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Cover Picture: Leicester's High Cross and Highcross St. 1832
by John Flower.

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THE CHANGING FACE OF LEICESTER

Presidential Address delivered by A.F. Orton on October 6, 1986.

My Lord Mayor, My Lady Mayoress, Members of the Council and of the Society,

When I was invited to become President of this ancient and illustrious Society, I experienced a feeling of astonishment that I should be thought worthy of such an honour and to take the place of Mr. Lloyd-Smith, who has brought such a dignity and leadership to the Presidential office which I could not possibly match. I was, of course, proud to accept the invitation, because I was aware – who could not be? – of the influence of the "Lit and Phil" on the cultural life of the City since the Society's foundation a century and a half ago. Our surroundings tonight are a reminder of our founding of the Leicester Museums, our membership list includes names of many leading academic, professional and business figures of the City and County, and our link with the University of Leicester is, may I suggest, that of parent to child, though the child has now reached a very sturdy adulthood and keeps a benevolent eye upon its elderly relative.

I share with you, My Lord Mayor, the privilege of having been born in Leicester. My actual birthplace, Bond Street Maternity Hospital, has long since been demolished, and modern Leicester babies are now, at least in very many cases, born in the splendid new maternity wing of Leicester Royal Infirmary. I have spent my childhood, my schooldays and my working life as a teacher in this city which was described by Thomas Baskerville, a visitor in the eighteenth century, as "an old and stinking town set on a dull river".

I have kept during the last thirty years or so, a modest photographic record of some of the changes which have taken place in the City, and I thought it appropriate to share with this audience some of the memories of those years in this, my Presidential Address, which I have called "The Changing Face of Leicester". We may obtain some idea of the local scene one hundred and fifty years ago through the work of John Flower, our own local urban landscape artist, who lived and worked here from 1793 to 1861. He must have made a much better living from his drawings than artists are popularly supposed to do, since the house which he built in 1851 at 100 Regent Road is still a very imposing building, now used as a Social Centre by employees of the East Midlands Gas Board. By its side in 1973 still stood another pleasing building which, unfortunately, had suffered the kiss of death – 'Acquired for Office Development' – and was in that year demolished to make way for a more modern structure. This is the theme upon which tonight I shall show you a few variations.

John Flower's best-known picture is that of the site of the old High Cross, the original town centre. Several buildings shown in this print still exist, although most of them have been heavily restored. The imposing Borough Gaol in the centre of the picture has been replaced by a warehouse, but one of its walls was retained when the gaol was demolished in 1890, presumably to support the neighbouring shops – a tobacconist's and a locksmith's dated 1717 – in which the original dormer windows have been replaced by skylights. The site of the High Cross is marked by stones in the road surface, and if we look at Throsby's engraving of what the Cross was like in Tudor times, we realise how necessary it was to remove what was even in the eighteenth century a
considerable obstruction to traffic. In 1769 the Cross was reduced to a single pillar and then about 1830 removed altogether to the front of the Crescent, built in 1820 in King Street. The Cross suffered there at the hands of vandals, and at the suggestion of Alderman Arthur Wakerley (1862–1931) it was taken to his new house in Gwendolen Road for safe keeping until such time as a safe resting place could be found for it. This was the garden of the Wyggeston Chantry House in the Newarke. By 1977 the Leicester Rotary Club had raised a fund to restore the Cross to the City Centre and it was moved to its present site in Cheapside, despite some opposition from Market stall-holders. It soon became the target of more vandalism, but after some considerable delay the blemishes were removed and at the moment the High Cross seems free from the attentions of the aerosol-wielders.

The old Free Grammar School building of Flower’s picture narrowly escaped demolition. As a school it had fallen into disuse in the 1850s, became a carpet warehouse and was then abandoned to the occupation of tramps and pigeons. Then a Nottingham bus company took over the building, heavily restored it and turned it into offices for the company.

In 1877 the new Wyggeston Boys’ School was opened and the school occupied the premises in Highcross Street until 1920, when it was moved to the site which it now shares with the University, while the Alderman Newton’s School moved into the Highcross Street buildings. The school building once again became vacant in the 1970s and now houses the new independent Leicester Grammar School. The number of survivors of Canon Went’s school sadly diminishes year by year but there are still some of us left who had to cross Highcross Street for our Art lessons at Wyggeston House under the eccentric but effective tuition of George Spawton Catlow. This building later became a section of the Sanitary Department, which dealt with vermin of various kinds. It is now a Costume Museum, no longer concerned with schoolboys or vermin.

The face of education has changed over the years and we no longer see school photographs like those we have of Wyggeston Girls and their teachers and the severe atmosphere of an Elementary School class taking an Art lesson under the rather forbidding eye of the Art teacher and, in the background, of the Headmaster, who obviously wanted to know what was going on in his school. Responsibility for the two Wyggeston Schools and for other local Grammar Schools other than the new independent school has now been taken over by the County Education Authority, but the Wyggeston Charity still provides accommodation for elderly people at Wyggeston’s Hospital on Hinckley Road. We can no longer watch the Wyggeston Grammar School girls play tennis as they did in 1914, where we see them in their straw hats and the older girls with their long skirts, their adult hairstyles and their fish-tail-handled Slazenger rackets. This is now a shopping area and the old hospital buildings have been replaced with a very pleasing new edifice with an imposing chapel. The original Wyggeston Chapel was a neighbour of the Guildhall and the Parish, later Cathedral, Church of St. Martin. This is externally a Victorian Church, but the older parts of it date back to the twelfth century. It has a splendid tower and spire which were constructed in two parts in 1861 and 1867 to replace, in a correct Early English style, the old spire. The architect was Raphael Brandon. John Flower has left us a record of Southgate Street and the house of the Confrater, a Church official who was responsible for the physical well-being of the inmates of Wyggeston’s Hospital. Part of Southgate Street became rather shabby, despite the presence of the Consanguinitarium, built as a residence for needy members of the family of John Johnson (1732–1814), one of Leicester’s most famous and prolific architects. When this building was demolished, a new Consanguinitarium was built in Earl Howe Street, and is still in existence. Southgate Street in 1963 had some quite pleasing old
buildings, notably Mr. Sherwin's Shop. He was a shoe repairer, a cobbler who had the philosophical attitude to life often found in members of that trade.

For some years, the Coach Station in Southgate Street gave passengers what could have been a poor impression of Leicester if they were merely passing through, but we now have in our new St. Margaret's Coach Station one of the best in the country. With the exception of Wyggeston's House, all the old property in the rest of Highcross Street has gone. It consisted chiefly of timber framed houses with an outer brick cladding, the best-known probably being Freeman's, the Engravers.

The centre of our present City - indeed, of the whole world for many local people - is now the Clock Tower; but in the Middle Ages and right down to the eighteenth century this spot - Coal Hill to our fathers (to mine, at any rate) - was outside the town walls, and the real centre of the town lay further to the west where the Fosse Way, the Roman Road, crossed the River Soar and its distributaries by the West Bridge and the Bow Bridge. In the 1970s additional bridges were built alongside the existing ones, and the work involved with these and their approach roads meant the tearing out of this, one of the oldest parts of our City. St. Peter's Catholic Church and its ancillary buildings had to go, and a new church was built some distance to the west on Hinckley Road. King Richard's Road School, where I began my teaching career in 1931, was demolished in 1978 to leave no trace at the end of Tudor Road. A clean sweep of practically the whole area of housing and commercial premises between the River and Fosse Road left but one building standing, Emmanuel Baptist Church, founded in 1672 and closed for worship in 1972. This splendid piece of Victorian brickwork presented a problem to the planners, who do not seem to have known what to do with it. The solution came one night when the whole building went up in flames, burning like a volcano to leave a charred ruin which declined into a heap of bricks. But at least one brick survived as a souvenir of a fine Victorian building.

Of all the historical characters who have visited Leicester, King Richard III has probably left the strongest impression, though he stayed for only one night at the Blue Boar Inn on his way to Bosworth Field and his death. In 1520 the old inn (originally the White Boar) was showing signs of decrepitude, and it was soon to be demolished and replaced by unprepossessing Victorian shops. Further down Highcross Street stood a very elegant house at No. 90, but in 1971 it was bulldozed almost overnight. A new Blue Boar Inn was built in Southgate Street, only to disappear and leave nothing but a faint mark on the end of Stretton's factory to recall its existence. Even that mark has now been cemented over. Castle Street, formerly a through road, is now a quiet backwater by St. Mary's Church, where the young Henry IV was knighted in 1426. Much of the property heretofore has been demolished, including St. Mary's School, founded in 1785, with its charming figures of "two Charity Children in Coade Stone", a record for the sale of which is still in existence. Coade stone was a synthetic material invented by a Lambeth stonemason and used for the making of figures, vases, monuments, plaques, chimney pots and fire places, which were marketed at the end of the eighteenth century by the inventor's daughter Eleanor. The School was demolished in the 1970s to make way for a brewery. The Coade Stone figures, fortunately, have been preserved and are well cared for at a local Junior School. If we pass through the timbered arch of the Castle Gatehouse and the stone Rupert's Gateway (known more properly as the Turret Gateway) we arrive at the Trinity Hospital in time to accompany in civic procession the Lord Mayor of 1949, Alderman W. Wale, with his Lady Mayoress, his Mace Bearer, and other civic dignitaries on Trinity Hospital Sunday.

Throughout the City the face of Leicester has changed and the process continues. Clyde Street Wesleyan Chapel, with its school, has been replaced
by the Cardinal Telephone Exchange; Stead and Simpson's Italianate offices have been succeeded by a more modern building, while the Clock Tower is now dominated by a building which reflects modern tastes both in its architecture and in its commercial purpose.

But let us finish by returning to King Richard's Road to look at the Dannett Estate as it was in 1971, in 1974 and now - a very pleasant place in which to live. We will return into the old town centre along Braunstone Gate where the old and the new offer contrasting styles of commercial properties to what was the heart of the city for nearly two thousand years. We will stand where the Romans came to civilize the British and built a temple to Mithras to celebrate that civilization - a site now beneath the Holiday Inn!

A.F. Orton B.A.
38 Sybil Road
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LE3 2EX
1. Leicester Cathedral Church of St. Martin from New St. A Norman foundation with a new tower and spire by Brandon in 1867.

3. House at 100 Regent Road built for the Leicester artist, John Flower; now EMGAS Social Centre.

5. St Mary's School, founded in 1785 with Coade stone figures of charity children, 1788; later it was the Mass Radiography Centre.

6. High Cross in 1980, looking into Highcross St. Several buildings survive from John Flower's time.
MICRO ELECTRONICS IN MEDICINE

Professor N.R. Jones

Lecture delivered on 18th March 1986

We are all now aware of the micro electronics revolution and its effects on, for example, manufacturing industry and commerce. The changes brought about by this revolution are affecting medicine no less than other areas of our society.

First let me summarise the important changes which have taken place in electronics which are having such a great effect on the world today. After a false start in the 1930s (the cat's whisker radio), the modern age of solid state electronics really began with the invention of the transistor in 1948. Since that time there have been several important inventions in solid state electronics with different types of transistors, different materials, and, above all, the incorporation of many interconnected devices on one piece of semi-conductor which is known as an integrated circuit. The growth of integrated circuit technology, which has proceeded rapidly since the mid-sixties, has led to the decrease in cost and size of electronic systems of such significance that it has affected almost all aspects of modern life. This lecture describes how these changes are beginning to affect medicine and still include some speculation about trends for the future.

The reduction in the cost of electronic systems now makes it economic to provide multiple versions of diagnostic instruments which were previously supplied at a central location to be shared by many users. The obvious effect of this is in the decentralisation of services and the greater convenience and speed of access to diagnostic data. Less obvious but perhaps more important effects, however, are: on the design of the device itself in that it may be simpler to use but contain more inherent intelligence: the type of user who may now be a technician or the patient himself rather than a consultant; and finally on the type and amount of data generated. These considerations have led to entirely novel portable machines being proposed for measurements which were once only done in the laboratory, if at all, e.g. airways resistance meters, and to sophisticated methods of communications of data, e.g. arrhythmia monitors.

Part of this progression towards many small devices rather than few large ones derives not only from the reducing cost of the electronics but from the decreasing size, weight and power requirements. The obvious area of benefit from this consideration, however, is in devices which have to be carried by the patient or even implanted in the patient. Here again we see an expansion of new applications or enhancements of old applications as the main effects of the charges as rather than mere miniaturisation of existing devices. We see ideas for programmable implantable insulin infusers, gait analysis and other monitoring devices which include telemeters as well as an increase in the sophistication of heart pacemakers at the same time as we see their miniaturisation and an increase in battery life.

One of the most promising areas for the future arising from the miniaturisation of electronics is in functional electrical stimulation. Here I think we can look forward to seeing some degree of mobility and control returned to spinal chord injured patients arising from the use of intelligent stimulation devices which can be carried by the user. Several problems still have to be overcome, not least with regard to the design and placement of the electrodes for long term use.
Many of the examples already referred to contain some element of data storage and processing and it is in this area, computation, that microelectronics has had the most impact on society in general. The same seems to be true in medicine.

The high resolution imaging medicines which give low x-ray doses owe their success to computational power as do many important new machines in pathological testing and several other areas of diagnosis. The computer with its low cost data storage and manipulation capability is of great significance in medicine not only as part of a diagnostic machine, but for the keeping of patient records and for general hospital management.

In the future we can see problems continuing in the provision of up-to-date and reliable data and in the maintenance of data security. It is also possible to see the beginnings of a radically new and, to some, disturbing field of application; the use of Artificial Intelligence Methods on medicine, particularly expert systems techniques. It is now becoming clear that these ideas are irresistible and will result in considerable changes in many fields of the diagnostic and even the treatment process. The perfection of computer speech input and output may be important here.

