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East Midlands Geological Society

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Front cover: Nottingham Castle Rock freshly exposed by removal of its blanket of ivy and shrubs; compare this with the photograph on the front cover of Mercian Geologist in 2004. Photo: Tony Waltham.

Back cover: Aftermath of the Christchurch earthquake in New Zealand (list of captions on page 283).Photos: Richard Hamblin (BGS, NERC).

Contents

Geobrowser 222

Vale – Alan Dawn 224

Great Stretton Erratic: Helen Boynton 225

From the Archives – Charnia 226

Mercian News 227

The Record 228

John Hunter and Richard Shaw 229
The Cressbrook Dale Lava and Litton Tuff, between Longstone and Hucklow Edges, Derbyshire

Martin Cross 243
Slope geomorphology and threshold slopes at Callow Bank, Hathersage, Derbyshire

Hugh S. Torrens and Trevor D. Ford 249
Elias Hall, pioneer mineral surveyor and geologist in the Midlands and Lancashire

Tim Colman 262
The last 50 years of mineral exploration in Britain

Jonathan R. Lee 274
Cool Britannia: from Milankovich wobbles to Ice Ages

Reports

Members' Evening, 2011:

Escape from Christchurch: Richard Hamblin 280

Ostracods of Groby Pool: Katy Gosling 284

Rock tour of Scandinavia: Ian Thomas 285

Excursion – Matlock Gorge: Lynn Willies 287

Excursion – Clitheroe reef belt: Neil Turner 289

Book Review 292

How we got our oxygen

The focus today seems to be mainly on global climate change, particularly the link between warming of the planet and the exponential increase of atmospheric CO_2 since the start of the Industrial Revolution. But in the long run oxygen is far more important because without it animals, and therefore us, would never have evolved in the first place. A number of studies are now linking the oxygenation of our atmosphere into a complex, long-drawn-out scenario involving plate tectonics, biological evolution and chemical reactions.

Most workers agree that by the end of the Hadean Period of meteorite bombardment about 3800 million years ago, the earliest atmosphere essentially consisted of hydrogen and oxygen – in other words water vapour. Much of this fell out as rain, and virtually the whole of the Earth's surface was covered by ocean. In these waters the first life-forms evolved as anaerobic bacteria. They did not need free oxygen, but with the sun significantly cooler than it is today they played a role in keeping the planet warm by releasing methane to the atmosphere (*Science, 2002, p.1066*). In this inviting situation, the cyanobacteria began to develop. The best-known are those that form stromatolites, living today but found in rocks dated to 3500 million years old *(Nature 2006, p.714)*; the super-abundant modern microscopic organism *Prochlorococcus* has also been identified as a living ancestor of the cyanobacterium (*Nature, 2003, p.1042*). The importance of these organisms is that they photosynthesize, releasing oxygen as a waste product to the local environment. But because early oceanic waters were rich in iron, there being no oxygen to combine with elements weathered from the adjacent landmasses, all of this released oxygen was initially combined into the iron oxides magnetite and haematite; this chemical process peaked at around 2500 Ma, when particularly voluminous banded iron formations were laid down.

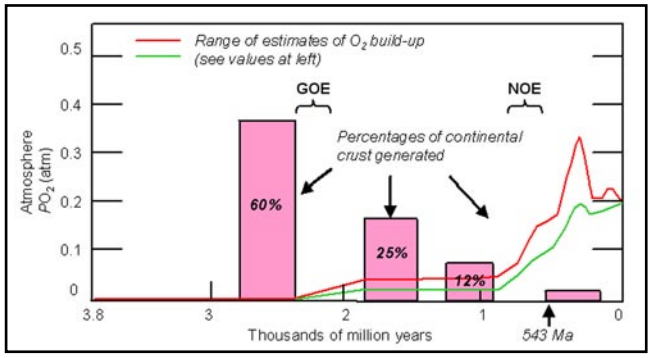
Stromatolites alive in Shark Bay, Western Australia.

Banded ironstone formation from Australia.

