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East Midlands Geological Society

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PROFILE

Mike Allen

Our new president, Mike Allen, came into this world in February 1952; the second son in a household of mixed English – German parentage. Infancy was passed in Beckenham, his birthplace, before spending the year ahead of formal schooling entrusted to the care of a maternal grandmother living near Hanover. Much of this time was spent becoming proficient in several card games, especially canasta favoured by grandma. At the age of five it was necessary to rapidly re-learn English on returning to these shores in time to commence full time education.

At age seven the family moved to Thorpe Bay, still within comfortable range of 'the City' for a commuting accountant father. It was on the delightful sun-kissed sandy beaches and rock pools of 'Southend-on-Mud' where the first stirrings of interest in things deposited along strand lines captured a youngsters imagination, nurturing a fondness for collecting stones and fossils and developing an interest in the world around.

Another family move at age eleven eventually proved to be a blessing as the local grammar school in Haywards Heath provided the opportunity to study O, A and S levels in geology, a subject not then widely on offer, and only newly introduced into the school curriculum. A project on the varying purity of the Chalk of the Sussex Coast combined a passion for both chemistry and geology, and contributed to the choice of University course at Bristol, reading chemistry as a subsidiary subject for the first two years, graduating in single honours geology in 1973. During this time he joined the Geological Society of London as a student member. A year of further study followed, taking the MSc course in Rock Mechanics and Structural Geology at Imperial College, before deciding that it was time to start earning a living.

Three potential roads opened up with job offers from Soil Mechanics, the Institute of Geological Sciences (now the British Geological Survey) and the National Coal Board. It was the third of these avenues that was taken up in 1974, offering a Sassenach the chance to discover the unknown world north of the Watford Gap, having only ever ventured further north on a few family holidays and university field excursions. That choice has never been the source of any regret!

After an initial period of general training and introduction to the underground environment, a career followed in deep mines as an exploration and mine geologist based mostly in the Nottinghamshire coalfield. At the time, the heralded "Plan for Coal", with the potential for new coalfields, offered a bright future that seemed to stretch far ahead. The post offered much variety, initially working on the Vale of

Belvoir exploration programme while also providing a geological service to colliery management and planners on matters of safety (both underground and on colliery spoil tips) and forecasting geological risk to production. Various positions ensued as internal reorganisations followed, leading to a more expansive office-based role ranging from seam mapping, reserves evaluation and subsidence enquiries.

An overseas secondment to B.P. Coal South Africa in 1981 was spent working on an exploration project assessing reserves for a new coal mine in the northern Transvaal. This was at a time when apartheid was still an uncomfortable reality and the country needed new reserves to sustain its 'Sasol' oil requirements in the face of economic isolation.

Following the development of a professional institution of geologists during the 1980s with some interest, chartered status was gained in 1991. Views on the future of coal changed as political and environmental factors began to alter attitudes, such that the industry underwent a massive change with large-scale colliery closures and then privatisation in 1995. This led to the necessity to seek pastures elsewhere, outside geology.

When an advert calling for part-time tutors in adult education came to his attention, he was prompted to establish an introductory course on geology at Judgemeadow College in Leicester, which continues as an informal meeting of friends and for whom he organises geological excursions during the summer.

Over the past decade he has become an increasingly active member of several geological societies, helping with conservation work, penning articles for newsletters and currently chairing the Education Committee for the Warwickshire Geological Conservation Group, overseeing their winter lecture and summer field programmes.

THE RECORD

EMGS 2017 summer programme: 7 excursions

In May the first visit of the season was to Charnwood Museum in Loughborough to see their Charnwood Rocks exhibition. Organised by the Russell Society, and introduced by Frank Ince, this brought together rocks, minerals and fossils from the Charnwood area to celebrate the 60th anniversary of the first report of a Precambrian fossil in Charnwood Forest.

Also in May 2017 Tim Colman led a small group to the Sedgewick geological museum in Cambridge.