An important consequence of the expansion of possibilities brought about by the development of the integrated circuit is the need for smaller, cheaper and perhaps disposable transducers. This has led to a secondary phase of development in microelectronics, the miniature sensor. Much of this again arises from semiconductor technology, e.g. the disposable pressure transducer and the chemfit, but much of the work these days is concentrating on the use of optical devices and the transmission of data down optical fibres. Miniaturisation implies localisation in terms of data collection, which can be an advantage. Implantable optical devices can be constructed so that no electric shock risks exist for the patient.

While the major future advances in medicine will arise from the sciences of biology and pharmacology resulting from possibilities of DNA manipulation and in the design of targeted drugs, engineering will also play an important role. Engineering will, in addition, contribute to the main line of developments through contributions to new biosensors such as the DNA probe and to the art of measuring very small quantities.

The future of micro-electronics can be seen in the sub-micron circuit elements made from a variety of semi-conductors. Some of these devices will operate at very high speed (the Josephson Junction for example can switch in less than $20.10^{-12}$ seconds). The future may also hold strange new miniature devices derived from biological molecules. The possibility of using whole biological systems for sensing and computing is being actively researched. Such solutions, if they can be realised, are likely to provide a compatibility with life which will provide new opportunities in medicine and perhaps even provide useful direct interaction with the brain.

Received 11th July 1986

N.B. Jones
Department of Engineering
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HALLEY'S COMET - A ONCE-IN-A-LIFETIME EXPERIENCE

Heather Couper, BSc, FRAS

President, The British Astronomical Association,
Lecture delivered on Monday, October 20th, 1986.

I propose to start my lecture with a little poem. Composed around 1910 it goes like this:

"Of all the comets in the sky,
There's none like Comet Halley.
We see it with the naked eye
And periodically."

Comets in general, and Halley's Comet in particular, have fascinated mankind for ages. Why? Why have we always looked at comets in great awe, in fascination and in fear? I cannot answer that question; all I can do is to show you, by pictures going back thousands of years, how comets have always captured the imagination of mankind.

Comet West which was visible in 1976, had a fan-shaped tail and was discovered by Richard West, of the European Southern Observatory in Chile. But at the moment, the place for discovering comets is Japan. The Japanese, with electrically heated slippers, sit outside in comfort with their enormous binoculars and hunt for comets. This explains why many comets bear Japanese names. Up to three independent discoverers can be commemorated in a comet's name, and one recent comet bore the memorable name of Comet Tago-Sato-Kosaka.

But to return to Comet West. It was a truly awesome sight in the sky. To make things clear right from the start, comets hang in the sky like daggers about to strike. They do not streak across the sky like shooting stars or meteors. In the dawn sky of 1976, Comet West hung suspended like a ghostly fan - and its tail stretched across several Moonwidths of the sky. Unfortunately the media did not get on to it and so nobody ever heard of it.

But what about comets in the distant past? One of the earliest records of comets goes back to around 183 BC. It's actually an encyclopaedia of comets collated by the Chinese, printed on silk. The Chinese had a particularly wonderful name for comets. They called them hairy stars, because in their sketches they look like little stars sprouting hair.

The main point about comets, throughout all of history, is that they made people fearful. They were regarded as portents of doom and destruction because they were unpredictable and nobody knew what they were. People thought they were something very close by - within the earth's atmosphere, in fact. There's a French engraving of 1857 which conveys this doomsday image very vividly. It portrays a comet hurtling in from outer space and ripping the world in two straight down the middle of Africa.
It's easy to dismiss all this as amusing superstition, but a comet could look like a terrifying thing. In fact only the other day I was talking to a nurse from Leeds. Coming back from the hospital, early one morning, she looked in the sky and saw Comet West. Not knowing what the ghostly object was, she was extremely frightened. Fortunately her husband knew a little about astronomy, and was able to explain what she had seen.

Comets are, like planet Earth and the other planets, members of our Solar System. The Solar System is our backyard in space. At its heart is our local star, the Sun. It's an ordinary star, very average indeed, and circling it are the planets Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune and Pluto.

But where do comets fit into this scheme of things? Remember that the planets go around the Sun in nearly circular paths, all in the same plane. Comets usually have very elongated orbits and arrive from directions often well above or below the planets' plane. Nobody has ever been able to track a comet back to its source, but it looks very much as if they have their origin a long way out from the Sun, perhaps a good fraction of the way towards the nearest star. Because they can come from any direction, it would seem that they are distributed in a gigantic but tenuous cloud which surrounds our planets in a kind of amorphous sphere. So while the planets have a flat distribution, the comets have a spherical distribution. The cloud has been named the Oort Cloud after the brilliant Dutch astronomer Jan Oort, who postulated its existence many years ago. Astronomers estimate that the cloud may contain up to one million million comets.

What does a comet look like in its 'raw' state? We don't know. By the time a comet passes close to Earth, it is all fireworks - under the heat of the Sun, the comet obscures itself under an impenetrable shroud of boiling gas. For most of the comet's orbit, this boiling shroud must lie frozen on the comet's surface. The problem is that in this 'naked' state, the comet is too far away to be observed. So our ideas of what a naked comet looks like are inspired guesswork. Most astronomers agree that comets are largely made up of ice. Mixed in with the ice are chunks of rock and dirt - giving rise to the description of a comet as a 'dirty snowball'. Most of these 'snowballs' are thought to be about 10 km across.

Why don't naked comets live happily in the Oort Cloud for ever and ever? The answer is that the comets in the cloud feel the gravity of the Sun only very weakly. They can be dislodged by the extremely gentle pull of a passing star. Nudged by the star's gravity, one of the comets take a path that sends it hurtling towards the Sun. Once launched, most comets never return to the Oort Cloud. Held down by the strong gravity of the Sun and planets, their fate is to cruise the Solar System on elongated paths until they finally wear out.

Before I leave the Oort Cloud behind, many of you are probably wondering where it came from. As I said earlier, it is a cloud of a million million frozen comets - in all likelihood, material which was left over from the birth of the Sun and planets some 4.6 billion years ago. It is virgin material which has been unaltered since our Solar System's birth. If you could grab hold of a comet and find out what it is made of, then you would be looking at material which has not changed in four and a half billion years. It would give us invaluable clues as to what formed the Solar System in the first place.

In its long, long dive towards the Sun for most of its journey a comet remains frozen, a ball of ice just a few miles across. As time goes by, however, the comet draws closer to the Sun, accelerating as it goes. As
it enters the inner Solar System, it begins to feel the warmth of the Sun's rays. Its icy surface begins to evaporate, and that's when the comet starts to grow an enormous head, or coma, of gas around itself.

It's here that the comet begins to feel the power of the solar wind, a gale of charged atomic particles streaming out of the Sun at many millions of miles per hour. Buffeted backwards by the force of this wind, the gases from the comet are driven back in a long tail. As it rounds the Sun, tail streaming, the comet has its few weeks of greatest glory.

Every time a comet round the Sun, it loses a bit of itself. It is calculated that every time Halley's Comet goes around the Sun it loses about one metre of its surface, which corresponds to two hundred million tons of ice. But there's plenty left! And it is not just the ice which is boiled off; the dust grains which give comets their 'dirty snowball' tag are driven away, too. In fact, the most spectacular comets of all show two tails: a straight gas tail pushed directly back by the solar wind, and also a dust tail composed of tiny particles of cosmic 'soot', which curves around the comet's orbit. So a textbook comet has an enormous coma which may be, at its best, the size of the Sun; a blue gas tail perhaps fifty or sixty million miles long; and a yellowish dust tail of a similar kind of length.

But to Halley's Comet, and to the question astronomers are being asked every day: how do you pronounce the great man's name? It is spelt H A L L E Y, so it is almost certainly not pronounced 'Halley'. Historians have unearthed a number of receipts made out to a Mr. Hawley, so it is quite possible that when Halley was alive he did actually pronounce his name, or people pronounced his name, 'Hawley'. Halley was one of the greatest British scientists of all time. He was unfortunately over-shadowed by his contemporary, Isaac Newton; but with the coming of his comet, we get the chance to put the record straight. He was born in 1656, and died in 1742: a life time of eighty-five years. By all accounts he lived well, and was much loved: he was kind, diplomatic and had a tremendous personality.

After two years at Oxford he joined an expedition to the Southern Hemisphere to help astronomers map stars you could only see below the equator. These were virtually unknown as practically all astronomers had until then been based in the northern hemisphere. Halley — in the nicest possible way — was always an opportunist. To gain favour with the King — Charles II — he decided to name a southern constellation pattern after him, and informed the Monarch of this on his return to England. Charles was flattered, and in return, instructed the authorities at Oxford to award Halley his MA degree without his having to do any further work. It was an auspicious beginning to a very chequered, yet distinguished, career. He was an editor; he patented a diving bell; and he translated the classics; he was the first person to work out life expectancy tables. So bear Halley in mind when you look at your life insurance papers! He was also fascinated by meteorology and geophysics. In fact the geophysicists claim him for their own, but astronomers, I think, have first claim. As if all this were not enough, he was also a diplomat par excellence. He was sent on several trips abroad to intercede and negotiate on behalf of the English King. But his real love, if he really had one, was the sea. One of his main claims to fame is that he was the only civilian ever appointed a sea captain in the British Navy; he actually skippered his own ship in an unsuccessful attempt to work out a method of determining longitude at sea.

Because of his naval and diplomatic experience, he was given the task of looking after Peter the Great, the Tsar of Russia, when he came to learn the art of British shipbuilding, which, at around 1700 or so, was the best
in the world. The Naval Dockyards were at Deptford on the Thames - Deep Ford - a village which has gone sadly downhill since its great days. There is a splendid Victorian painting by Daniel Maclise which shows the scene at Deptford in those days, King William III - small and dapper - is visiting. Peter is also there, huge and uncouth, like a navvy. With him are his "companions" - a dwarf, a monkey, a coloured boy and a young Drury Lane actress about whom the less said the better.

To return to Halley and his comet; he saw 'his' comet for the first time in 1682 when he was a young man, observing it from his back garden in Islington. Very much later he became involved with the work of Isaac Newton, his friend and his contemporary. If it hadn't been for Halley, Newton probably never have made public his findings about the nature of gravity. Halley bullied Newton to publish them - and eventually ended up financing the whole operation. Anyway, Halley wondered if comets were subject to the laws of gravity. He looked at records going back many years for his 'own' comet and many others. The first conclusion he came to was that comets did not move through the atmosphere, but were far out in space. Then he predicted that, like planets, comets moved in orbits about the Sun. Then came his masterstroke: he calculated that several comets - the 1682 comet amongst them - would return when their orbits brought them back to the Sun again. Most of Halley's work on comets was done near the end of his life, because, when he was sixty-five years old, he was appointed Astronomer Royal. He vividly remembered the comet of 1682, and on calculating its path through space, he saw great similarities between a comet that appeared in 1607 and one that was seen in 1531. These three objects, suggested Halley, were in fact one and the same, and furthermore, it returns to the vicinity of Earth at roughly 76-year intervals. Halley correctly predicted that it would return again in 1758. Thus Halley's Comet acquired its name.

Halley's Comet comes back to us every seventy-five or seventy-six years, depending on whether it has had a close encounter with a giant planet which may have changed its speed. Its orbit takes it outside the path of Neptune and inside the orbit of Venus.

In common with its fellows, Halley's Comet is now trapped amongst the planets by the gravity of the Sun, but it betrays its far-off origins, for its orbit makes an angle of 18° with the plane of the Solar System: evidence that its birthplace is not amongst the planets. Now, it has become a regular visitor to the inner Solar System.

We now have a record of thirty returns. If I could actually have lived during a particular return, I would have liked to have been around in AD837. It's then that the comet approached us more closely than at any other time in recorded history. It's quite the opposite of the present encounter which - because of the Earth being in the wrong place - is the worst for 2,000 years. In AD837, the comet approached to about three million miles away only fifteen times further away than the Moon. Just to put that in real terms, what must it have looked like when it came closest to the Earth? At that distance, the comet and its tail would have literally covered half the sky. Just imagine your feelings if you did not know what it was. Remember that people then believed that comets were atmospheric phenomena; the comet must have appeared poised to strike at any moment. At its closest, it would have moved over a third of the sky in twenty-four hours. Close approaches like this have given comets their terrifying reputation in folk memory.

The most famous sighting in the whole of history was that of 1066. Everyone is familiar with the representation of King Harold of England on
the Bayeux Tapestry. Around him his nobles gather excitedly, pointing to the comet passing overhead. Harold sits on his throne, disconcerted - while beneath him are the ghost ships of the French fleet which would lead to Harold's death and the conquering of England. “Istimirantur Stellam” reads the inscription - "They marvel at the star". According to legend the 1066 apparition of Halley’s Comet changed history.

Another famous sighting was in 1301. Halley’s Comet inspired the Florentine painter, Giotto di Bondone, to use the comet for the Star of Bethlehem in a nativity scene though this is unlikely to be correct because Halley’s Comet came around too early in about 128 BC. Jesus was born in 5 BC or 7BC, depending on the calendar system you use.

The first recorded scientific account of its passage was in 1531, among the sightings Edmond Halley took into account in making his prediction that the regular "comets" were all one and the same thing. In 1531, the comet was observed by Peter Apian, in Austria. On subsequent nights in August 1531, he made drawings of the comet, noting the position of the recently-set Sun below the horizon. Although the angle of the setting Sun changes, the comet’s tail in every position faithfully points away from the Sun. Although Apian did not know the explanation, he was the first person to demonstrate that a comet’s tail always points away from the Sun, no matter in what direction the comet is travelling.

In 1835 some splendid drawings were made by John Herschel, brilliant son of the renowned William Herschel, from the Cape of Good Hope. Herschel’s pastel drawings show jets and streamers emerging from the head of the comet.