Plate-tectonic driver for the planet's oxygenation

Most of the major banded iron formations we see today immediately pre-date the first Great Oxygenation Event (GOE), which occurred between 2450 and 2200 Ma ago. This event is commonly attributed to the new availability in the atmosphere of photosynthetic oxygen (*Nature, 2004, p.913*); however, there was another factor, less obvious but equally important. Large tracts of shallow shelf seas were now in existence and they trapped sediment, including reduced organic carbon, thus preventing the capture of free oxygen from the water (*Nature, 2004, p. 913*). Secondly, they provided lagoonal environments for the type of cyanobacteria that make up modern stromatolites.

To form shallow seas requires the growth of landmasses and therefore of continental crust, which means that plate tectonics, rather than simple biological evolution, could be regarded as the principal underlying force driving oxygenation. This is the concept behind the theory of a Cybertectonic Earth (*J. Geol. Soc., 2007, p.*277); to some extent it opposes Lovelock's Gaia Theory (*Oxford University Press, 1979*), in which the importance of the biosphere tends to be unduly emphasized in the context of overall planetary evolution. As the graph shows, crustal growth has occurred incrementally (*J. Geol. Soc., 2010, p.229*) with the most productive phase, involving the generation of 60% of the planet's continental crust, pre-dating and thus possibly acting as one of the triggers for the Great Oxygenation Event. Following this, oxygen build-up

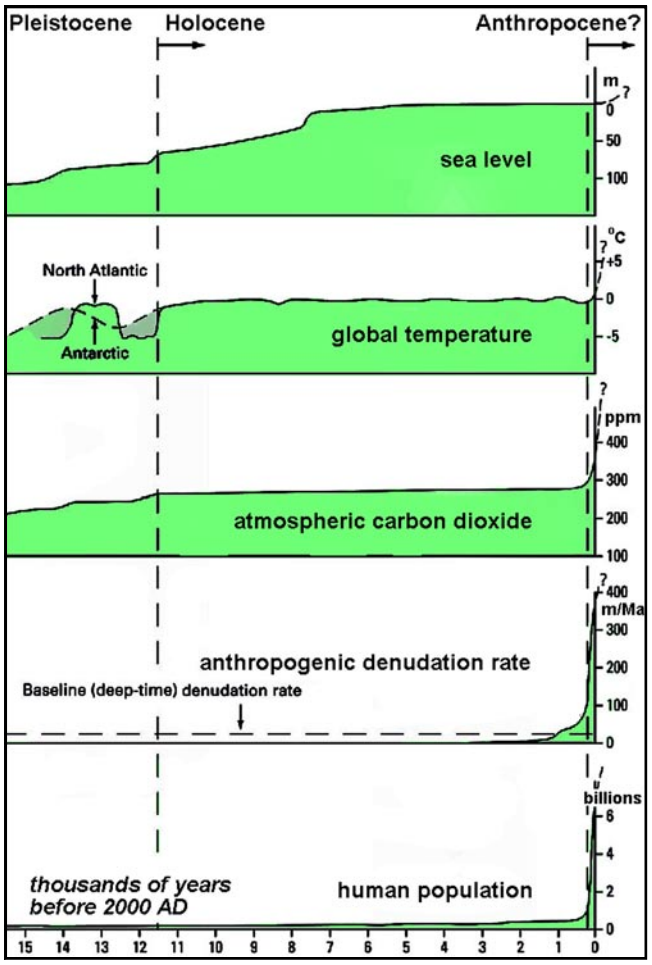


Oxygen levels correlated with continental growth.

levelled out in response to its involvement in weathering processes on the new landmasses, as well as in formation of the ozone layer. By Neoproterozoic times (600 Ma) however, these 'sinks' (to which oxygen was lost) had been largely filled and atmospheric oxygenation proceeded apace, resulting in the Neoproterozoic Oxygenation Event (NOE) (*Geol. Soc. Amer. Today, 2011, p.4*). This paved the way for the rise of animals in the final part of the Precambrian, and the explosive increase of animal life after this period had ended, 543 million years ago.

Anthropocene: a new geological epoch?