June saw an excursion to Creswell Crags, where the group examined the dolomitic limestones exposed in the gorge that was formed during the Pleistocene glaciations. Some of the group also went into the caves on the very informative 'Life in the Ice Age' tour.

The July weekend excursion to Ravenstonedale, in Cumbria, was by Tim Colman to examine the structures and geomorphology of the Carboniferous Limestone, with exposures in gorges and on limestone pavements. Included was a walk along the Adam Sedgewick trail and the opportunity to visit his birthplace.

In August, Vanessa Banks led a joint excursion with the North Staffordshire Geological Society to Monsal Dale. It explored some of the Quaternary landforms and hydrological features in the dale, and considered formational influences on both the hydrogeology and mass movement within the Peak Limestone Group.

In September another joint visit, with Stamford Geological Society, was made to Ketton Quarry, where the entire Middle Jurassic sequence can be seen.

The temporary exhibition at Wollaton Hall, 'Dinosaurs of China: Ground Shakers to Feathered Flyers' was visited by a large group in September, with the benefit of a personal guided tour by the curator Adam Smith. It was a rare opportunity to see the spectacular new discoveries from China, notably of feathered dinosaurs where the feathers really are visible.

EMGS 2017-2018 winter programmes: 7 meetings

After the AGM in March 2017, Adam Smith, curator of the Nottingham Natural History Museum at Wollaton Hall, introduced swimming plesiosaurs and flying dinosaurs to the Society. His academic focus is on Mesozoic marine reptiles, particularly plesiosaurs and ichthyosaurs, and he described new plesiosaur species with an analysis of how these extinct reptiles swam.

In April Dr Julie Prytulak described the biggest volcano on Earth. Lying on the Shatsky Rise on the Pacific Ocean floor 1500 km east of Japan, the Tamu Massif is a Jurassic volcano some 500 km in diameter and 4000 m high, with its crest 2000 m below sea level. Tamu did not originate over a mantle plume, but was driven by partial melting and compositional variation at a depth of 100–250 km within the mantle, in the style that generates Large Igneous Provinces. Efforts from a diverse group of scientists are gaining invaluable information about the deep interior of the Earth.

Opening the next winter season in October, the lecturer had to cancel at very short notice, but Tony Waltham stepped in with a photographic montage of the geology of the Canyonlands of America. The Colorado Plateau is distinguished by spectacular landforms mainly formed in Mesozoic sandstones and beautifully exposed in the dry lands of Utah and Arizona.

In November's lecture, Colin Summerhayes reviewed the development of climate change models. He showed how cores of marine sediment, stalactites, ice, tree rings and corals reveal the factors, natural and man-made, influencing climate change. Over the past million years our climate has been governed by orbital change and solar change. Over the past 2000 years those natural changes drove us into the Little Ice Age. Present orbital and solar properties are like those of the Little Ice Age, yet temperatures are rising. The only driver we can find to explain that divergence is the rise in emissions of carbon dioxide.

In December, Tony Waltham reprised his Glossop Lecture at the Engineering Group of the Geological Society in London, 'Control the drainage: the gospel accorded to sinkholes'. The main karst geohazard is the development of new sinkholes within the soil profile over cavernous limestone; they develop by suffosion, where soil is washed down into cavities in the stable rock. Most are formed by rainstorms, new drainage inputs or water table decline. Rock collapse is less common. Most sinkholes are induced by civil engineering activities, and are therefore largely avoidable.

David Martill began 2018 with the results of his dinosaur hunting in the Sahara Desert. An extensive plateau, the Hamada Kem Kem, fringes the ancient plain of the Tafilalt in southeastern Morocco. This desert borderland, once recognised for its trans-Saharan gold routes, is now famed for its ancient fossils. A vigorous international fossil trade provides thousands of families with an income much better than can be gained from grazing goats and growing dates. Thousands of Palaeozoic trilobites, goniatites, orthoconic nautiloids and crinoids are now in museums and on mantelpieces around the world. Rising above these Palaeozoic beds, the Kem Kem escarpment is formed of Cretaceous sandstones rich in terrestrial vertebrates, with a wide variety of dinosaurs, pterosaurs, crocodiles, turtles and some of the largest fishes ever to have inhabited rivers, all preserved within this Lagerstätte. *Spinosaurus*, a fish eating, semi-aquatic dinosaur was probably longer than *T. rex*. *Carcharadontosaurus* was a large predator of other dinosaurs. Even the pterosaurs were gigantic, with some *Coloborhynchus* and *Alanqa* exceeding six metres in wingspan.