The last sighting of Halley’s Comet before this one, of course, was in 1910. The classic photograph shows it next to the planet Venus, its tail streaming into space. At its best, the comet’s tail stretched across 25 degrees of sky; more than a quarter the way from horizon to zenith. It was undoubtedly a very spectacular object and many people who saw Halley’s Comet in 1910 remember it as if it was yesterday. The comet was at its best from April to June 1910. On 20th May it actually passed in between us and the Sun. As it passed in front of the Sun, astronomers looked at it very carefully, hoping to see the comet’s tiny nucleus against the bright solar disc. It’s ironic, really: when a comet is in its frozen, ‘natural’ state, it is too far away for us to study; when it’s close to us - and therefore close to the Sun - it hides its secrets under an enormous coma of gas. The 1910 transit of the Sun was, then, an excellent way to get to "peer inside". The result - alas - was negative: nothing at all was seen. Also on that day in 1910, the tail of Halley’s Comet actually brushed the earth.

The comet also generated all kinds of interesting commercial paraphernalia which I have come to call “Halleyphernalia”. Cigarette cards; jewellery; music; even cartoons. Everybody jumped on the bandwagon: advertisers, songwriters, you name it! There were some glorious 1910 advertisements, promoting everything from yeast through fountain pens to champagne.

And now the comet has visited us again. It was first seen on this present return in October 1982. There was an unofficial race amongst astronomers to be the first to catch it, and the telescope which won was the 200 inch or 5 metre Hale telescope on Palomar Mountain in California - the world’s second biggest telescope. The ‘recovery’ photograph was hardly sensational to say the least. It showed the comet, twenty million times too faint to be seen with the naked eye.
Halley's comet crossed the plane of Earth's orbit at an angle of 18° on 27th November, 1985. So if you like, it came 'up' from 'down under'. Unfortunately, the comet moves in the opposite or 'retrograde' direction to the Earth, and so, as the comet gets brighter, we draw away from it. When the comet was closest to the Sun on 9th February 1986 - within the orbit of Venus - the Earth was on the opposite side. After perihelion, the comet re-emerged from the Sun's glare and the Earth swung round to meet it. The comet and the Earth were at their closest - about 40 million miles apart - on 11th April 1986 but it was only visible to those in or near the Southern hemisphere, because of the geometry between the comet and the Earth.

At the start of November, it was just above the constellation of Orion the Hunter - one of the two patterns in the sky that most people can recognize. Then it moved westwards until it was below the Seven Sisters or Pleiades star cluster in mid-November. In early December - it slowly moved beneath the big, barren Square of Pegasus. After mid-December it was increasingly hard to spot because the Moon got in the way. After that it moved behind the Sun, and was lost in its glare. When it re-emerged at the beginning of March, it was unfortunately too far south for us to see. I flew out on Concorde to New Zealand for my southern views. Imagine seeing the comet from 60,000 feet! On 11th April Halley came closest to Earth on this visit. That's when it was at its best and its gas and dust tails extended across 20° of sky. After this, it grew fainter.

Poor comet! Have you seen some of the hype that has pursued it on this occasion? Those Halley's Comet Gala posters all over London! And did you know that Halley's Comet has run in the London Marathon? It did quite well. It was not quite travelling at 150,000 miles an hour, but it nevertheless covered the course in a very respectable three and a half hours. The 'comet', incidentally, was Ian Ridpath - an astronomy writer and keen marathon runner. I don't think his tail got too tangled!

This time around, however, there was one thing that Halley's Comet had not seen before. On this occasion it was visited by no less than five space probes: two Russian, two Japanese and one European. The two identical Russian Vega probes were first off the mark. They were launched in 1984 on a trajectory which took them past the planet Venus. When they got there, they dropped off landing craft and balloons into Venus' atmosphere to check on its composition and density. Incidentally, there is a great deal of unwritten collaboration between the Soviets and the Americans, and American radio telescopes were used to track the balloons as they went down. Having dropped their cargo, the probes went on their way towards the comet. They encountered it at a distance of about ten thousand kilometres in March 1986; Vega 1 on the 6th and Vega 2 on the 9th. The Vegas got some really excellent photos of Halley's Comet.

They were much closer than the two Japanese probes, Suisei and Sakigake. The main probe, Suisei, passed about two hundred thousand kilometres away from the comet, while Sakigake was about five million kilometres off. They both got there about the same time, around 8th March, 1986.

The important thing about these probes is that they returned data to help us Europeans know where to aim our Giotto. It's named after Giotto di Bondone who, you will remember, painted Halley's Comet in 1303. And although it is a European probe which was launched on an Ariane spacecraft in July 1985 Giotto was actually built here in Britain at the British Aerospace works in Bristol. Incidentally, if you'd like to see what it
looks like there is a full-scale replica in the 'Spaceworks' exhibition at the National Maritime Museum, Greenwich.

Giotto successfully met Halley’s comet on the night on 13/14th March, 1986, and there was wide television coverage of the event. It went right into the coma and, as was feared, the bombardment with dust particles at a relative speed of 150,000 miles per hour caused some damage. All contact was lost for a few minutes, and the television camera failed to recover but many of the other experiments went well.

At first, the TV images didn’t provide a very clear idea of the comet’s nucleus. Scientists had expected the nucleus to be quite bright, and Giotto’s camera was programmed to home in on the brightest features it could see. However, after computer processing, the brightest regions were found not to be the nucleus at all, but jets of hot gas emerging from it instead.

The nucleus itself was found to be completely jet-black. It is the blackest object in the Solar System: an avocado pear-shaped lump measuring 17x9x5 km. On it, you can see tiny craters and vents where the gas is escaping – there’s even a "mountain" 1/2 km high – but overall, the nucleus is very smooth.

What intrigues astronomers most about the nucleus is its extreme darkness. It appears to be coated in a tarry "gunge": a carbon-rich substance similar to that which makes up meteorites called carbonaceous chondrites. It is yet more evidence that complex organic compounds are common in space – with all their implications for the origin of life on Earth and elsewhere in the Universe.

Giotto has made astronomers anxious to sample another comet. Is Halley’s typical? We won’t know until we investigate another comet at close quarters and, possibly, obtain a sample of its material. Any sample return mission would have to be international – the costs would be far too great for one nation alone to bear – but the Giotto mission has given us considerable practice in international space collaboration.

The Giotto mission was outstandingly successful and, for the first time, we have been able to study a comet in close up. Had it not been for Giotto (and the Vega probes, of course), we would all have remembered the comet’s 1985-86 visit with this rhyme:–

Of all the comets in the sky  
There’s none like comet "Hawley".  
We see it with the naked eye  
But this time, rather poorly.

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KORA - KENYA'S LAND OF FRANKINCENSE, HENNA AND MYRRH
- A NATURAL HISTORY OF THE KORA RESERVE

Malcolm Coe

Lecture delivered on January 19th, 1987
to a joint meeting of the Society and its Natural History Section

The Kora National Reserve lies NE of Nairobi, between altitudes of 900 feet and a little under 2000 feet. It is bounded by the Tana River in the north, the Mwitamysi dry river bed on the east, and the North Kitui Reserve in the west. It comprises an area of about 1700 km², which is dominated by Acacia-Commiphora scrub, whose canopy cover varies between 40% and 80%, comprising the least disturbed of this important habitat in the whole Tana River Basin.

The Kora Research Project was a joint endeavour between the Royal Geographical Society in London and the National Museums of Kenya in Nairobi. Its aim was to provide an opportunity for UK scientists to work alongside their Kenyan counterparts, in building up an inventory of the biological and physical attributes of the Kora National Reserve, in order that the Wildlife Conservation and Management Department of the Kenya Government can draw up a Management Plan for the future management and utilisation of this important region.

Kora is best known as the region where George Adamson and his collaborators have lived since 1970, to continue his important work of rehabilitating captive lions for life back in the wild. Indeed the protection of this area of pristine bush is entirely due to Adamson's work, and its gazetting as a National Reserve in 1973 was entirely due to his presence.

The RGC-NMK base camp was sited on the Tana River 35 km from George's camp, where our presence provided a protective presence in the west against poachers and intruding pastoralists. From here we studied the flora and fauna of the Reserve, recording 711 species of flowering plant, despite the severe drought, which had struck the whole Sahelian region between 1982 and 1984, when only 4 inches of rain fell in 2 years. These ground studies were complemented by satellite studies carried out by NASA and the United Nations Environment Project. Further habitat and geomorphological studies were complemented by low level aerial survey, which provided a valuable source of background data for the field scientists.

In addition to George Adamson's lions, which provided a constant source of interest and a spice of danger, as they patrolled the fence of our camp at night, the area proved to be a haven for carnivores, with a healthy cheetah population (perhaps the best left in Kenya), and many caracal, serval, other wild cats and two packs of wild dog. Large herbivores were at low density in such thick bush, but the Gerenuk, Lesser and Greater Kudu antelope were common, while elephant herds totalling up to 700 individuals are beginning to have an impact on tree cover, through their destructive feeding.

Some of our more interesting studies were of the isolated rock outcrops on which we could observe evolution in action, for their isolation in a "Sea of Savannah" has led to the development of a large number of endemic plant and animal species, including the flat-headed bat, the pancake tortoise and the hairy fly - a unique insect that feeds on bat guano in rocky cracks. These
rocky islands possess rock pans in which many animal and plant species pass through their short life histories when they fill with rain, following the infrequent showers in the region.

Plans to build a dam in the Reserve were an important part of our studies, which included research on the insects of the river banks and the impact that changed water-flow rates and levels would have on the endemic fish fauna. The pressure from subsistence agriculturalists in the west and intruding pastoralists with livestock poses an even more immediate threat in the east and south and the damage to the bush and tree cover from browsing domestic stock, poses the most severe immediate threat.

Further studies of the resins of the 12 Commiphora species, and the gums of the 13 Acacia species hold out the possibility that we can find commercial uses for these plant products, in the hope that their collection by pastoralists will find a new source of income, thereby preventing tree felling, and hopefully reducing the numbers of domestic stock in the region. In the long term however, the prospects are bleak, unless the Kenya Government are willing to institute a population policy, which will reduce the pressure on these fast-dwindling areas of pristine wilderness.

A popular account of the Project is to be found in the author's "Islands in the Bush", published by George Philip in 1985, and in "Kora: An ecological inventory of the Kora National Reserve" - published by the Royal Geographical Society in 1986.

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Ravenna, not without sound reasons, has been called the City of The Mosaics. Not one place can be found, neither in the East, nor in the West, where so many ecclesiastical buildings have been preserved in so small a place, of such venerable age, and in such perfect condition. Their glory and uniqueness, however, are their mosaics on the inner walls, reflecting not only the command of their craft by the artists who created them, but the spiritual involvement, as well, through which their work completely conveys the hopes and longings of the times in which they lived, inspired by the message which a new religion brought. Rome and Greece - essentially - never lost their impact upon the shaping of European life and art that took place in this period, despite the fact that they could not satisfy the soul and mind, anymore, of searching European man. This young culture, therefore, would have withered, if its roots had not been nurtured by what a new, third force, Palestine, did offer. In that epoch the tripodal foundations were laid, which, up to date, have been the indispensable and positive support of European life and culture.

With few exceptions, the greater the artist, the further he distances himself from political and other controversial trends of his days, though his work may often bear the fruits of them, enriching us as the most individual expression of his individual emotions, and, at the same time, as a reflection of the trends and thoughts of his days. That is doubly so with the great masters of the Ravenna Mosaics who, be it anonymously, - was not everything done "ad majorem Dei gloriam"(?) - reveal the struggle for, understanding of, and the differences of approaches, to all that was presented in these spiritual fields to this part of the world. They did it, however, as participants, not as mere illustrators, or illuminists. They were missionaries with the priests who carried the message, and delighting in what was great and new and exciting to them. For hundreds of years, opposite the main entrance to San Vitale, the marvellous sixth century Church which is, perhaps, the most magnificent circular building in the western world, an inscription proclaimed: "Aut lux hic nata est, aut capta hic libera regnat" (Either the light was born here, or, though captured, reigns here in freedom). How fortunate that we know that it was once there; who could disagree who ever had the slightest glance of Ravenna? And all this can be experienced, too, as an expression of the transition of Antiquity to the Middle Ages, however much, like all great Art, it belongs to every period in time.

The interplay, too, of the Arts can be experienced in Ravenna, with - again - the Mosaics as a "background". In 1301 Dante Alighieri was Prior of Florence. A year late Charles de Valois marched into the city, sent by Pope Boniface the Eighth, Dante's greatest adversary, to restore the Peace. The opponents won the day, and Dante was banned from the city for ever. Roaming from Italian Court to Court, he ultimately settled in Ravenna where he died in 1321. His more modern mausoleum is in the midst of the city. There are no diaries, or other records, enumerating what he has written in Ravenna, but when we read in Paradiso LXXX, verses 61-67 of his Divina Commeda:

"And I saw light in the shape of a river,  
"Red-gold scintillation between two banks,  
"Coloured with glorious spring.  
"From that stream living sparks emanated,  
"And at both sides they mingled with flowers,  
"Like rubies, set in gold." ... ... ...then we can hardly
refrain from asking whether the exquisite Ravenna Mosaics have not inspired the most illustrious citizen the city ever harbored within its walls, one of the master poets in world literature.

The transition from Antiquity to the Middle Ages, the descent and acceptance of a new religion; the mosaics convey that, too, to us. Mosaics came to the West from India, via Persia, and reached great heights of performance in Greece and Rome, though the best Roman productions may have been made by Greek artists. Their presentation, however impressive, was and remained utterly realistic. The Ravenna mosaics strike us so much through their modernity, because they were more indicative than realistic, and dealing with eschatological matters in a serious and involved way. The tesserae, made as of old from 1 c.m.² pieces of stone, imbedded into the wall, whilst the mortar was still wet, often got a special "finish" by adding cobalt for blue pot metal; copper oxide for green; copper for red, etc. Those master artists knew their chemistry, though it had no name. And glass melts were added, overlaid with a thin layer of gold or silver metal plating, or stone tesserae so treated, overlaid with a thin film of colorless glass. Th scintillating effect in the candle-lit chapels and churches with their alabaster windows! How subtly and directly the outward senses moved and move the inner being - a pure sign that a live and ascending civilisation tried to find an expression, certainly as far as its devoted artists were at work. And finally, the subject matter surveyed; the development from Calla Placidia (402), and in the shape, yet, of a Greek Cross, to the magnificence of San Vitale (525-540) with the Roman Basilica, chosen as the general shape for the Crucifixion building, as far as architecture is concerned. Old and New Testament as the "settings" for the mosaics on walls which were completely filled with dreams of paradisical scenes and heavenly revelations (any wonder that Dante was inspired?), or indicating the reward of martyrdom, depicting Abel's offering and Isaac's sacrifice, or Moses, receiving the Ten Commandments, just to indicate a few. And with that all the shaping in different ways of the approach of the messages, as seen by either Arians or Ebionites; Docetists or strictly Orthodox, serenely depicted on the walls, but mercilessly fought, sometimes, in the world of reality. The Ravenna Mosaics highly rank in the Cultural Heritage of Europe.