In 2000 Paul Crutzen, a Nobel-prize-winning chemist, made an off-the-cuff remark that the Holocene Epoch (the latest division of the Quaternary Period) had ended – to be replaced by the Anthropocene, in which the global environment has been changed by the effects of human development. The suggestion was taken seriously by others, and a recent publication by the Stratigraphy Commission of the Geological Society of London has discussed these effects in an attempt to ask whether such a new term can be justified by formal recognition, and if so, where and how its boundary might be placed.

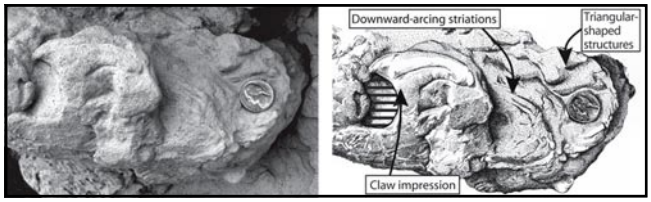


Parameters that may relate to the Anthropocene.

As yet there is no precise starting date for the Anthropocene, and until this is decided it must still be regarded as an informal term, albeit with an ever-increasing degree of usage. Certainly one could employ a number of criteria to measure and/or observe the first impacts of human development. Some suggest going back as far as 8000 years ago, when ancient farmers began to clear forests to grow crops *(Nature News, 10th December 2003*), but as the graph shows many of the more distinctive patterns we associate with human interference (e.g. atmospheric CO_2, anthropogenic denudation) would not have existed then. In a conference on the Anthropocene held at the Geological Society in London in May this year, others argued that 8000 years ago only one fifth of the planet's ice-free surface had been modified, whereas by 1750 AD not only was the Industrial Revolution starting but half of the Earth's biosphere qualified as being semi-natural and 'used'. The Stratigraphy Commission concluded that it may not be possible to set a date for the Anthropocene that would satisfy every criteria of human impact, but that a best guess around 1800 AD could be practical enough.

Digging for food: cunning dinosaurs

Perceived wisdom has it that large, lumbering dinosaurs rather stupidly laid their eggs in nests that could easily be robbed by nimble, quick-witted early mammals. With this type of scavenging, and then the meteorite impacts (*Geobrowsers passim)*, no wonder they were doomed to eventual extinction. However, features found in Late Cretaceous strata in Utah, USA, suggest that this was not always the case; before the K/T boundary extinction, dinosaurs were beginning to turn the tables on the mammals (*Geology, 2010, p.699*). In a sequence of overbank sandstones representing part of a fluvial floodplain, remarkable mega-trace fossils have been found, and interpreted as complex burrows. They commonly end in small chambers that the study compares with those made by modern rodents; but associated with the burrows are scratches and claw marks with a scale and morphology typical of a predatory dinosaur, probably a maniraptoran theropod. This study is the first to uncover dinosaur *strategies* for hunting burrowing mammals, as opposed to previous evidence of dinosaur predation such as bite marks, gut contents, coprolites and trackways.



Dinosaur trace fossil from Utah.