In her last Presidential Address in February, Vanessa Banks continuing the theme from previous years by speaking on karst processes in the Peak District. Describing the wide range of erosional and depositional karst processes and landforms to be found in the region, she discussed their timing and how they have contributed to our knowledge of the geological and hydrogeological history of the area.

FROM THE ARCHIVES

Drayton's *Poly-Olbion*, 1613 - 1622

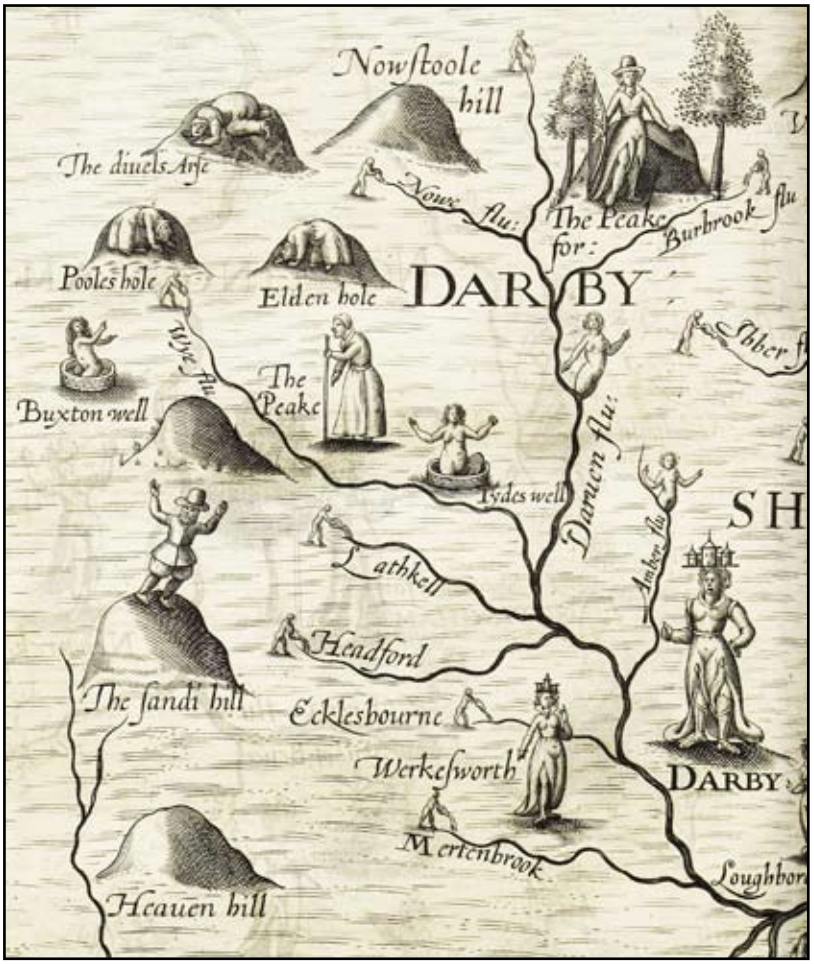
The library of the British Geological Survey (BGS) has been in existence since at least 1842, the year in which the Survey's first Director, Henry Thomas De la Beche, first recorded the purchase of 'books for the Library of the Museum'. The Library today holds many rare old volumes pertaining to geology, mineralogy and fossils, mining, agriculture and topography. In this last category falls a curious work by the poet, Michael Drayton, entitled: *Poly-Olbion, or, a chorographicall description of tracts, rivers, mountaines, forests, and other parts of this renowned Isle of Great Britaine, with intermixture of the most remarquable stories, antiquities, wonders, rarityes, pleasures, and commodities of the same: digested in a poem.*

Poly-Olbion was published in two parts. The first part appeared in 1612, though evidently without a date; it was reissued bearing a date of 1613. A second part was published in 1622, together with the first part, now furnished with a new title-page. BGS holds the 1613 edition of the first part, bound together with the second part, and the book was acquired by the Library on 12 May 1846.