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MONUMENTS AND MAIDENS, FEMALE BODIES, MALE MEANINGS?

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Lecture delivered February 2nd 1987

The allegorical female figure is a familiar sight in the contemporary city, yet few questions are asked about the arguments that structure the representation of Justice, Liberty, Cities and various desirable states, gifts and qualities. Indeed, civic statuary and public monuments are probably some of the least noticed art works in the world. As Robert Musil pointed out in Vienna, raising a statue to some great man usually consigns him to instant oblivion. Yet allegorical figures are inspired by many beliefs and presuppositions that can illuminate ideas about men and women, vices and virtue; these ideas have very ancient roots, but are nonetheless current today.

The Statue of Liberty is one of the most famous - and the largest - examples; though she is matronly, she is also forbidding of countenance. Yet poets like Emma Lazarus and immigrants arriving in their thousands at the turn of the century and afterwards hailed her as a great mother, a mother of mercy, holding up the light of hope for them. She became the recipient of their dreams about America, and the figure of America's best dreams about itself, however breached in the observance. The figure of the motherland relies on ideas about motherhood; but this aspect of Liberty's character remains her only point of contact with female experience. Otherwise, the freedom she represents does not refer to women's freedom; rather women's legal and social rights have to be overlooked when accepting the image of American Liberty in female form. Such oblivion to the condition of real, as opposed to ideal women, turns up consistently in the allegorical tradition.

The female form personifies a very wide range of concepts Britannia, for instance. On Victorian monuments like Thomas Brock's complex of sculpture opposite Buckingham Palace, various phenomena from Navigation to Gunnery all appear as young women.

Artists have used various devices to avoid confusion in the beholder's eye between the ideals personified in the female form, and women themselves. First, they frequently create a contrast between the historical individual the monument honors, who is often male, by representing him in his own clothes, his own time and setting, with the instruments of his activities about him. On the other hand, his 'muses', the embodied virtues he practised in life, usually wear classical drapery and very rarely do anything but recline at his feet or acclaim him. Activity becomes identified with the masculine sphere; abiding eternally with the feminine.

Differences of scale provide another means to distinguish ideal female (towering, divine) from humankind (human size) - this device can be found in mediaeval illuminations and frescoes, like Ambrogio Lorenzetti's Allegory of Good Government in Siena, as well as nineteenth century monuments like John Foley's O'Connell column in Dublin.

When the artist fails to make distinctions of this kind, the muses can sometimes appear to be real women; this vein of iconography has proved an inspiration to women painters, who identified with the muse, like Artemisia Gentileschi who painted herself as Pittura, an allegory of Painting.

Why have the virtues, the arts, the continents and so forth come to be represented in the female form in the first place? The first, most obvious,
reason seems to be their linguistic gender. Most abstract nouns of virtue are feminine in Latin. Some of the words for vices are too, but while the imagery of Justice, Prudence, Temperance and Fortitude remains feminine, the mediaeval carvings and Renaissance paintings and nineteenth century sculptures of vices like Lust and Falsehood, Greed and Envy do not always observe the original gender of the word in Latin. The artist sometimes wants to tell a story, and show the sin of greed being committed - sinners are sometimes male; but also the representations are influenced by the convention that 'men do, women are', and active protagonists of a vice tend to be male.

The convention that the good and the desirable appeared in female form set so firmly in France, that Le Gaz and Le Telephone appear as nymphs alongside other, feminine marvels and discoveries like La Photographe and L'Electricité. Some of the Victorian and Edwardian versions of allegories, made for postcards in the photographer's studio, carry the tradition to comic lengths.

Yet linguistic gender cannot explain the phenomenon of female allegory by itself. Allegory, according to the OED, is the 'description of a subject under the guise of another subject of aptly suggestive resemblance.' How does the female form aptly, suggestively resemble the plethora of concepts it has been used to represent?

Behind the tradition lies the classical idea of women's closeness to matter; as matter they can be moulded and shaped to mean what the fashioners wish. Like Pandora, the first woman, who was herself made like a work of art and given all her attributes of outward and inward character by others, the generic woman postulated by the allegorical tradition can be worked to produce different concepts others hold; also from her material body, there issues forth the protagonists who practise the concept she represents, the free citizens of America, the wise judge of Justice, the artists who obey the muse. The allegorical woman is understood to be subject matter in full sense of both words.

The argument is not put that women are closer to the virtues represented, but that they are appropriate i.e. allegorical usage because their beauty makes men aspire to them. This Neo-platonist argument, dating back to the high middle ages, justifies the appearance of the nude to personify ideals, like Naked Truth herself. But contemporary exploitation of nakedness has emptied Renaissance idealism of its strength and innocence; and the nude today can rarely escape connotations of sexuality, and degradation within that. The range of significance that the female form could achieve has been attenuated. We need to make good that loss by understanding the history of the female figure's uses and proceeding to creating a new iconography that takes account of women's lives, individuality, condition and feelings.

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THE IDEA OF THE GARDEN IN THE CITY

Brigid M. Boardman

Lecture delivered on 16th February 1987

Taken separately the ideas associated with both garden and city have profound implications and when taken together there are many more. If we explore the idea of the garden within the city as the place for individual refreshment and self renewal, and essential to the communal life of the city we need not go beyond the European background, where the origins of the idea of the garden in the city in this sense were adapted from the ancient world into the Christian Church – notably in the monastic foundations of the Middle Ages. These influences contribute to the more specifically English tradition, for which London is the particular example. For to a greater extent than the capital of any other country London has represented the history and outlook of the realm as a whole.

When man ceased to be a hunter he was more a gardener than a farmer and the cities of the ancient world arose from the trade resulting from his cultivation of the earliest garden plots. The myths are full of references to the garden as the place where divine, human and natural life once existed in a harmony impossible to the life of the city. And in the cities the actual gardens became at once places for spiritual and physical refreshment – and symbolic assurances of a future ideal when the harmony would be restored to individual and community alike.

It was the Romans who developed these associations as part of their bequest to Western civilization. Public gardens were essential to their idea of the urban community but private gardens were no less important for the family that was the basis for the community. Significantly, therefore, the Christian Church adopted the Roman plan of the villa surrounding a central garden for the monastic layout that became universal during the Christian centuries. For apart from the practical convenience of the Roman plan there were more far reaching motives directing the choice. The Church also took over the idea of an ideal city, the Church as the City of God to be perfected in heaven and foreshadowed in the monastic community. According to Christian and Hebrew mythology the history of mankind began in a garden and will be consummated in a city – the New Jerusalem incorporating the original paradise garden. So the monastic cloister evolved from the Roman idea of the garden, behind which lay the beliefs of the ancient world, to become a reflection of the paradisical life of Eden as well as a place for actual refreshment and renewal.

In England we can follow the same symbolic associations but there are other factors not found elsewhere. The climate has given the country its potential for agricultural wealth and its luxuriant scenery and these in turn have resulted in other characteristics also not found in the rest of Europe. There is an aversion to urbanization which is inseparable from a deep affinity with the land as the primary source for security and prosperity. Yet the same natural conditions have given rise to the spread of trade and so to the increasing urbanization that accelerated with unprecedented speed during the Industrial Revolution. As a result of this paradox the garden's symbolic role has taken on a special significance. The remainder of the original harmony
between divine, natural and human life has become the more deeply embedded the more the alienation from the land has been experienced through the process of urbanization.

This deeply embedded outlook has expressed itself largely in practical forms. The favourable climate means that the idea of the garden has depended less on generalities and conventions than elsewhere and more on the physical reality of the beauties and everyday uses of the garden. It can indeed be said to have become part of the empiricism characteristic of English attitudes at almost all levels.

As part of this process, within the community the garden has also become an outlet for the native emphasis on the individual and his opportunities for self expression. So the garden reappears as the place for personal refreshment and renewal in an urban, and therefore often alien, society.

Throughout the Middle Ages the idea of the city as an ideal, the City of God, was accepted in England as elsewhere. But it bore no relation to the squalid reality of the towns when compared with the continental cities. With their gardens it was, however, different. The earliest English gardens were herb gardens, cultivated mainly by the monks, and their herbals were renowned throughout Europe for the originality of their researches and of their naturalistic illustrations. The garden was therefore first and foremost a place associated with healing and so with restoration of mind and body alike.

After the Reformation the monks were replaced by the writers of garden manuals and as the towns grew with the expansion of trade the emphasis was increasingly on the city garden offering recreation and refreshment. Foreign visitors frequently commented on the English habits in this respect and on their gardens as the most outstanding feature of the cities which otherwise could not compete with those abroad.

London expanded more rapidly than any and its gardens survived even the Great Fire of 1666. Early maps illustrate the number of private as well as public gardens and throughout the 17th century the parks retained a semi-rural character where tourists were sold fresh milk from the cows pastured there.

During the 18th century the growth of the nation into a world power was reflected in the transformation that took place as the parks and gardens were formalized in an attempt to compete with their European counterparts. But by the next century the effects of the Industrial Revolution brought another change as the parks and pleasure gardens and most of the private gardens disappeared, absorbed into the building projects which the artist John Martin incorporated in his lurid presentations on the Fall of Nineveh or the City of Hell in Milton's 'Paradise Lost'. By the mid-Victorian period the slums and backyards of Gustav Dore's 'London Pilgrimage' completed the change.

Yet in our own time there has been another. Since World War II many of the old gardens have been restored, disused churchyards made into quiet retreats of trees and flowers, and even the Bank of England has its inner garden on the site of the Church incorporated into its latest building expansion. The Halls of several of the Livery Companies still retain a least part of their original pre-Reformation gardens. The one alongside the Drapers' Hall in the heart of the City was once a monastic garden and is said to be now the most valuable garden site in the world.

The most notable example is the garden, still preserved, created by the Goldsmiths' Company during the last war from the bomb damage surrounding their Hall. More than the rest it represents a movement underlying this most recent change not generally recognised. After the brief interval, historically
speaking, of England's national achievements, the more deeply embodied traditional outlook shows signs of revival. One sign is the importance beginning to be attached to the land. And within our admittedly - and perhaps inevitably - declining cities the revival of their gardens, for which London is only a chief example, is another sign of hope for a new, if different, future. Beyond this, the bomb site garden may suggest a wider meaning to us as the close to our topic. Civilized man cannot, it seems, live without the city, but nor can he live in a civilized state without the garden in the city.

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MODERN ENGLISH GRAMMAR: ITS HISTORICAL COMPONENT

Robert Burchfield


The English language has evolved from the time of the earliest records (A.D. 740) to the present day, a period of some 1250 years. However, in the twentieth century many people are worried about standards of grammar, and in particular about the way in which grammar has gradually disappeared as a formal part of the curriculum in state schools. The result is that many young people go out into the world with an insufficient knowledge of how the language works, and with no knowledge of parts of speech or of the way in which the constituent parts of a sentence are put together.

Many middle-class people, especially those of a conservative disposition, look with distaste at the poor spelling and grammar of some of the young people who have been through the school system. Harsh judgements about the way in which the language is changing are also made by, among others, journalists and (in a recent debate) the House of Lords.

Criticism tends to concentrate on a relatively small number of features (e.g. verbs in -ize, split infinitives, prepositions at the end of a sentence, misuse of the pronoun "I" in "this recording gave much pleasure to Elizabeth and I") and on a few individual words and their use, e.g. "hopefully" as a sentence adverb, "gay" used instead of "homosexual", "disinterested" confused with "uninterested", "disassociated" used instead of "dissociated", etc.

This approach is a natural one, but its weakness lies in the fact that the features and individual words criticized are unrelated members of a very complicated network of systems.

It is much more important to study the main sectors of English grammar in a diachronic (or historical) manner, and not merely in a synchronic (or descriptive) manner, so that one can see in which direction the language has proceeded since A.D. 740 and how it is likely to develop in the future. Unfortunately it is not easy to study English grammar in this way because there is no multi-volume Oxford English Grammar corresponding to the 16-volume Oxford English Dictionary, though there are several large works, prepared on historical principles, by continental scholars (especially Jespersen, Pourtales, and Visser).

Numerous examples of a diachronic approach may be cited. For example, Shakespeare's use of "will" showing ellipsis of a verb of motion ("Ile to my books") was not a 16th-century innovation but was recorded already in Anglo-Saxon ("ic to sae wille", Beowulf 318), and was in use throughout the intervening centuries. Similarly the modern American use of "go" followed by a plain or bare infinitive, as in "I guess I'll go finish my shift" (Hill Street Blues, TV film) and "Sure she does, and she can go live there too" (G. Keillor Lake Wobegon Days) shows a common Elizabethan construction, e.g. "Ile go see if the Beare be gone", (Shakespeare) remaining in use in the United States though it has virtually disappeared in Britain.

A fairer way in which to form a judgement about the state of the language is to study large features of the language historically. Grammatical concord was shown to have remained virtually stable from Anglo-Saxon times to the present day, especially in the way in which good writers have always allowed collective nouns like army, audience, committee, jury, and so on, to be followed by either a plural or a singular verb, depending upon contextual considerations, and also in the way in which at every level of writing an apparently plural subject is sometimes regarded as a single entity and then governs a singular verb. For example:
the innocence and purity of their singing comes 
entirely from their identification with the 
character

(B. Levin)

all that dust and dirt and noise which, it seemed,
was less than unforgivable

(D.J. Enright)

By contrast the elaborate rules and the distinctive forms of the subjunctive mood in Anglo-Saxon have been steadily eroded until, in the period since about 1800, the subjunctive has been restricted for the most part to formulaic uses (e.g. "If I were you", "be that as it may") and occasionally after "(as) if", "(as) though", etc., and after a few verbs ("demand", "insist", etc.). Other uses have flooded in to fill "the vacuum", i.e. the language has found other ways of expressing the same "mood".