VALE

Alan Dawn 1923–2010

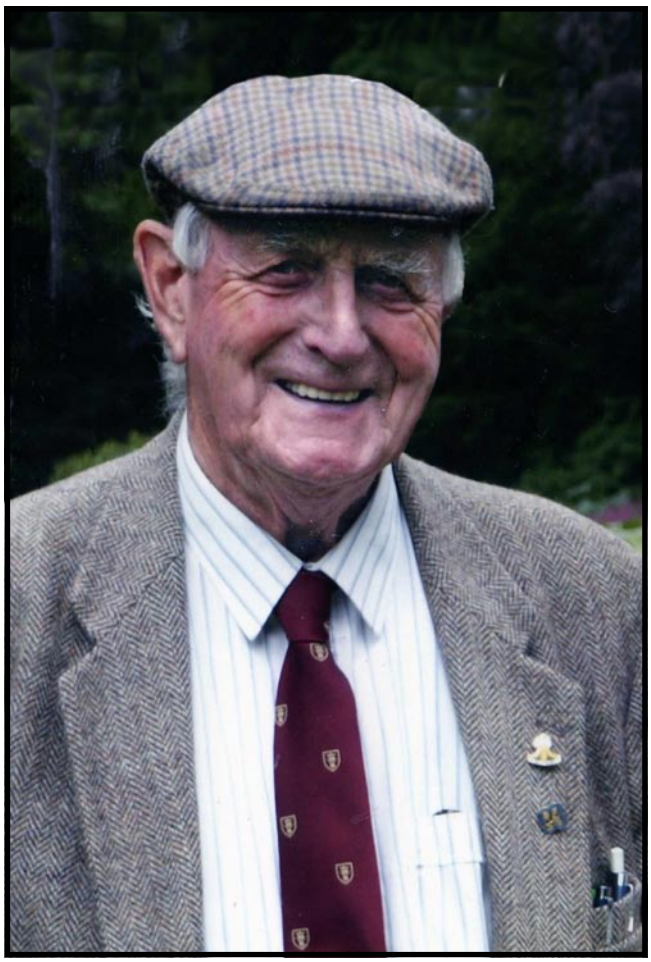
Born into a farming family near Sheffield, Alan was educated at the local school and gained a degree in geography at Sheffield University after an interruption to serve in the Royal Navy during the war. He went into teaching, with his first post in Stamford and then in Bourne. Alan Dawn was a great teacher, a gifted artist, a dedicated geologist and an enthusiastic orchid grower.

I first met Alan on a bus entering Monument Valley, Arizona. This was on the pioneering 1980 University of Nottingham geological field trip to Western USA. Alan was sitting across the aisle, and while most people were attempting to photograph though the tinted bus windows Alan was sketching. I was amazed how he could capture the essence of the mesas and buttes with a few strokes of his pencil.

The last field trip we both went on was much more recently, and was to the Isle of Eigg. Alan's legs were giving him problems so on the last stage of climbs he would sit down and take out his sketch pad until we returned. The end result was twelve views of Eigg on a calendar that was sold for a good cause.

Another chance meeting occurred at a British Orchid Society show where Alan was exhibiting. "Come to Stamford and see my collection" he said. When I did, I found him painting water-colours of geological exposures. These were preparation for the evening class that he taught. Rather than make sketches on the chalk board Alan would paint watercolours, photograph them and project the images for his students to see. I left with an orchid plant that still survives.

Although a member of the East Midlands Geological Society for many years, a regular contributor to the *Mercian Geologist*, a field trip leader and a speaker at Member's Evenings, Alan's geological legacy will be remembered through the Stamford Geological Society. He founded this thriving society with his wife Pauline, and was President for many years, inspiring so many with his hands-on, fieldwork-driven approach. With a small band of Stamford members, he was responsible for the creation of the Ketton Geological Reserve, and for the finding, excavating, recovery, conservation and presentation of numerous very large fossils, particularly ichthyosaurs, plesiosaurs and pliosaurs, from the Oxford Clay in the Peterborough brick pits. One of these projects, undertaken in conjunction with Portsmouth University, was the recovery of the enormous fish, *Leedsichthys problematicus* (Mercian, 16, 43) Another find was *Pachycostasuarus dawni*, a new species (Mercian, 14, 93). Much of the work was done at the Peterborough Museum where Alan was a volunteer and where the finds and replicas built by Alan and the group are now on display. Many of these feature backdrops painted by Alan. The group also unearthed



the Deeping Elephant from Pleistocene deposits and replicated it at the Museum; one tusk was 3 m long.

Alan's work has been recognized nationally. In 1990, he became the first recipient of the Palaeontological Association's Award for Amateur Palaeontologists, and in 1994 he was awarded the Foulton Medal from the Geologists' Association. Not one to specialize, Alan's last talk to the EMGS was on Member's Evening 2008, when he talked about zeolites in Icelandic basalts. He delivered the talk with his usual aplomb while separated from the audience by a table on which there was a very large mysterious object hidden under a cloth. A true showman to the end, on completing the talk he removed the cloth to reveal the largest plesiosaur skull I have even seen. It was his latest find. As someone said: *They don't make them like that any more*.

Alan Dawn will be greatly missed, and is affectionately remembered by many.