The work is an expansive poetic journey through the landscape, history, traditions and customs of early modern England and Wales. Drayton's 15,000-line poem, which navigates the nation by way of its principal rivers, is embellished by William Hole's thirty, whimsical, engraved maps. The map extract reproduced here accompanies the 'sixe and twentieth Song', which occurs in part two (1622), and concerns itself in part with the Peak District of Derbyshire within the drainage area of the River Derwent (here variously called *Daruen* or *Darwin*) and its tributaries. Drayton expounds at unusual length on the wonders of the Derbyshire Peak, suggesting that it had made a great impression upon him.

This is what he says of Peak mineral production:

For shee a *Chimist* was, and Natures secrets knew,
And from amongst the *Lead*, she *Antimony* drew,
And *Christall* there congeal'd, (by her enstyled Flowers)
And in all Medcins knew their most effectuall powers.
The spirits that haunt the Mynes, she could command and tame,
And bind them as she list in *Saturns* dreadfull name:
Shee Mil-stones from the Quarrs, with sharpned picks could get,
And dainty Whetstones make, the dull-edgd tooles to whet.
Wherefore the *Peake* as proud of her laborious toyle,
As others of their Corne, or goodnesse of their Soyle,
Thinking the time was long, till shee her tale had told,
Her Wonders one by one, thus plainly doth unfold.



Part of map by William Hole, in part two of Drayton's Poly-Olbion*, 1622.*

The reference to the extraction of antimony in association with lead is of especial interest. Ford *et al.* (1993) notes that the presence of *antimoniated lead ore* at Gregory Mine, at Ashover, has been reported in several 19th century publications, but regards the presence of (workable) antimony in the Derbyshire Peak as unconfirmed by modern work. Our poet however clearly indicates that antimony was being extracted for its medicinal use, along with fluorspar (the 'Flowers' in line three). Antimony salts were used in medicine as an emetic and 'in some eruptive or exanthematous fevers, in catarrhal affections, and as an ointment to be applied externally' (Wang 1919, pp. 168–9). Trevor Ford has drawn attention to a reference from 1799 to the application of powdered 'blue fluorspar' in the treatment of gall stones (Ford 2005).

Our poet then follows with an account of the several Wonders of the Peak: the *Divels Arse* (Devil's Arse, or Peak Cavern, Castleton), *Pooles hole* (Poole's Cavern, Buxton), and *Elden hole* (Eldon Hole, Peak Forest). From the details given it seems clear that Drayton had entered or at least visited these caves himself. His words

concerning Poole's Cavern are:

Whose entrance though deprest below a mountaine steepe,
Besides so very strait, that who will see't, must creepe
Into the mouth thereof, yet being once got in,
A rude and ample Roofe doth instantly begin
To raise it selfe aloft, and who so doth intend
The length thereof to see, still going must ascend
On mightie slippery stones, as by a winding stayre,
Which of a kind of base darke Alablaster are,
Of strange and sundry formes, both in the Roofe and Floore,
As Nature show'd in thee, what ne'r was seene before.

But Eldon Hole is his favourite:

For *Elden* thou my third, a Wonder I preferre
Before the other two, which perpendicular
Dive'st downe into the ground, as if an entrance were
Through earth to lead to hell, ye well might judge it here,
Whose depth is so immense, and wondrously profound,
As that long line which serves the deepest Sea to sound,
Her bottome never wrought, as though the vast descent,
Through this Terrestriall Globe directly poynting went
Our *Antipods* to see, and with her gloomy eyes,
To glote upon those Starres, to us that never rise;
That downe into this hole if that a stone yee throw,
An acres length from thence, (some say that) yee may goe,
And commanding backe thereto, with a still listning eare,
May heare a sound as though that stone yet falling were.