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PLUMBING SYSTEMS OF BLACK SMOKER SPRINGS AND OPHIOLITE SULPHIDE ORES

J.R. Cann

Summary of the Bennett Lecture delivered on February 9th, 1987

Black smoker hot springs emerge at c. 350°C onto the ocean floor at a pH of c. 3.5, bearing 100 ppm of Fe and excess sulphide, in solution mostly as dissolved H2S. Mixing with cold, neutral sea water causes sulphides to precipitate in chimneys and mounds made up of lava or chimney fragments cemented by sulphides. The sulphide deposits in the ophiolite complex rocks of the Troodos Mountains of Cyprus are the fossil analogues of these sulphide deposits, and range in size from very small up to 14 million tonnes (Mt), with Cu grades from trace to 3% and similar Zn grades. If a 3 Mt Cyprus deposit is to be created by the action of black smoker springs, it requires 30 k² of water, heated to 350°C. Computer modelling shows that the most likely source of heat is latent heat of crystallisation of basaltic magma in an underlying axial magma chamber, with heat being transferred to the circulating hydrothermal fluid through a thin (1-10 m thick) layer of solid uncracked rock. Fieldwork in Cyprus shows the ore deposits to be underlain by vertical alteration pipes, about 100 m in diameter, showing a concentric zonation, with a central core which has been highly altered, and is now made up of layer silicate minerals with quartz and pyrite.

These alteration pipes penetrate 1 1/2 - 2 km below the ancient sea floor, through the extrusive rock layers and sheeted dykes and near to the underlying plutonic section, which represents the solidified axial magma chamber. At this level are developed strikingly striped altered dykes, in which the sheeted dykes are altered to alternating pale green stripes of epidoteite (epidotite + quartz) and darker chlorite-bearing stripes. These zones of epidotes extend for up to several kilometres parallel to the strike of the dykes, are 500-1000 m wide, and perhaps 100 - 200 m thick. These zones contain abundant fluid inclusions, which homogenise at about 350°C, and are highly depleted in Cu, Zn and Mn. A 2 km length of epidoteite zone is sufficient to supply the metals and sulphide (partly by reduction of sea water sulphate during epidote formation) for a 3 Mt ore deposit. The epidoteite zones clearly represent reaction zones where seawater and rock react to form black smoker hydrothermal solutions, heated by the underlying magma, thus confirming the predictions from the computer modelling. The overall geometry and mass balance of a large-scale system can thus be worked out by a combination of observation on the sea floor, computer modelling and geological investigation of ophiolite complexes such as in Cyprus.

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28
THE MIDDLE LIAS SILTS AND CLAYS AND AMALTHEID AMMONITES FROM
TILTON RAILWAY CUTTING, LEICESTERSHIRE

by D.M. Blake

Abstract

Although Tilton Railway Cutting has attracted many researchers, the Middle Lias Silts and Clays exposed there have received only brief comments. This paper records in detail the stratigraphy and fauna of some 2 metres of the series immediately below the conglomeratic base of the Marlstone Rock Bed. The presence of the Subnodosus Subzone (and hence the Margaritatus Zone) is established for the first time at Tilton.

INTRODUCTION

The railway line from Bottesford to Market Harborough via Tilton cutting (SK761055) was opened on the 15th December, 1879. The cutting exposed a section of Middle and Upper Lias rocks (Lower Jurassic) and although it has been mentioned in several publications the authors concentrated on the Marlstone Rock Bed and the overlying Upper Lias Clays whilst the underlying Middle Lias Silts and Clays received only a passing mention. Wilson (1885) saw 13ft of "Middle Lias: Shales - with bands of sandstone and scattered limestone nodules", whilst Woodward (1893) noted about 20ft of "Micaceous sandstone and sandy shales" under the Marlstone. The railway cutting section detailed by Fox-Strangways (1903) does not define the junction between the Marlstone and the Silts and Clays but from his total thickness of the Marlstone, given as "about 18 feet", it would appear that there were exposed about 3ft of grey sandy shales and 2ft of sandstone beneath the Rock Bed. He went on to list: "Sandy shales (at the bridge and behind the signal box) and limestone bands with pyrites ...... about 25 feet", and, "Sandy shales (in the stream) ...... 10ft to 15 feet", but with no indication as to the correlation of the exposures. Hallam (1968) recorded about 13ft of "clays etc" in the cutting. An unpublished section by Jones and Mathieson (Leicestershire Museums 1972), recorded 3.96 metres of ferruginous sandy clays below the Marlstone Rock Bed.

Contractors cleared the site for the Nature Conservancy Council in 1984. J.G. Martin of the Leicestershire Museum Service made a detailed measured section of the newly exposed silts and clays in 1986 and obtained several specimens of amaltheid ammonites. These indicated the presence of the Subnodosus Subzone of the Margaritatus Zone. The present author visited the site in April 1987 and collected further material including more amaltheid ammonites from other horizons within the new section. The aim of this paper is to place on record the details of that section.

A collection of fossils and representative samples of the beds has been deposited in the Leicestershire Museum (accession numbers G2.1986-G12.1986 inclusive; G67.1987), where a site file can also be found.
LOCALITY

Tilton Railway Cutting SSSI (SK761055) lies approximately 1.75 kms to the east of the village of Tilton-on-the-Hill (SK743057) and runs for approximately 0.5 kms in a SSE direction from the road bridge. Some 2 metres of Middle Lias Silts and Clays were exposed beneath the Marlstone Rock Bed on the east bank near the road bridge.

STRATIGRAPHY

The Middle Lias consists of two units, the Marlstone Rock Bed above and the Middle Lias Silts and Clays below (see Table 1). The thickness of those clays through Northamptonshire and Leicestershire is about 20 to 30 metres (Hallam 1968).

<table>
<thead>
<tr>
<th>Stage</th>
<th>Zones</th>
<th>Subzones</th>
<th>Local Strata</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper</td>
<td>Pleuroceras</td>
<td>P. hawskerense</td>
<td>Marlstone Rock Bed 0-5.6m (partly Toarcian)</td>
</tr>
<tr>
<td></td>
<td>spinatum</td>
<td>P. apyrenum</td>
<td></td>
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<tr>
<td>Pliensbachian</td>
<td>A. gibbosus</td>
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<td>Non-sequence?</td>
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<tr>
<td>(Domerian)</td>
<td>Amaltheus</td>
<td></td>
<td>-?-?-?-?-?-?-?-?-?-?-?-?-</td>
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<tr>
<td></td>
<td>A. subnodosus</td>
<td></td>
<td>Middle Lias</td>
</tr>
<tr>
<td></td>
<td>margaritatus</td>
<td></td>
<td>Silts and Clays</td>
</tr>
<tr>
<td></td>
<td>A. stokesi</td>
<td></td>
<td>20 - 30m</td>
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<tr>
<td>Lower</td>
<td>Prodactylioceras</td>
<td>Oistoceras</td>
<td>Upper Clays</td>
</tr>
<tr>
<td></td>
<td>davoei</td>
<td>figulinum</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Aegoceras</td>
<td>capricornus</td>
<td>c. 100m</td>
</tr>
<tr>
<td>(Carixian)</td>
<td></td>
<td>A. maculatum</td>
<td></td>
</tr>
</tbody>
</table>

Table 1 Stratigraphic Divisions of the Middle Lias and top of the Lower Lias of Leicestershire (after Dean, Donovan and Howarth 1961; Hallam 1968; Cope at al 1980; Howarth 1980).

The new 2 metre section at Tilton lies immediately below the 0.05-0.12m thick green, chamositic conglomeratic sandstone which forms the erosive base of the Marlstone Rock Bed. The sequence is composed of ferruginous, micaceous mudstones, siltstones, and sandstones some of which contain ferruginous nodules (Fig.1), and is described below.
Fig. 1. Section of Middle Lias Silts and Clays from Tilton Railway Cutting. (Modified from an unpublished section by J.G. Martin 1986)
MEASURED SECTION

Middle Lias Silts and Clays

Bed 3f Mudstone; hard, lenticular; laminae black edged, brown along partings, weathering greenish buff. Micaceous, ferruginous, occasional shell fragments. One small Protocardia truncata (J. de C. Sowerby). up to 0.12 metres

Bed 3e Mudstone; soft, laminated (particularly top 20 cms), dark grey weathering light brown. Micaceous, ferruginous, shell fragments. Increasing iron content downwards forming hard layer at base. Small bivalves indet. 0.35 metres

Bed 3d Siltstone; friable, dark grey. Micaceous, abundant shell debris. One small poorly preserved amaltheid ammonite; (accession no.G67.1987.18); bivalves indet. 0.28 metres

Bed 3c Siltstone; hardening downwards, dark grey weathering light brown. Micaceous, ferruginous, very shelly with occasional small ironstone nodules. Pleuromya costata (Young and Bird), many small bivalves indet. 0.15 metres


Bed 3a Mudstone; laminated, grey weathering dark brown. Micaceous, very ferruginous, shelly. 0.05 metres

Bed 2b Sandstone; hard, light grey weathering light brown. Micaceous, ferruginous, calcareous, scattered shell fragments. Irregular bottom surface. Sphalerite crystals present infilling one ammonite specimen. Basal 3-4 cms becomes extremely shelly with thin ironstone veins and lenses almost entirely of small bivalve shells with occasional small amaltheid ammonites. Tentatively identified as Amaltheus cf margaritatus de Montfort (accession no.G67.1987.17); Amaltheus subnodosus (Young and Bird) (accession no.G67.1987.15.1 and 15.2); Amaltheus cf wertheri (Lange) (accession no.G67.1987.17); belemnites; Pleuromya costata (Young and Bird), Modiolus sp., bivalves indet. 0.22 metres

Bed 2a Sandstone; calcareous, soft, light grey weathering light brown. Micaceous, ferruginous, shelly. Bivalves indet. 0.16 metres

Bed 1c Ironstone; dark brown weathering light brown. Amaltheus cf margaritatus de Montfort (accession no.G67.1987.4 1-2) on top surface. 0.02 metres
Bed 1b Mudstone; silty, friable, laminated, grey weathering light brown with small ironstone nodules and a thin, discontinuous ironstone base. Micaceous, ferruginous, silty, shelly. Belemnites; broken shell debris.

Bed 1a Siltstone; argillaceous, laminated, grey to dark grey weathering light brown, scattered small ironstone nodules. Micaceous, ferruginous, silty. Belemnites, Pleuromya sp., bivalves indet., small poorly preserved ammonite.

AMMONITE ZONATION

The Middle Lias Silts and Clays are usually taken to belong to the Margaritatus Zone (see Table 1 and Cope et al 1980). The only previous mention of ammonites that are at all indicative of this zone at Tilton, appears to be that of Woodward (1893), who stated that A. margaritatus was found there. A. margaritatus is not however confined to the zone to which it gives its name (Howarth 1958).

The five ammonite ammonites found in 1986 near the top of Bed 3b by J.G. Martin were sufficiently well preserved to be specifically identified (later confirmed by Dr. M.K. Howarth of the British Museum, Nat. Hist.), as Amaltheus margaritatus de Montfort and A. subnodosus (Young and Bird) proving for the first time the presence of the Subnodosus Subzone (and thus of the Margaritatus Zone) at Tilton.

The ammonites collected by the author in 1987 extend their distribution in the section. Bed 1c was the lowest to yield an ammonite but it was in a poor state of preservation. The external mould had strong, non-tuberculate, sigmoidal ribbing permitting a tentative assignment to A. margaritatus de Montfort. This would indicate that Bed 1c was also in the Subnodosus Subzone, A. margaritatus not being recorded from the Stokesi Subzone (Howarth 1958 and Dean, Donovan and Howarth 1961). The specimens found in Bed 2b were smaller than those of Bed 3b and all came from the bottom 4cms of the bed. They definitely indicate a Subnodosus Subzone age, although A. wertheri is more typical of the underlying Stokesi Subzone. This latter identification is only tentative however. Bed 3d was the highest yielding an ammonite. It was found 16 cms from the top of the bed but the specimen is poorly preserved and has not been identified beyond being an ammonite.

ACKNOWLEDGMENTS

I wish to thank Mr. J.G. Martin of the Leicestershire Museums Service for allowing me access to his material and for his help and guidance in the preparation of the manuscript; Dr. R.G. Clements for additional information and helpful comments; Dr. M.K. Howarth of the British Museum (Natural History) for identifying some of the ammonites; the Leicestershire and Rutland Trust for Nature Conservation for permission to visit; and finally my gratitude to Mrs. E.M. Barradell for patiently typing the manuscript and Miss H.J. Briers for doing the final amendments.
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34
ICHTHYOSAURS WITH SOFT TISSUES: ADDITIONAL COMMENTS

by David M. Martill

ABSTRACT

Comments on the preservation of ichthyosaurs from the Lower Lias (Hettangian) of Barrow-upon-Soar are made additional to those put forward by Martin et al 1986 (this journal). Evidence that some so called "soft tissues" in ichthyosaurs are not skin, but well preserved prokaryote or fungal infestation is presented.

INTRODUCTION

Ichthyosaurs with so called "soft tissues" are known from a number of localities in the Jurassic of northwest Europe. Modern reconstructions of ichthyosaurs are based largely on exceptionally preserved specimens with complete body outlines from the Lias Epsilon (Toarcian) of Holzmaden and Boll, southwest Germany (McGowan 1979). Recently Martin, Frey & Riess (1986) reviewed less well known fragmentary material from the Lower Lias (Hettangian) of Barrow-upon-Soar, Leicestershire, and produced a new reconstruction of the ichthyosaur outline based partly on this material.