REPORT

The Great Stretton Erratic

The Great Stretton erratic boulder was found by Rod Branson in 2008. It lies near the hamlet of Great Stretton, east of Leicester, 400 m along a footpath leading south off Gartree Road towards Gorse Lane (NGR SK64980049). The stone had been lifted out of a drainage ditch by a tenant of the Cooperative Farms.

This large erratic has not previously been recorded. It is a metabasite (metamorphosed basic igneous rock), unusual in that has not before been listed within the glacial erratics of the Midlands. It was within the Oadby till, which is generally regarded as having been deposited by an Anglian glacier moving from the north or northeast. The erratics in this till are mostly Chalk or Jurassic, derived from East Yorkshire and Lincolnshire, along with Carboniferous pebbles from northeast England and a scatter of Scandinavian rocks, including rhomb-porphyry from the Oslo area.

The boulder is elongate, about 2.12m long, 1.24 m wide and 0.8 m thick, and weighs roughly three tonnes. It is rounded with weathered surfaces. Though smooth, one of the upper surfaces shows faint glacial striations, visible only when the light is good. On the rounded edge forming the crest there is a second, later, set of striations at an acute angle to the first. These two sets of striations may have been imposed either at the source or during transport.

The erratic is dense, pale to medium bluish grey, weathering to green and brown. There is a foliated, metamorphic fabric rock, as well as patches of coarse crystals and thin seams of fine-grained material; these represent pegmatitic and aplitic phases of a pre-metamorphic igneous rock of gabbroic composition. In thin-section, the rock is roughly foliated, greenish-grey and has a granoblastic texture with relict, coarse, greyish, ragged amphibole crystals in a fine-grained matrix. There are small acicular crystals of strongly foliated and pale greenish-yellow actinolite. Adjacent to the large amphiboles are pale gren to colourless pleochroic foliated flakes of chlorite. Fine granular aggregates of clinozoisite are associated with actinolite and chlorite. Talc and white mica occur as scarce flakes, mostly in chlorite. There are also large grains of leucoxene with euhedral shape but a granular polycrystalline structure; these are probably pseudomorphs of ilmenite. Small isolated crystals of titanite are intergrown with zoisite and amphibole. Albite is very scarce and there are rare apatite prisms. The lack of plagioclase is striking, and may suggest that the original rock was a medium to coarse-grained pyroxenite of Ca-rich gabbro.

Comparison of this rock with thin sections of British and Northern European greenschist facies metabasites has revealed no exact match (John Faithfull, pers. comm.). Samples from the Auchhoad Sill, Inverneil, Loch Fyne, are fairly close in mineralogy and texture. Another similar rock occurs at Conadh Mheadtonach, Ardrishaig, Loch Fyne. The source is clearly an area of deformed greenschist facies with metamorphosed basic intrusions. Comparable rocks are present in the Norwegian Caledonides. Derivation from the Loch Fyne area of western Scotland raises problems of how the Stretton erratic was transported across the country to be enclosed in the Anglian till of the East Midlands with its north to northeast derivation, so perhaps a Norwegian source is more likely.

Another large metamorphic erratic composed of "hornblende schist" was found in the Bassingfield gravel pits between West Bridgford and Cotgrave. No detailed petrographic description has been traced, but it appears to be a similar rock type. It was transported to Nottingham University Park by Swinnerton in 1947, who described it as a hornblende schist, and it now lies half-hidden in bushes close to the lake. Legend has it used for ceremonial purposes by Bronze Age man.

Thanks are due to Rod Branson, Andy Howard (BGS), John Faithfull (Hunterian Museum, Glasgow), Andy Saunders, Trevor Ford and Roy Clements for their help and advice.

Helen Boynton

The Great Stretton erratic.

The Bassingfield erratic.

FROM THE ARCHIVES

Discovery of the Precambrian Fossils in Charnwood Forest

Down Memory Lane with Trevor Ford

In May 1957, three schoolboys, Roger Mason, Richard Blachford and Richard Allen, were rock-climbing together in an old quarry in Charnwood Forest, when Richard Blachford found a leaf-like impression on an inclined bed of fine-grained sediment; a second impression was close by. Richard pointed them out to Roger, who had taken some geology classes and realized that the impression could be an important fossil find.