Ford (2008) tells us that Eldon Hole is the only natural open pothole in the Peak District, describing it as a gash 34 m long by 6 m wide on the southern slopes of Eldon Hill. It descends vertically to about 60 m (200 feet) from the surface, with a low passage off to a large cavern and a further drop to a final depth of 80 m — so not quite all the way to the Antipodes!

The virtues of the spa waters at Buxton and Tydeswell are described in turn. Then 'for change', our poet goes on to describe a curious sandy hill:

A little Hill I have, a wonder yet more strange,
Which though it be of light, and almost dusty sand,
Unaltered with the wind, yet firmly doth it stand;
And running from the top, although it never cease,
Yet doth the foot thereof, no whit at all increase.
Nor is it at the top, the lower, or the lesse,
As Nature had ordain'd, that so its own excesse,
Should by some secret way within it selfe ascend,
To feed the falling backe; with this yet do not end
The wonders of the *Peake*...

Referring to William Hole's map we may perhaps see the poet himself 'running from the top' of *The sandi hill* with what appears to be gleeful abandon. This windswept hill, which no amount of erosion seems able to reduce in height, can in all probability be identified with a hill that occurs in the narrow angle between the converging rivers of Churnet and Dove, lying immediately north of Rocester and just within the county of Staffordshire. Though unnamed on the 1:25,000 scale Ordnance Survey map, it evidently goes under the name of Barrow Hill, the top of which is marked by a knoll at 150 metres above OD, to the north of Barrowhill Hall. Geologically this hill is made up of an isolated patch of glacial till resting on Mercia Mudstone and capped by glacial sand and gravel.

It has not been possible with certainty to identify *Heaven hill*, depicted on the map to the immediate south of *The sandi hill*, though it must be part of the hill-range that extends southwards from near Rocester along the eastern side of the River Dove, for there is a Havenhouse Farm on this range. Drayton merely refers to the hill in passing when he salutes the Peake hills that extend from *Nowstoll* in the north (*Nowstoole hill* on the map, which cannot be identified, unless it is an alternative name for Win Hill, which lies in the angle between the rivers Noe and Derwent) to *Heaven Hill* in the south.

The full text of the Poly-Olbion is accessible online via Exeter University's Poly-Olbion Project (from which the present writer has derived some of his introductory material) at poly-albion.exeter.ac.uk/the-text .

Thanks are accorded to Anne Dixon, Chief Librarian at the British Geological Survey, for allowing photography of the William Hole map.

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David G. Bate, British Geological Survey

View towards Barrow Hill from the River Churnet; the Sandy Hill described by Drayton lies beyond the trees, though in Drayton's day the whole area may have been sheep pasture without woodland.

GEOBROWSER

Cosmic trigger for our youngest glaciation?

The Younger Dryas Stadial, lasting from c.12,900 to c.11,700 years BP, was the most recent and longest of several interruptions to the gradual warming of the Earth's climate since the severe Last Glacial Maximum, which started to ameliorate around 20,000 BP. Named after the alpine-tundra wildflower *Dryas octopetala*, the leaves of which are locally abundant in the Late Glacial sediments of Scandinavian lakes, it is known in Britain as the Loch Lomond Stadial, and its influence on landforms has long been recognised in mountainous areas where glaciers temporarily returned. A good example in Scotland is the 'parallel roads' of Glen Roy, which are shorelines caused by the progressive draining of a glacier-dammed lake.

What has really puzzled workers was the dramatically sudden Younger Dryas climatic change, which took place in a matter of decades that saw average global temperatures plunge between 2°C and 6°C. The review by Renssen *et al.* (*2015: Nature Geoscience 8*) notes that the event has traditionally been attributed to a sudden shut-down of the Atlantic meridional overturning circulation by meltwater discharges, possibly from the Great Lakes or the Greenland ice-cap. Other 'natural' explanations include strong, negative, radiative forcing, perhaps caused by a net decrease in greenhouse gases and/or increase in atmospheric aerosols, and drastic shifts in atmospheric circulation. The models of Renssen *et al.* suggest that taken alone, none of these mechanisms would account for the suddenness of the Younger Dryas warm-cold transition, although the change could be simulated by using them in combination.