In their discussion of the mechanisms of soft tissue preservation Martin et al refer to Martill (1985) and Martill pers comm. Their paper is a valuable contribution to our knowledge of the stratigraphic distribution of ichthyosaurs in which soft tissues are preserved, and provides a useful catalogue and bibliography relating to the specimens held in the collections of the Leicester Museum and Art Gallery, but some of the arguments require modification and additional comments are made herein on progress in soft tissue preservation research that should be helpful for future workers.

Current interest in ichthyosaur soft tissues stems from two recent research projects; an ichthyosaur functional morphology study by Frey (1985), and a study by Martill (1985, 1986a, 1986b, 1986c) in which the taphonomy and preservation of Mesozoic marine vertebrates was the main objective. Frey studied ichthyosaurs with soft tissues preserved to assess the external shape and function of the limbs in underwater locomotion. Martill on the other hand was largely concerned
with the physical processes that lead to exceptional preservation, e.g. anoxia, rapid burial, scavenger inhibition.

In both cases it was found that ichthyosaur soft tissue preservation is a far from simple process, and specimens that in the past have been considered to be representative of ichthyosaur morphology are not quite what they appear to be.

The following brief paragraphs are intended to clarify certain ambiguous statements in Martin et al. (1986). These only relate to those parts of their paper which refer to the writer's own research. Much of the work quoted was in an advanced state of preparation, and Martin et al's understanding of the preservation is based on conversations held before the research was complete.

On page 60 of their article Martill (1985) is quoted as reporting soft tissue of ichthyosaurs from the Callovian of Cambridgeshire. I have excavated several ichthyosaurs from the Cambridgeshire Callovian, but unfortunately none of these specimens has shown any traces of soft tissue preservation. However, a specimen of the large pachycormid fish *Asthenoacormus* sp. (BMNH P61563) from the Jason Zone (Middle Callovian), at Dogsthorpe (national grid reference TF 219019) was associated with black organic films and buff coloured phosphatic material in the region of the gut. Within this material was a small fragmented *Leptolepis* sp. *sensu lato*. Clearly the *Leptolepis* is part of the gut contents of the larger fish, but it is difficult to interpret the exact nature of the black or buff phosphatic material. The black film might represent part of the gut wall, and the phosphatic material may be coprolitic in origin. Scanning electron microscope (SEM) studies of both these materials failed to demonstrate unequivocably that either material represents preserved soft tissue.

On page 65 (Martin et al 1986) there is a discussion of soft tissue preservation. Much of the work quoted was a review of the results of research workers who are still actively working on the problems of soft tissue preservation, and who have yet to publish their results. Martill recorded filaments of bacteria or fungi in ichthyosaurs from Leicestershire (Martill 1986) prior to the publication of Martin et al.

Currently, there is a large and growing school of palaeontologists and diageneticists who are studying the taphonomy and preservation of soft tissues so as to assist with palaeoecological interpretations. Martin et al state that the Barrow-upon-Soar specimens do not consist of the original organic material. Whilst it is true to say that much of the original organic material has been metabolised by microbial activity, there have been no attempts to identify the nature of the organic molecules present in the so-called soft tissues. It therefore remains possible that some of the organic material is ichthyosaurian rather than entirely microbial.
In the same section an ichthyosaur with soft tissues preserved is reported from the Callovian of Bedfordshire. There are no written accounts of ichthyosaurs with soft tissues from Bedfordshire, and Martin et al do not quote a specimen number. There is however an ichthyosaur from neighbouring Buckinghamshire (Martill in press) which is associated with black films containing rod-shaped and filamentous micro-organisms. This specimen is currently on display in Milton Keynes library, specimen number BCM 1001.1983.

Work currently in progress and in press (Martill, in press) shows that black films associated with the Barrow-upon-Soar ichthyosaurs contain abundant diaphanous and bifurcating filaments, often several microns long, and approximately one micron diameter. These filaments have the appearance of collapsed tubes of circular cross-section (Fig. 1), and may be related to the autotrophic cyanobacterium Beggiatoa (Williams and Reimers, 1983).

Also in this section Martin et al. go on to compare Barrow soft tissue preservation with that of the Eocene soft tissue fauna from the Grube Messel of West Germany. In that microbial organisms are present in both cases is true, but there the similarity ends. At Grube Messel the Eocene oil shales yield frogs, birds, bats and other vertebrates in which distinct outlines of the animals are preserved. Wutke (1983) described the presence of four types of rod-shaped bacteria from these outlines, and noted that they were preserved in siderite. The Barrow-upon-Soar soft tissues material so far examined contains no rod-shaped bacteria (a single ichthyosaur from the Middle Callovian of Buckinghamshire contains rod-shaped bacteria), only filaments, and these appear to be preserved as an organic material. Of particular importance here is the nature of this organic material. This is an area that remains to be investigated. Some fungi produce hyphae with an outer wall composed of a resistant bio-molecule similar to chitin. Thus whilst the statement that the bacteria were killed by their own waste products might be valid for the Grube Messel soft tissue fauna, if the filaments in the Barrow-upon-Soar ichthyosaurs are fungal hyphae, then their preservation may be a direct consequence of the resistant nature of the hyphal wall.

Further to this, Martin et al. state that in the case of the Barrow specimens the micro-organisms are composed of phosphate. I have analysed the Barrow material and find phosphate present in the bone of the skeleton (this was to be expected) and in coprolitic material from the gut region (in particular from a buff-coloured circular mass in Leicester Museum specimen G441.1891). However, no phosphate was detected in the filaments. Leicester Museum specimen no G448.1891 shows buff-coloured fibrous material, which may be phospatic, in the region behind the fore paddle. It is not clear whether this represents soft tissue or part of the gut contents which leaked into the body cavity during decomposition. This specimen awaits further study.
ICHTHYOSAUR SOFT TISSUE PRESERVATION: SOME PROBLEMS

Soft tissue preservation is not common in the fossil record and, when it occurs, is usually due to some peculiar physical or geochemical phenomena. One of the most important questions to ask is why have the soft tissues been preserved? I have tried to answer this question with respect to the preservation of ichthyosaur soft tissues found in Jurassic bituminous shales. There are several localities in the Jurassic of northwest Europe in which soft tissues have been reported, but the ichthyosaurs from the Posidonia Shales (Toarcian) of Holzmaden and Boll are the only specimens known today in which supposedly the entire outline of the animal is preserved. There is considerable doubt as to the authenticity of the outline of these ichthyosaurs, which makes the fragmentary, but unadulterated, Barrow-upon-Soar material most interesting.

The German specimens are preserved as complete articulated skeletons in black shales with organic carbon contents in excess of 10%. The "soft tissue" outline is preserved as a black or dark brown film, sometimes shiny, and often with lighter patches distributed through it. A detailed examination of the taphonomy of German soft tissue ichthyosaurs shows that entire outline specimens are all preserved lying on their right or left sides. None are preserved lying dorsally or ventrally. Apart from two large specimens, all German soft tissue ichthyosaurs are specimens of small Sienopterygius sp. and are rarely more than one metre long.

The first of these specimens was described by Fraas (1892). In this specimen the vertebral column has a sharp break about midway along the body. Above this break is a large triangular projection of black, carbonaceous material. Behind this projection are several smaller projections extending from the posterior base of the large triangle to the anterior border of a large lunate tail. Fraas (op. cit.) described the large projection as a dorsal fin similar to that found in sharks, and the smaller projections as a serrated keel. All reconstructions of ichthyosaurs from this time on show the presence of a large triangular dorsal fin.

Prior to this discovery, ichthyosaur reconstructions varied considerably. Owen (1838) had considered that ichthyosaurs had a tail fin because so many of the specimens obtained from the Lower Lias of Street, Somerset, and Lyme Regis, Dorset, had a prominent "break" towards the end of the vertebral column. Owen interpreted this "break" as a result of current activity acting upon a tail fin, and breaking it as decomposition weakened the ligaments.

Some authors simply drew a line approximating to the shape of the skeleton outline, and had little regard for interpretation (D'Orbigny, 1849), while other authors added keels along the back bone, but failed to present evidence in support of this (Hawkins, 1834).

I have examined several German specimens with complete body outlines preserved as black carbonaceous material in
museums in Paris, Chicago, Oxford and Tübingen. There are certain anomalies that suggest the preserved outlines (not the carbonaceous material itself) are not genuine, and have been considerably "improved" by preparators.

Taphonomic studies of ichthyosaurs made by Martill (in press) have demonstrated that black carbonaceous materials may be present on the undersides of skeletons that have sunk into soft anoxic sediment, but are absent on upper surfaces of skeletons subjected to aerobic decay processes. If a carcase were to have its entire outline preserved along the midline, as in the German ichthyosaurs, then half or more of the specimen would need to be submerged in anoxic sediment soon after death.

All of the German specimens with outlines show the body outline as it would appear along the midline as viewed from the right or left side. This in itself is an anomaly, as ichthyosaurs are often found preserved dorso-ventrally as well as laterally flattened.

Many of the German ichthyosaurs show differential preservation between the two sides of the skeleton suggesting that decomposition on the upper side was markedly distinct from that on the lower side. In the case of the Paris specimen, two of the dorsal ribs from the "up facing" side of the specimen have broken free from the carcase, demonstrating that the integument was not intact on that side. The outline of the specimen however is complete, and includes a large dorsal fin. It is difficult to see how the specimen could be so perfectly preserved on the "down facing" side while being so actively decomposed, and perhaps even scavenged on the 'up facing' side.

The Chicago specimen shows a perfect outline along the midline (Fig. 2), but also shows the integument extending on to the dentition. Again, it is difficult to see how such a sharp line can remain around the entire carcase, but extend beyond the jaw bone onto the teeth.

These are just a few of the taphonomic anomalies that suggest that there has been a significant degree of "improvement" of these specimens. In many of the specimens it is clear that the entire outline has not been preserved, and that some filling of gaps has taken place by the preparators of the specimens.

Further doubt has been cast on these specimens with the recent discovery that the so called "soft tissue" is composed largely of the remains of filamentous bacteria or fungi (see below).

Broili (1942) analysed "skin" material from the German specimens and found that it contained abundant amino acids. He was able to conclude that the black film was organic in origin, but could not confirm from these analyses that it was ichthyosaur skin. A major component of skin is the helically coiled structural protein collagen. Fossil collagen is known in a variety of fossil groups from graptolites (Crowther and Rickards, 1977) to higher vertebrates. Fossil collagen has
been reported in fish from the Hettangian of Dorset (Dobrenze and Lund, 1966), and on this basis it was decided to investigate the black films associated with ichthyosaurs using scanning electron microscopy, to establish if collagen had been preserved.

SEM studies performed on material from the large ichthyosaur, *Ophthalmosaurus* sp. from the Lower Oxford Clay of Buckinghamshire, and which is similar to the German ichthyosaurs, showed the black material to be composed of a mass of ovoid bodies approximately 1 micron long X 0.5 microns across. These bodies were uniform, and present in millions. They clearly represent lithified bacteria that were responsible for the decomposition of the ichthyosaur carcase, and are presumably preserved in-situ. In this case they represent a type of "fossil photograph" of the soft tissue. A portion of material removed from the mandible also indicated the presence of diaphanous and branching filaments. (The filaments probably represent autotrophic cyanobacteria such as *Beggiaea* or fungi, the ovoid bodies may represent sulphate-reducing bacteria. Work on the exact nature of the filaments is incomplete).

The results obtained from the material removed from the *Ophthalmosaurus* show that no skin collagen is preserved. A similar study was made on material removed from German specimens and from specimens from Barrow upon Soar, Leicestershire. In each case abundant diaphanous and branching filaments were discovered ramifying the black material, but as yet features characteristic of skin remain to be discovered. The filaments were associated with abundant pyrite, a by-product of bacterial reduction of sulphate.

**DISCUSSION**

It is clear that the black material found coating ichthyosaur skeletons, and sometimes extending out onto bedding planes to surround the skeletons, is not preserved skin *sensu stricto*. It is a preserved mass of filamentous or rod-shaped micro-organisms which were responsible for the degradation of the ichthyosaur soft tissues. During the burial process large portions of the infested integument were buried, with the eventual preservation of the infesting organisms. It is to be expected that the burial and preservation of these organisms may result in portions of the outline being retained. However, during the growth and development of the filaments, a halo of filaments may be produced in the way suggested above, which itself has the potential to be preserved. If a skeleton were discovered that was surrounded by an oval halo of carbonaceous material, the overall shape of an ichthyosaur may not be preserved, but could be carved from it to suit the preparator's (or customers') taste.

While this latter comment may seem a little cynical, it is worth pointing out that ichthyosaurs with soft tissues are only recorded from a small number of quarries in the Holzmaden district. Most of these were worked by one company employing their own preparators. Nearly all major museums in the world
obtained a single specimen during the earlier part of this century. And yet no newly discovered soft tissue specimens have come to light in recent years. It is also worth noting that "skin" ichthyosaurs sold for more money than "skin-less" ichthyosaur skeletons. At the end of the last century a "skin" specimen could sell for up to $750 (Baur 1895).

SUMMARY

Our current knowledge of ichthyosaur taphonomy and preservation suggests that it is unlikely that entire skin outlines could be preserved except under unusual conditions. The role of fungi or autotrophic cyanobacteria is important in contributing black organic material to the area in which some ichthyosaur skeletons come to rest. The bacteria or fungi feed on the decomposing carcasses and are preserved along with the skeleton. If the bacterial/fungal infestation is restricted to the integument of the carcase it is possible that the preserved mat may assume the shape of the outline of the ichthyosaur. It is however, likely that the mat may extend beyond the integument as a halo, and infiltrate surrounding sediment. I suggest that the majority of Holzmaden ichthyosaurs have been discovered in a black halo, and a shark-like shape has been carved from it by preparators seeking greater profits. It is unclear why no plesiosaur or crocodile has yet been discovered with more than just isolated patches of black material, but this could in part be due to the greater rarity of these reptiles generally. The presence of a dorsal fin is far from established at present.