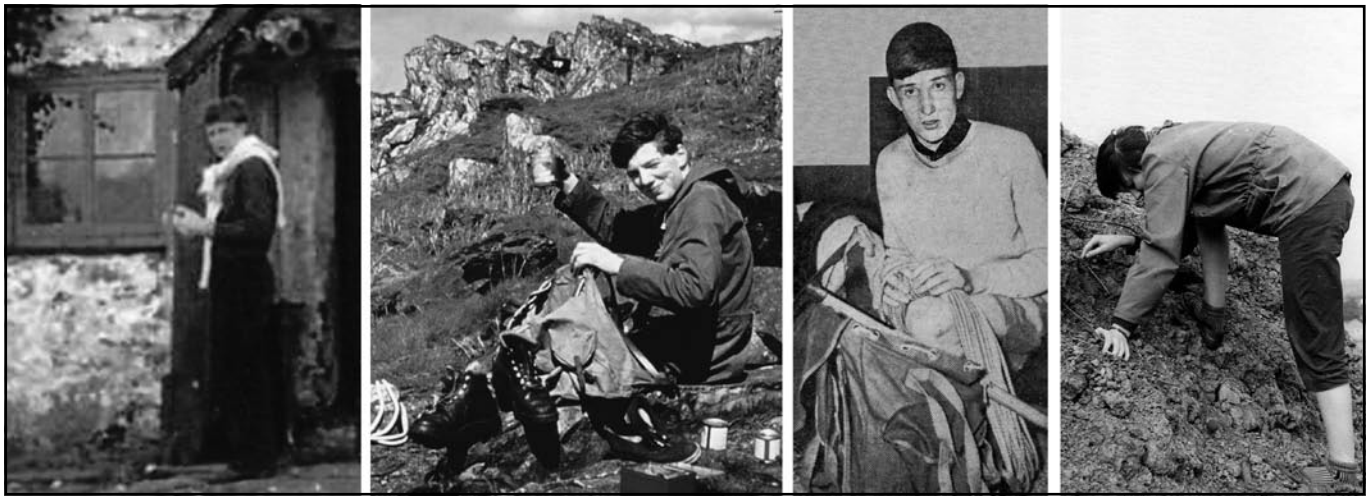
He came in to Leicester to report the find at the recently established Geology Department of the then University College. I happened to be the only member of staff around, and I was rather sceptical. To back up his claim, Roger returned on May 30th with a pencil-rubbing of the rock surface, and with his father whom I knew as a part-time member of the University staff. The three of us piled into the car, and drove straight out to Charnwood, where my scepticism was soon dispelled. It was a genuine trace fossil (with no body parts), an impression of a segmented, leaf-like organism some 20 cm long, unlike any other organism, living or fossil.

I took photographs of the fossil, and a week or so later showed them to my former lecturer Peter Sylvester-Bradley at Sheffield University (he was later the first Professor of Geology at the University of Leicester). He encouraged me to write a note for the Proceedings of the Yorkshire Geological Society, of which he was the editor. Thus the pioneer paper naming the fossil *Charnia masoni* and its companion *Charniodioscus concentricus* was published in a regional journal (Proc. Yorks. Geol. Soc., 1958, v.31, p.211-217); in hindsight such an important discovery ought to have been recorded in *Nature*.

Through the good offices of Colin Sizer (Leicester City Museum Keeper of Geology), his Director, Trevor Walden, and Sir Robert Martin (Lord Lieutenant of the County), arrangements were made to extract the block bearing the two fossil impressions. Two quarrymen from Mountsorrel used chisels, hammers and crowbars to lever out a block about two metres across and 50 cm thick. As it weighed at least 200 kg, we had to borrow a lorry to get it back to Leicester Museum. Unknown to me, Colin Sizer then took the block to a local monumental mason who had a carborundum saw a metre in diameter, with the intent of cutting the large block into more manageable pieces. He brought the saw up a little too sharply, so that it shattered. And the block split, leaving the *Charnia* impression on a slab weighing about 10 kg and *Charniodiscus* on two slabs separated by a joint; they could easily be fitted together. Thus, by good luck, the two specimens became more manageable, and remain the type specimens that are still housed in Leicester City Museum.