Against this background, the notion that the Younger Dryas could have been caused by some sort of cosmic impact has steadily gained ground. Initially proposed in a book by Firestone *et al*. (*2006: The Cycle of Cosmic Catastrophes*), the hypothesis is now very much to the fore thanks to discoveries at sites in North America containing Younger Dryas boundary sediments (YDB sites). From these, Kennett *et al*.

Locations of ice cores and Younger Dryas boundary (YDB) sites with peak biomass-burning proxies. Diamonds represent 6 ice records that display chemical proxies in support of anomalously high YDB biomass burning. Taylor Dome and Taylor Glacier are off the map in Antarctica. Circles represent 23 sites with a documented YDB layer containing peaks in biomass-burning proxies. (After Wolbach et al., 2018)

(*2009, doi.org/10.1073/pnas.0906374106*) described shock-synthesized diamonds (known as lonsdaleite). A global perspective was subsequently provided by Bunch et al. (*2012, doi.10.1073/pnas.1204453109*), who focused on charred carbon-rich layers at 18 dated YDB sites across Asia, Europe and the USA. All contained very high-temperature impact material such as nanodiamonds, metallic microspherules, carbon spherules, magnetic spherules, iridium, platinum, charcoal, soot and fullerenes enriched in helium-3, a combination which cannot simply be explained by volcanic, anthropogenic or other natural processes. Of considerable significance is the occurrence of scoria-like debris of the type only found in close proximity to a cosmic impact or airburst. These have now been reported from YDB sites in a total of eight countries on four continents, suggesting that there may have been a widespread shower of extra-terrestrial bodies, rather than a single large one.

Although there have been challenges and complications to the Younger Dryas impact theory, two major papers in the Journal of Geology (*Wolbach et al., 2018, v.126/2*) review compelling, globally-sourced

The lake terraces known as the Parallel Roads of Glen Roy.

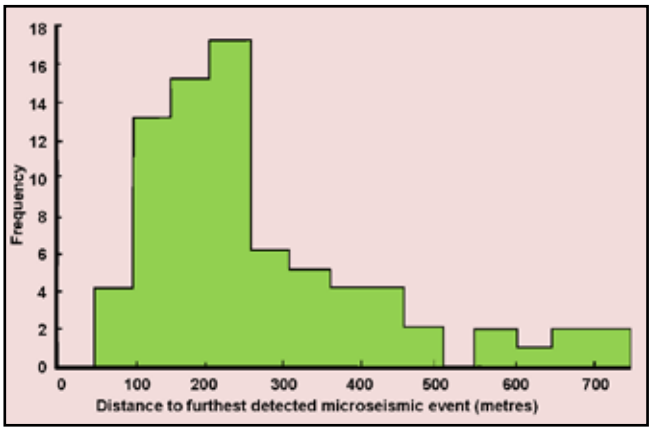
lines of evidence interpreted as showing that the Earth collided with multiple fragments of a 100-km-diameter disintegrating comet at the time of the Younger Dryas cooling. Geochemical signatures in Greenland ice cores, such as anomalously high concentrations of platinum, constrain the event remarkably closely to about 21 years spanning ~12,836–12,815 cal BP. Such a major and protracted impact/airburst event must have generated voluminous dust clouds, and there is evidence for this in four ice-core sequences from Greenland, Antarctica, and Russia, all of which show anomalous peaks in combustion aerosols such as nitrate, oxalate, acetate, and formate. According to Wolbach *et al.*, this reflects one of the largest wildfire episodes in more than 120,000 years, with some 9% of Earth's terrestrial biomass consumed.