The fragmentary nature of the Barrow-upon-Soar ichthyosaur "soft tissue" specimens, and a lack of complete outlines, even though complete skeletons are known, suggests that forging has not taken place. There are only three specimens from Barrow in which the outline has an intact margin. These specimens do contain filamentous bacteria/fungi, but the outline is not a black film. In the case of one specimen a thin film of pyrite is present, in another, an aggregate of microscopic selenite crystals is suggestive of a weathered pyrite film. Light and scanning electron microscopy of one of the Barrow specimens reveals a significant degree of ultra-structure, demonstrating that soft tissue morphology can be preserved. The Barrow material is of greater importance than the Holzmaden material as it holds the key to the true shape of Lower Jurassic ichthyosaurs. It is hoped that an initiative for re-exposing the Lower Lias at Barrow can be established.

In many larger marine vertebrates a triangular dorsal fin is used to prevent roll. Most fast swimming dolphins have a prominent dorsal fin. They use their tails for propulsion, and steer with their forepaddles. They do not have rear paddles and rely on large, erect dorsal fins to prevent roll. It would therefore come as little surprise to palaeontologists to discover that ichthyosaurs had both a dorsal fin and a lunate tail, as they are always found in fully marine environments. But unlike most dolphins, ichthyosaurs used their fore paddles for propulsion, and their tails for steering. Their rear paddles could therefore have been employed to prevent roll. There was no need for ichthyosaurs to have a dorsal fin. Frey (1982) compared ichthyosaur locomotion closely with that of
Amazon dolphins (*Lnia*) which only have a rudimentary dorsal fin. Amazon dolphins are relatively sluggish swimmers, and use their fore paddles for propulsion. Perhaps Liassic ichthyosaurs were also sluggish swimmers, rather than the rapid-swimming, streamlined, dolphin analogues they are often thought to be.

ACKNOWLEDGEMENTS

I would like to thank George McTurk for operating the scanning electron microscope. Ron Testa of the Field Museum of Natural History, Chicago, produced the photograph in figure 2. Specimens for this study were loaned by the Earth Science Section, Leicestershire Museums and Art Gallery. Part of this work was carried out during tenure of a University of Leicester Scholarship. A historical study of ichthyosaur palaeontology was carried out at the Field Museum of Natural History, Chicago, during tenure of a Harkness Fellowship.

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Fig. 1. (a) Scanning electron micrograph of anastomosing diaphanous and filamentous cyanobacteria or fungi within so-called soft-tissue material from a Barrow-upon-Soar ichthyosaur. (b) Detail of filament showing collapsed nature of tube. Magnification X 6000. Scale bar 1.67μm.
Fig. 2. Supposed body outline of *Stenopterygius quadriscissus* (Quenstedt) showing lunate tail, fore and hind paddles and 'restored' erect shark-like dorsal fin. Specimen in Field Museum of Natural History, Chicago, FMNH P.14621.


Owen, R., 1838. Note on the dislocation of the tail at a certain point observable in the skeleton of many ichthyosauri. Trans. geol. soc. Lond. 2nd ser. vol. 5, 511-514.


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A GUIDE TO THE GEOLOGY OF THE PRECAMBRIAN ROCKS OF BRADGATE PARK
IN CHARNWOOD FOREST, LEICESTERSHIRE.

D.S. Sutherland, H.E. Boynton, T.D. Ford,
M.J. Le Bas and J. Moseley
with the assistance of K. Pontin and M.K. Whateley

Bradgate Park (Natl. Grid Ref. SK 5310) is the area of
Charnwood Forest most often visited for geological excursions,
providing a graphic introduction to the varied geology of the
oldest rocks in England and a particularly pleasant walk (up to
about 4 miles or 6 km). It is open to the public, but permission
to take geological parties should be sought from the Bradgate
Trustees by application to the Ranger and Land Officer, Estate
Office, County Hall, Glenfield, Leicester LE3 8RE (Tel. 0533
871313).

The Park is less than 10 km north-west of Leicester, between
A50 and A6, and 4 km east of Junction 22 of M1. There are three
public car parks, at Newtown Linford (SK 517102), Hallgate (543114)
and Hunt’s Hill in the north-west (523117). This guide will take
you through the geology beginning from the Hunt’s Hill entrance,
but the roughly circular route can be joined from either of the
other entrances, or from footpaths entering the park from the west
(522110) and north-north east (532115). The excursion can take
all day, but even a more cursory half-day visit is worth while.
Detailed examination of all the outcrops described could occupy
several visits. This guide is intended to be of help to students
of geology and the interested amateur; we have included a glossary
of some geological terms at the end.

PLEASE NOTE
Under no circumstances should hammers be brought into the Park;
there must be no disturbance of outcrops, and no specimens may be
taken.

INTRODUCTION

Discontinuous outcrops of late Precambrian rocks occupy over
110 square km in Charnwood Forest, north-west of Leicester. They
form a group of hills, rising up to 200 m above the adjacent valley
of the Soar, and elongate from north-west to south-east in a
pattern that reflects the structure of the Precambrian geology
(Fig. 1). Bardon Hill in the west is the highest point (280 m).
Beacon Hill (509148), some 3 km north of Bradgate Park (and also
open to the public), is an excellent viewpoint from which to
appreciate the geological structure.

Most of western Leicestershire is covered by red Triassic
deposits of the Mercia Mudstone (formerly known as the Keuper
Marl); the crags of Precambrian rock that formed the landscape of the Triassic desert eventually became buried by the accumulation of breccia, sandstone and red mudstone, but when these deposits came gradually to be removed by erosion, at some time in the Tertiary era, the Charnian peaks were partly exhumed. Later, during the Pleistocene, this landscape was covered at least once, probably twice, by the extensive ice sheets which developed in Britain, leaving, as they finally receded perhaps 120,000 years ago, the varied debris of glaciation. The deposits covering the Precambrian today therefore include the remnants of the Triassic red beds and considerable areas, in places as much as 12 m thick, of glacial till (boulder clay) and outwash material.

The Precambrian rocks

In Charnwood Forest rocks representing the basement of central England come to the surface. They mostly comprise a waterlain succession of bedded tuffs and sediments at least 4 km thick, the bulk of which are the products of extensive and prolonged explosive volcanism ranging in composition from andesite to dacite. In the north-west, between Whitwick and Bardon Hill, the regularly bedded ash deposits give way to a varied development of coarse agglomerates, breccias and lavas, including intrusive porphyritic dacites and andesitic lava flows (the latter found interbedded with pyroclastic rocks in Bardon Hill quarry (Old, in press)). These rocks are probably contemporaneous with at least some of the bedded pyroclastic and reworked tuffs of the Maplewell Group (Table 1). Such rocks, of calc-alkaline composition, are considered to indicate the existence of a volcanic island-arc, very much like present-day Japan, along the margin of a continent that lay probably not far to the south, across the English Midlands, during the late Proterozoic (Le Bas, 1982; Thorpe et al., 1984).

The classic account of the Precambrian geology is that by W.W. Watts, based on his work begun in the last century, and published posthumously (1947), but the stratigraphical nomenclature has recently been revised by Moseley and Ford (1985) and their revision forms the basis for this field guide (Table 1). The area is also covered by the British Geological Survey Memoir for the Coalville area (Sheet 155) (Old, in press).

The Charnian Supergroup comprises the Blackbrook, Maplewell and Brand Groups; the first two are largely composed of volcaniclastic sediments (the volcanic components being recognisable in thin section or, where very fine-grained, by chemical analysis), but the Brand Group is composed of quartzites and slates with a less obvious volcanic contribution. The Blackbrook and Maplewell Groups are dominantly tuffs, very coarse to very fine-grained, showing many of the signs of having been deposited in the form of turbidites; they are mainly medium- to very thinly bedded (10–30 cm to <3 cm), often graded or having laminated bedding consistent with their having been dropped from a laden turbidity current, but scouring and sole markings are absent. They are considered to have accumulated in a back-arc basin behind the island arc; present-day marginal basins are characterised by
Figure 1. Simplified geological map of the Precambrian rocks of Charnwood Forest.
TABLE 1  The main stratigraphic divisions of the Charnian Supergroup (Moseley & Ford, 1985).
(Earlier stratigraphic divisions by W. W. Watts (1947) in parenthesis)

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<th>GROUPS</th>
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<th>WATTS' TERMS</th>
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<td>SWITLAND FORMATION Pelites</td>
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<td>BRAND GROUP</td>
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<td>BRAND HILLS FORMATION Quartzite and pelite; conglomerate</td>
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<td>(Trachose Grit and Quartzite)</td>
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<td>Hanging Rocks Conglomerate Member</td>
<td>Hanging Rocks Conglomerate</td>
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<td>BRADGATE FORMATION</td>
<td>Hallgate Member</td>
<td>(Woodhouse and Bradgate Beds)</td>
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<td>Coarse to very fine-grained tuffs &amp; slump breccias</td>
<td>Sliding Stone Slump Breccia Member</td>
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<td>MAPLEWELL GROUP</td>
<td>Old John Member</td>
<td>(Beacon Hill Beds)</td>
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<td></td>
<td>Coarse to very fine-grained tuffs and slump breccias</td>
<td>Sandhills Lodge Member</td>
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<td>Beacon Tuffs Member</td>
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<td>Benscliffe Member (Felsitic Agglomerate)</td>
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<td>BLACKBROOK GROUP</td>
<td>Undivided</td>
<td>(Blackbrook Beds)</td>
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<td>BLACKBROOK RESERVOIR FORMATION Tuffaceous pelites</td>
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<td>IVES HEAD FORMATION Tuffs and greywackes</td>
<td>South Quarry Slump Brecca Member</td>
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<td>Lubcloud Greywackes Member</td>
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<td>Morley Lane Tuffs Member</td>
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turbidite deposits of this kind. Whilst they have the appearance of greywackes and finer grained pelites, the Charnian rocks are demonstrably volcaniclastic, being derived either directly from volcanic eruption, or perhaps more often by the secondary spreading and redistribution of volcanic ash over a wide area of the sea floor. In examining these rocks one needs to bear in mind both the volcanism and the deposition by sedimentary processes under water, and in particular to weigh up whether individual beds are the result of a volcanic eruption (close by or at some distance along the volcanic chain), or whether they represent reworked volcanic debris redistributed in the form of water-borne turbidites. In this guide we try to point out relevant criteria, but there is ample scope for future detailed study of the Charnian volcanic and sedimentary regime.

Intercalated among the bedded tuffaceous rocks are several distinctive horizons of breccia and lapilli-tuff which Watts used as marker beds in subdividing the stratigraphic succession. Remapping has shown that there are more of these horizons than were previously recognised, many of them discontinuous, and unable to be correlated with any certainty, but two well-known units are retained as stratigraphic markers over a limited area. These are the rhyolitic lapilli-tuff of the Benscliffe Member (Watts’ ‘Felsitic Agglomerate’, the ‘Pink Grit’ of some authors), at the base of the Beacon Hill Formation, and the Sliding Stone Slump Breccia Member at the base of the succeeding Bradgate Formation. The first is not seen in the area covered by this account; the other is a well-known feature of Bradgate Park and is described later. Another useful marker horizon is the Sandhills Lodge Member within the Beacon Hill Formation, correlated over a limited area, and seen in Hunt’s Hill Wood at the north-west entrance to Bradgate Park; it is a coarse, rhyolitic lapilli-tuff which was formerly mapped as Felsitic Agglomerate, but is now recognised as a separate horizon.

Charnwood Forest has achieved some fame as the first locality in Britain where fossils have been found in the Precambrian. Since the first frond-like impression was noticed by a Leicester schoolboy in 1957, other fossil structures have been found, which are probably various coelenterates and an arthropod (Ford, 1968, 1980; Boynton, 1978; Boynton and Ford, 1979).

Various markings on the bedding planes near the top of the Maplewell Formation have been interpreted as the impressions of soft-bodied organisms such as jellyfish (Cyclomedusa spp.), sea-pens (Charnia masoni, Charniodiscus concentricus), primitive arthropoda (Pseudovendia charnwoodensis), and other primitive organisms as yet not formally named or described. It is thought that these organisms lived either attached to the sea-floor near the Charnian volcanoes or floating near the surface in the same area. They were probably filter-feeders living on plankton, and their remains sank to the bottom or lay flat thereon when they died, the impressions of their bodies being preserved when buried by an influx of sediment. The markings now exposed on some bedding planes are faint and easily overlooked; unfortunately some have been vandalised. They are best seen in plaster casts available in the Geology Department of the University of Leicester.
These fossils are closely similar to those of Late Precambrian age in South Australia (where there are many more and better preserved specimens), in Newfoundland, Russia, China and Namibia. Together they indicate a stage in the evolution of life on Earth before shells had appeared and before there were carnivores and scavengers.

Structure

The Charnian rocks have been folded into an open, asymmetric anticline plunging gently to the south-east, the resulting outcrop pattern being in the form of a U open to the north-west. The axial trend of the anticline, although generally trending NW-SE, varies from 148° in the north-west, locally 160°, to 090° in the south-east, near the Hallgate entrance to Bradgate Park. Minor folding can be seen in many outcrops, for example on Beacon Hill, and at the Hallgate and Stable Pit localities of Bradgate Park. The mechanism of folding has been discussed by Evans (1963).

The rocks are generally pervaded by cleavage, which noticeably affects the fine-grained rocks more closely, and at a steeper angle, than the coarser ones. In many outcrops there is repeated alternation of steep and less steep cleavage in a sequence of alternating fine- and coarser-grained layers; this feature, recognisable by the rippled effect on some cleavage surfaces, has been called cleavage refraction. The cleavage is not everywhere parallel to the axis of the main anticline; in the north-west it diverges by as much as 60°, and may have affected the rocks after folding. The cleavage is produced by the low-grade metamorphic crystallisation of new chlorite and sericite in a planar-oriented fabric, as seen in thin-section; in rocks coarser than sand grade the chlorite flakes are deflected around the grains in a more wide-spaced, anastomosing pattern but the grains, too, show some rotation, bending, and elongation by additional growth in the direction of cleavage.