Subsequent research has revealed that ring-like markings had been found a century earlier, in 1848, but they had been dismissed as non-fossils by Victorian experts. Also, a schoolgirl from Grantham, Tina Negus, had seen the fossil when out picking bilberries, perhaps a year before Roger and his friends went climbing in the old quarry. On telling her geography teacher about her "fossil" at Charnwood, she was summarily dismissed with "There are no fossils in Precambrian rocks": contemporary science in the raw. Tina returned to the quarry the following year, but was dismayed to find that the fossil had gone. She only entered our story after she saw Roger in a television programme about *Charnia*. In between my first and second visits, in 1957, someone else had hammered the rock around the fossil, but we never found out who was responsible. It makes me wonder how many other people had seen *Charnia* and then said nothing.

When the news broke, the Director of the Geological Survey, Sir Cyril Stubblefield, and the chief palaeontologist, Dr F W Anderson, caught the next train from London, and we took them out to Charnwood, where they were amazed that the fossil had been exposed for about a century and nobody had reported it.



Richard Blachford *Richard Allen* *Roger Mason* *Tina Negus*

In the fifty years since my paper was published in 1958, comparable fossils have been found at several more sites in Charnwood Forest. Within only months of my original paper appearing, Professor Martin Glaessner of Adelaide, Australia, reported the discovery of comparable fossils in the Ediacara Hills, north of Adelaide. Unwittingly, I had beaten him to it by naming *Charnia* and *Charniodiscus*. A recent book was dedicated to me as "a founding father of Precambrian palaeontology".

Fossils comparable to *Charnia* have since been found in many other parts of the world, notably South Australia, Newfoundland, Russia and Namibia. I have been fortunate to visit the first two of these. The abundant late Precambrian fossils are now known from several remote localities in Newfoundland, where a nearby visitor centre attracts several thousand visitors each year. So far about a hundred species of fossil impressions have been named, mostly from rocks of comparable age, though accurate dating is not easy. An Ediacaran Division of geological time has been established to embrace the rocks now generally dated from 635 to 542 million years, i.e. latest Precambrian, also known as Neoproterozoic. This covers the period from the end of a global glaciation known as "Snowball Earth" to the beginning of the Cambrian. The ancient rocks of Charnwood Forest date from this period.

The biological affinities of the organisms which made the impressions are still controversial – are they plants or animals, or some strange in-between forms? Are they evolutionary ancestors of the fossil phyla found in Cambrian and later rocks? Or do they represent a "dead-end" phase of the evolution of life? Current opinion is that they are not ancestors of the Phanerozoic phyla, but the debate continues.

Trevor D Ford, University of Leicester

MERCIAN NEWS

Editorial

With the closing of this volume of *Mercian Geologist*, Andy Howard and Tony Morris have resigned from the Editorial Board. Both served for many years, and Andy took on the larger tasks of Editor from 1996 to 1999. The Editor and Council thank them both for their contributions to the Society. We welcome Keith Ambrose and David Bate as the new Board members.

Also with the end of the volume, the Editor places on record his thanks to Trevor Ford, Richard Shaw, Gus Gunn, Paul Lusty, Mike Rosenbaum, Tom Sharpe, Peter Fookes and Richard Hamblin for kindly reviewing submitted papers within the last four years.

In contrast with tradition, there is no index on the printed pages that close this volume. An index will shortly go on the Society's website, where it is hoped it will be more useful and accessible to the majority of researchers. Ultimately this index will become comprehensive, as new listings will be added at the end of each volume; and indices going back to the start of Volume 13 will also be added. An index for Volumes 1 to 12 was published in Volume 13.

Council has decided that the *Mercian Geologist* will continue to be published in print and distributed to all Society members and subscribers. Papers and reports in back numbers of the journal will go on the Society's website as free downloads after a date two years after their publication. The web pages at www.emgs.org.uk will therefore become the *Mercian Geologist* archive for all except the current and previous issues. We hope this will be welcomed by members and readers, and the Editor continues to invite contributions for the *Mercian Geologist* from both inside and outside the Society.