Could it be that the cosmic event just happened to coincide with an abrupt climatic change that would have taken place anyway? Wolbach *et al.* think not: they estimate that the impact winter caused by the collision(s) would have been long enough to trigger Arctic sea ice expansion, rerouting of North American continental runoff, and changes to oceanic circulation – precisely the type of multiple climatic feedback considered by Renssen *et al.* to have ushered in the Younger Dryas Stadial. The absence of any obvious impact crater is not a deal-breaker, since, as hinted at by Bunch *et al.* (*op. cit.)*, the attributes of the Younger Dryas event could also be produced by multiple airbursts. Supporting this, Wolbach *et al.* note that the 1908 Tunguska cosmic airburst over Siberia, as well as destroying about 80 million trees and burning 500 km^2 of forest, also created features similar to those recorded in Younger Dryas boundary layers, such as magnetic spherules, meltglass, nanodiamonds and iridium concentrations.

There is a complication though. The Younger Dryas cooling also more or less coincides with the First (or Neolithic) Agricultural Revolution, which involved slash-and-burn techniques to create croplands. But was this sudden and widespread enough to cause the combustion peaks observed in the ice cores?

Problems of fracking-induced earthquakes

Last year's *Geobrowser* gave examples of how hydraulic fracturing could introduce fluids along nearby, critically stressed faults, causing their reactivation: a phenomenon already observed in the seismic activity recorded at Cuadrilla's pilot fracking site at Preese Hall, Lancashire (see *Geobrowser* for 2012). New research into this process was carried out by Durham and Newcastle universities using the microseisms generated during fracking at 109 sites in shale rock, mainly in the USA (*2018, doi.10.1007/s40948-018-0081-y*). Using advanced techniques to estimate how far the hydraulic fractures, and therefore by proxy the introduced fluids, extended horizontally from borehole injection points, they concluded that there is only a 1% chance of these fractures extending horizontally beyond 900 metres from an injection point.



Earthquake frequency plotted against distance away from fracking injection sites (After Wilson et al., 2018)

The implications of this are twofold: keeping within this distance from critically stressed faults would prevent them being reactivated by ingressing fracking fluids; furthermore, there would be a negligible chance for injected fluids or gases to enter a fault and rise upwards to contaminate shallow-level aquifers that may be used for public water supply. However this does not solve the problem of fault movements caused by waste-water injection into deep-lying aquifers, which is a separate process discussed in last year's *Geobrowser*.

This and other studies like it reviewed in previous *Mercian* issues, will feed in to the debate over whether fracking should be permitted in the UK. The research is particularly timely because in February this year the Government's Oil and Gas Authority overruled objections against Ineos Shale accessing land at the 3800-acre Clumber Park estate, near Ollerton, for the purpose of seismic exploration. With the benefits of modern high-resolution technologies the seismic profiles should pinpoint any fault affecting the shale source-rocks, and then model the structure in 3-D, thereby clarifying its stress condition and hence susceptibility for reactivation. Buffer zones could then be constructed to ensure that the fracking lines are at a safe distance from potentially unstable faults, although partitioning the resource area could complicate plans for exploitation.

It's a Square World

In April this year, Birmingham had the privilege of hosting the very first convention of the Flat Earth Society to be held in Britain. No doubt some of the 200 delegates would have found their way to the venue using satnav – which relies on satellites orbiting an essentially *global* Earth. One of the Convention's sponsors is an American organisation known as FECORE. They claim that '… mainstream science is severely hampered by faulty assumptions', the latter abounding on the colourful website describing their various 'projects'.

One convention speaker was David Marsh, a manager at a major NHS Supply Chain head office. He disagrees with the Big Bang theory, which is perhaps fair enough, but goes on to say that his own research '… supports

the idea that gravity doesn't exist and the only true force in nature is electromagnetism'. An impartial observer at the convention (*The Conversation, May 2, 2018*) noted that the speakers touted a multiplicity of competing models that included 'classic' flat Earth, domes, diamonds, puddles with multiple worlds inside, and even the Earth as the inside of a giant cosmic egg. Apparently the after-talk discussions were fairly minimal, and in this community it seems you can come up with all sorts of theories about the Earth's shape, without being seriously challenged. After all, how can a person who ignores or distorts facts, observations and even the fundamental principles of science be taken to task by another who does exactly the same?

