonous piles of basalt by Ian Williamson's lecture. Case studies from Skye, Mull and Canna have increased the understanding of the physical volcanology, its stratigraphy, facies architecture and secondary mineralisation, and the sedimentary environments associated with the volcanism.

In her first Presidential Address to the Society, Vanessa Banks explained the processes behind the increased numbers of slope failures, landslides, and sinkholes induced by the unusually high rainfalls in the winter of 2013/14. Infrastructure was affected across the country and prompted high levels of enquiries at BGS, from the public and from the media, concerning sinkholes.

The 2015 summer programme had 6 field excursions.

The use of stone in buildings and the suitability or otherwise of the local bedrock was the focus of a walk in Nottingham led by Steve Parry and Graham Lott.

The Marlstone Rock Formation with its ironstone workings at Holwell were visited with Keith Ambrose. This had been the last operating quarry in the area, closing in 1962, and was the only one with underground mining of the ore.

A combined excursion with the North Staffs GA group was led by Colin Bagshaw to investigate the Carboniferous limestone and igneous rocks of Masson Hill and the remnants of the local lead mining industry.

A visit to the Brassington area in Derbyshire with Jim Ridings enabled study of the Miocene sediments expose in the Bees Nest and Kenslow Top pits. The Brassington Formation is the best example of sediments in karstic fills that survived Late Neogene and Quaternary erosion.

Allan Straw and Peter Worsley led an excursion to consider evidence of glacial events between the Anglian and Devensian in Fenland and the Wolds. This produced some lively debate amongst the participants. A stratigraphically important site at Welton-le-Wold, near Louth, contains tills, artefacts and a mammalian fauna; this has enabled reconstruction of environmental change during several glacial and interglacial cycles, and has given rise to alternative interpretations.

The geology of both coastal and inland sites was seen during a weekend field excursion to Yorkshire, led by Ian Sutton. Visits were made to the Cretaceous Chalk of Flamborough, the Lower Jurassic at Staithes, the Upper Jurassic oolites of the Forge Valley and inland on the North York Moors to localities in the Tertiary Cleveland Dyke.The impact of Pleistocene glaciation on both areas was also observed.

On behalf of the Society, Albert Benghiat has been conducting a feasibility study for creating a geopark in the Peak District. This idea has attracted support from potential partners such as Peak District National Park Authority and many local organizations. The next step is to establish funding options and identify an organization interested in taking the project forward. This is too large a project for EMGS to take the lead role, but it is hoped that the Society will play its full part in helping with specific tasks within the wider project.

Janet Slatter

EDITORIAL

With so much material relating to geologically youthful events, it had been suggested that this year's *Mercian Geologist* should be labelled as a Special Issue, or even renamed Mercian Quaternary Geologist. But we have been very boring and done neither. However we have welcomed two papers that provide somewhat conflicting views within their very different styles. Allan Straw's overview of Quaternary Lake Humber is based on many years of study and observations over a wide area, whereas Robert Friend and friends describe detailed research on one small part of the same area. Geological science progresses only when fed by both detailed evidence and provocative overview. *Mercian Geologist* has therefore been happy to accept both these papers, in the hope that they might contribute to discussion and debate that can resolve controversy within our geological understanding.