The quarrymen start work on the old quarry face to extract the block that contained the original frond and discs.

THE RECORD

Our membership now stands at 281, with an additional 32 institutional members, and we welcome the new members who have joined the Society during the year.

Indoor Meetings

As has become the custom, March saw the Annual General Meeting followed by a Members Evening. John Aram spoke of the varied geology that can be seen on the many Shetland Islands. John Jones described the geology, mineralogy and underground workings of the Golconda Mine and some of the artifacts left by miners from the 1915-1950 period. Gerry Slavin, Gerry Shaw and Brenda Slavin followed James Hutton's geological journeys in search of positive evidence to support his theory of *The System of the Earth*.

In April, Dr Haydon Bailey presented *The Forensic use of Micropalaeontology*, recounting its history and the part it played in providing evidence that led to the conviction of Ian Huntley in the Soham murder case.

In October, Howard Falcon-Long took us underground in America in search of the Carboniferous forested landscapes that have been preserved intact over huge areas.

At the November meeting we were invited to walk through time along the *Jurassic Coast* with Sam Scriven to view its geological record, see how the coast is interpreted and managed, and see the impact of its World Heritage status.

In December, Jan Zalasiewicz considered the thought-provoking subject of what the Earth would be like one hundred million years into the future and what evidence of the human race might be found there.

In January, Jonathan Lee gave us *Britain in the Freezer* with a long-term perspective of Quaternary Ice Ages including new evidence for the earlier glacial history of Britain compared to the record in other areas of northern Europe.

This year's Presidential Address in February was given by Tim Colman on the subject of *The Last 50 years of Mineral Exploration in Britain*, its problems and the change in focus in the search for different minerals during that time.

Field Meetings

The number of members participating in field meetings has again increased this year.

Our May visit was to a variety of locations in the Clitheroe area led by Neil Turner to study the origins of the Lower Carboniferous reef belt and the geological history of the area's fossils and rocks.

Our evening field trip to Bradford Dale, one of the lesser known valleys in the White Peak, in June, was led by Colin Bagshaw and Ian Sutton, as a walk to see limestone features together with examples of natural and industrial history.

As a follow up to his indoor lecture in 2008, Will Watts led a packed weekend visit in July, to the restored Rotunda museum (the subject of his talk), followed by a walk around William Smith's Scarborough and visits to locations along Yorkshire's *Dinosaur Coast* led by local geologists.

Another very popular visit to Chatsworth House was led by Ian Thomas and members of the Russell Society in October.

Keith Ambrose and John Carney led two visits to view Charnwood volcanic rocks over a weekend in September.

In October a guided underground visit to the Coal Mining Museum at Wakefield was led by Paul Guion

Council

There were five meetings of Council during the year. In continuing to support geodiversity, several members of Council have worked in the major monitoring survey that is currently underway into the condition, access and risk of RIGS in Derbyshire, Leicestershire and Nottinghamshire. The Society's Trust Fund, held to promote and support geological projects within its area, has been reviewed up-dated. Work continues on transferring the Mercian archive into digital format to make it available to a wider audience.

In conclusion I would like to thank all those I have not specifically named in my report who give much of their time and energy in order to further the aims of the Society.

We are, as always, grateful to Richard Hamblin for organizing this year's successful programme of speakers, to Gerry Slavin for co-ordinating our Members' Evening, to Gerry Shaw and his helpers for providing the refreshments, Ian Sutton for again organizing the programme of Field Trips, to the field trip leaders who so willingly give us their time and expertise, to Sue Miles for editing the Society's Circular, and to Rob Townsend for continuing to maintain and develop the Society's website.

Janet Slatter, Secretary

Notes for authors

Guidance notes for authors intending to contribute to the ***Mercian Geologist*** may be seen on, and printed from, the Society website (www.emgs.org.uk). Paper copies may also be requested by mail or by telephone from the editor for anyone without web access. Contributions are welcome from both members of the Society and non-members.