In a Jeremy Vine Radio 2 phone-in programme, one of the convention speakers said that at first he thought the whole idea was ridiculous, but after 18 months of research decided that the Earth must indeed be flat. Based on a yacht in Penzance harbour, and therefore being of a nautical inclination, he suggests that the oceans could be confined by a giant wall of ice around the Earth's edges. Quite what happens at the tropical and equatorial regions, which can be rather warm, was not elaborated upon. Another caller neatly sidestepped the ocean spillage problem by suggesting that the Earth is one vast flat plane extending to infinity.

The extreme lengths gone to by some is exemplified by the exploits of a 61-year-old Californian limo driver, 'Mad' Mike Hughes. Mike constructed a steam-powered rocket in his garage, finally blasting off at a site in the Mojave Desert in March this year. Unfortunately he had to bale out at an altitude of about 560 metres, which was not quite high enough for him to prove that the Earth is flat (inews.co.uk, 25 March 2018). Undeterred, upon his discharge from hospital he is now crowd-funding for a more powerful, 2-stage system that will hopefully take him to an altitude of about 110 km. A rocket will be carried upwards by a gas-filled balloon, from which it will separate upon ignition, and one wonders what could possibly go wrong.

Of course the alternative theory, that the Earth is round, has been extant since at least the time of the Greek astronomer Eratosthenes (276–194 BC) and was proved, more prosaically, by Ferdinand Magellan's circumnavigation in 1519–22. But doubts have always persisted; indeed the Flat Earth Society boasts an ever-increasing membership. In explanation, *The Conversation* article noted that the level of discussion at the Birmingham convention mainly revolved around disenchantment towards existing knowledge structures, particularly those scientific institutions that supported and presented current Earth and planetary models. Creationist-type philosophies may play a part (see *Geobrowser* for 2013) in what is an essentially anti-establishment trend, much to do with the current resurgence of populism and 'fake news', and no doubt fuelled by the type of selective research facilitated by the internet.

Mike Hughes and his first rocket.

The cover photographs

Front cover

Image by Keith Ambrose of the Bantycock Quarry, at Balderton, near Newark, Nottinghamshire, of the Mesozoic succession exposed in the walls of the opencast gypsum mine.

The top 3 metres of brown, grey and paler beds are interbedded mudstones and limestones of the Barnstone Member of the Scunthorpe Mudstone Formation within the Lias Group. The lowermost limestone is mapped as the White Lias Formation of the Penarth Group.

Below, about 6 metres of the Cotham Formation appears as three distinct layers. The uppermost greenish grey unit is laminated calcareous mudstone, and the pale grey bed below is calcareous mudstone with siltstone and sandstone laminae. The lowermost, slightly darker bed is blocky calcareous mudstone.

The conspicuously dark grey bed is the Westbury Mudstone Formation, about 5 metres thick, forming the lowest unit of the Penarth Group.

The pale grey unit below, also about 5 metres thick, is the Blue Anchor Formation, the uppermost part of the Mercia Mudstone Group.

The red-brown formation at the base are mudstones of the Branscombe Mudstone Formation of the Mercia Mudstone Group. These are mainly blocky and structureless, but include some thin beds that are laminated. This formation includes thin beds of gypsum, the Newark Gypsum, and at least two gypsum beds are visible near the base of the face. The greenish grey bed near the base is a bed of siltstone.

Back cover

Images of America's red rock country on the Colorado Plateau of Utah and Arizona, from a lecture presentation by Tony Waltham to the Society in 2017.

In sequence from the top:
Monument Valley, seen from the top of Hunt's Mesa.
Antelope Canyon, near Page.
Spider Rock, 220m tall, in Canyon de Chelly.
Turret Arch, in Arches National Park at Moab.
Approach to Angel's Landing, above Zion Canyon.
Colorado River. seen from Dead Horse Point.
Goosenecks of the San Juan River.