Faulting of the anticline appears to be fairly widespread and post-dates both folding and cleavage. It is recognised by displacement of outcrops, as no faults are actually exposed other than in quarries.

Diorite Intrusions

There are two groups of diorites intruding the Charnian rocks, a darker, more basic group in the north and a southern belt of characteristically speckled dark green and pink diorite intrusions 8 km (5 miles) long, through Markfield and Groby. This latter group may be the somewhat discordant components of a sill. The rock is less basic than true diorite, having abundant interstitial micrographic intergrowth of alkali feldspar and quartz which surrounds generally euhedral zoned andesine plagioclase and altered augite (variably replaced by amphibole, chlorite and epidote). Accessory minerals are iron oxides, apatite and sphene. This rock has been described as a granophyric diorite but is properly termed a monzonitic diorite or potassic diorite. In the past it was
called markfieldite. The intrusions were probably emplaced before the Charnian folding and cleavage since, although the diorites do not show actual cleavage, they are traversed by ductile shear zones almost parallel with the cleavage direction; and spotted hornfelses at some diorite contacts show deformation of spots consistent with a later, superimposed cleavage (Boulter & Yates, in press).

AGE OF THE ROCKS OF CHARNWOOD FOREST

Fossils do occur in these rocks and radiometric age determinations have been made, and there is little doubt that the rocks of Charnwood are Upper Proterozoic. They probably lie within the range 700 to 550 Ma, the Charnian sediments being perhaps 650 to 700 Ma and the dioritic intrusions being about 600 Ma old.

Correlation of the fossils in the Bradgate Formation near the top of the Maplewell Group with similar fossils in South Australia and elsewhere, provide evidence no better than to indicate an Upper Proterozoic age. Whole-rock K-Ar isotope determinations made on the porphyritic dacite lavas at Bardon Hill have suggested a minimum age of 684±29 Ma (Meneisy & Miller, 1963), and if the field relations are believed, which at present suggest that they were contemporaneous with the tuffs and breccias just below the Bradgate Formation, then the Charnian fauna may also be c. 700 Ma old.

The only other published attempts to date Charnwood rocks are those on the diorites (markfieldites) which intrude the youngest Charnian sediments in Bradgate Park and extend along the south-western flank of the Charnwood outcrop from Groby to Markfield. A Rb-Sr isochron gave a date of 540±57 Ma (Cribb, 1975, quoted, using a revised constant, by Pankhurst, 1982) which is similar to a K-Ar age-determination of 547 ±24 Ma carried out on the diorite by Meneisy and Miller (1963). But such dates, suggesting a Lower Cambrian age for these intrusions, contradict the evidence seen (albeit intermittently) in Judkins Quarry at Nuneaton, Warwickshire, where diorite similar to that in the Markfield area also intrudes Precambrian bedded pyroclastic rocks, and where boulders of the diorite occur in the basal conglomerates of the unconformably overlying Hartshill Quartzite. This quartzite is Lower Cambrian (probably Tommotian) age, current estimates of the age of the base being 590 Ma. Therefore on stratigraphic grounds the diorites cannot be c. 550 Ma, but must be older. It seems likely that the 540 Ma Rb-Sr date is reset, and may actually indicate the age of the development of the Charnian cleavage, when epidote and chlorite formed in the bedded pyroclastic rocks. The northern diorites of Charnwood gave even younger Rb-Sr ages (c. 300 Ma), possibly reset during later (?Hercynian) mineralization which is known to have occurred.

The geochemistry of the diorites suggests that they are not comagmatic with the Charnian pyroclastic sediments. Whereas the older volcanic rocks are the products of calc-alkaline volcanism above a shallow subduction zone, the potassic diorites are more typical of the magmatism emanating from a deeper subduction zone.

These diorites are also petrographically and geochemically
distinct from the Caledonian calc-alkaline diorites of the 'Leicestershire pluton' which comprises the gabbro-diorite-tonalite-granodiorite complex of Mountsorrel, together with the intrusive rocks of Enderby, Croft and Stony Stanton to the south (Le Bas, 1981). That pluton has been reliably dated by several independent isotopic methods as Mid-Ordovician (c. 450 Ma), but some evidently ambiguous Rb-Sr dates of c. 530 Ma were unfortunately correlated with the erroneous 540 Ma dates of the Charnian diorites, causing confusion.
A GEOLOGICAL ROUTE AROUND BRADGATE PARK

Summary

By entering the park from the Hunt's Hill car park in the north-west, you can work systematically up the succession (Figs. 2 & 3). On this route the lowest strata seen in the Beacon Hill Formation, the Beacon Tuffs and Sandhills Lodge Members, are examined first (localities 1 and 2). The succeeding Old John Member is well exposed in the north of the park (locality 3) as far as the War Memorial.

The base of the Bradgate Formation is marked by a unit named the Sliding Stone Slump Breccia Member (Moseley & Ford, 1985). Its outcrop can be traced right across the Park (Fig.2), but in this Guide we leave the crags south of the Memorial (locality 16) to be examined on the way back, and now make for the faulted outcrops of this remarkable breccia just south-east of Old John Tower (locality 4) and the Sliding Stone outcrop to the east (locality 6). A short detour 160 m north of the Sliding Stone leads to locality 5, where a 'pull-apart breccia' can be seen in the Old John Member. The route then leads southwards through the Bradgate Formation, in which the well-bedded tuffs of the Hallgate Member overlie the Sliding Stone Slump Breccia, including several further examples of breccia (locality 6a). This group of outcrops terminates in a series of steep crags overlooking a shallow valley on the north side of Dale Spinney. At the eastern end of these outcrops is a rock surface formed by an extensive undulating bedding plane (locality 7).

The uppermost beds in the Hallgate Member are exposed near the Hallgate entrance, where they are affected by minor folding in the nose of the anticline, (localities 8 and 9a) and have sedimentary structures associated with turbidite deposition (ripple lamination, graded bedding) which are well seen at this last locality (9a) and in a small quarry (locality 10). Between Coppice Plantation and Cropston Reservoir is a very small exposure of conglomerate, taken to be infilling a channel in the underlying Bradgate Formation and representing the Hanging Rocks Conglomerate Member at the base of the Brand Group (locality 9). Some pebbles are rotated into and deformed by cleavage.

From the Hallgate exposures the route takes the tarmac road towards the ruins of Bradgate House and across the stream to the old Stable Pit, where the Quartz-arenite Member of the Brand Group is well exposed. It shows flexural-slip folding, steep boudinage and wrench faulting (locality 11). Exposures of the well-jointed diorite are seen beside the house ruins (locality 12). An outcrop of Triassic red marl can be seen across the stream (M on map) but cannot easily be reached. The route now follows the line of diorite crags westwards beside the River Lin which here has excavated an old Triassic gorge (locality 13), towards the Newtown Linford entrance; here (locality 14), the diorite can be examined, or the route taken directly up the hill towards the Memorial, looking at intermittent exposures and boulders to locate the approximate position of the contact between the diorite and the Bradgate Formation. The nearest exposures to the contact are at locality 15. Just below the Memorial continuous exposure in the lower part of the Bradgate Formation can be examined beside the path (locality 16), and compared with the succession at the Sliding
Figure 2. Geological sketch-map of the Precambrian rocks in Bradgate Park, (excluding Triassic rocks and Drift).
Stone (locality 6).

Details of localities

Hunt's Hill

Locality 1. Small exposures of medium-grained tuffs on the west side of the path represent the oldest rocks in the area of the Park; they are overlain by successively younger rocks southwards (Fig. 3). Notice the steep cleavage, and the bedding dipping at a moderately low angle to the south-east. Deciding where these rocks fit in the Charnian succession depends on the identification of the overlying lapilli-tuff (locality 2); Watts took this to be the marker bed he called the 'Slate Agglomerate', but others considered it to be the 'Felsitic Agglomerate' lower in the succession. Moseley (1979) has recognised it to be an additional horizon between these two (naming it the Sandhills Lodge Member), and the tuffs of locality 1 therefore represent the underlying Beacon Tuff Member of the Beacon Hill Formation (Table 1).

Under the microscope, these rocks are mainly medium-grained, crystal lithic tuffs, with abundant plagioclase crystals (some zoned, and up to andesine composition), quartz and untwinned, sericitised feldspar, various feldspar-rich volcanic rock fragments, pumice and secondary chlorite and epidote. The presence of pumice and fresh plagioclase suggests rapid deposition of volcanic ash with little reworking, but some quartz grains are rounded and may indicate addition of other sedimentary material. Beside the path, 20 m further on, another exposure shows the light-coloured weathering characteristic of acid (i.e. siliceous, feldspathic) tuffs.

Locality 2. Leaving the path at its highest point in the wood, proceed along the low ridge eastwards for some 50 m towards a pillar of rock 2 metres high which marks the outcrop of the Sandhills Lodge Member (Table 1). In this locality it is 9.4 m thick, but the base is not seen. It consists of coarse tuff with lapilli (<64 mm) of pink rhyolitic lava, together with occasional larger clasts (10 cm) of light-coloured laminated tuff. The unit is generally unsorted, but it passes up into less coarse-grained tuff having vague bedding structures; it is overlain by bedded tuffs. How was this rock formed? It has features consistent with deposition from a volcanic debris-flow, or submarine lahar. Similar features, however, are also characteristic of subaqueous ash-flows deposited directly from a pyroclastic eruption. Figure 4a illustrates these two possible processes: the typical graded sequences recognised in sedimentary turbidites and debris-flows (left) and in subaqueous pyroclastic flows (far right). Note that actual units vary in thickness and grain size, and not all divisions of a typical sequence are necessarily present. How either of these two types of flow might have formed is shown diagrammatically in Figure 4b, in relation to the volcanic environment of the Charnian deposits.
In thin section the tuff is seen to comprise many assorted fragments: felsites or rhyolites of varying texture, trachytic, feldspathic rocks and pumice, with crystals of plagioclase, alkali feldspar and quartz, along with later chlorite and epidote. Some of the quartz grains are rounded and a few are of metamorphic origin. The mixed character, with not a great deal of pumice, indicates that this is perhaps more likely to be a re-worked debris-flow than a primary pyroclastic flow. Chemical analysis (by JM) confirms that it is rhyolitic, with >70 per cent SiO₂.

Notice the effect of cleavage in these coarse tuffs. Compared with finer grained rocks the cleavage is poorly developed, but the matrix of the rock has achieved a degree of alignment by the development of chlorite oriented around the more rigid rock particles and crystal grains. Generally the macroscopic pink and buff rhyolitic fragments are little affected by cleavage.

About 20 metres to the south, still in the wood, are low outcrops of thinly bedded tuffs that overlie the coarse tuff. The bedding dips to the south-east.

The toilet building by the entrance to Bradgate Park is worth noticing, as it is constructed entirely from Charnian rocks. The roof is composed of Swithland Slates obtained locally from the well-cleaved pelites of the Swithland Formation. Large stones in the walls include porphyritic dacite from north-west Charnwood; some are characteristically hematite-impregnated while others are so intensely cleaved that quartz phenocrysts are cracked and feldspars flattened.

Figure 3. Diagrammatic section through the Precambrian rocks of Bradgate Park. Beacon Hill Formation: BT Beacon Tuffs Member, SLM Sandhills Lodge Member, OJ Old John Member. Bradgate Formation: SSSB Sliding Stone Slump Breccia Member, H Hallgate Member. Diorite (crosses), with faulted contact. bc boulder clay.
Old John Hill

Locality 3. On entering the park from the Hunt's Hill gate you will see a hill ahead of you surmounted by a stone tower; known as Old John Tower, it was built about 1784 and used as a hunting lodge. The unexposed lower slopes are occupied by boulder clay. On this hill there are excellent exposures of the type-section of the Old John Member, the uppermost beds of the Beacon Hill Formation (Table 1). These rocks consist of interbedded varied tuffs, and the strike is here more or less E-W, with a southerly dip steeper (52°) than in the Hunt's Hill outcrops. Such changes in attitude of bedding between outcrops may be due to undulating folds or perhaps to faults between the groups of outcrops.

The bedded tuffs show plenty of evidence of submarine deposition with a variety of sedimentary structures (Plates 1 and 2). The deposits range in grain size from coarse tuff to fine dust-tuffs in beds from 50 cm down to less than 2 cm thick. Graded bedding is recognisable in some layers, and many of the tuffs were evidently deposited as turbidites. You will also find examples of disrupted bedding, indicating movement on an unstable slope; and of breccia in which clasts of laminated tuff may have been torn up from the underlying sea-bed by a turbidite flow. Notice that these horizons are sandwiched between undisturbed beds below and above. One such horizon can be seen in the second group of crags as you approach Old John from Hunt's Hill, and another occurs higher up, towards the eastern end of the crags; here a band of breccia, 20 cm thickening to some 30 cm eastwards, is overlain by undisturbed finely bedded tuff. Strips of laminated tuff which constitute the clasts in the breccia are up on end, bent and thrust over one another (Plate 2A). The highest crags on the north side of Old John are formed of rhyolitic lapilli-tuff, with fine-grained pink fragments set in a coarse-grained tuff matrix. It passes laterally into tuff enclosing disrupted laminated clasts. In places there are small depressions in the bedded tuffs, 10-20 cm in section, infilled with laminated deposits; their origin is uncertain, but they might perhaps have formed by collapse of wet sediment associated with the escape of pore-fluid (Plate 2B).

The fine, siliceous dust-tuffs of porcellaneous appearance, once known as hornstones, represent the fine particles that took a long time to settle after an eruption, either having circulated in the atmosphere or having been suspended longer in the water. On the upper slopes north of Old John the rocks are predominantly fine, porcellaneous dust-tuffs, light grey but weathering to cream, some of them rusty red (with hematite) on joint surfaces; though fine-grained, they are not closely cleaved. Some beds of dust-tuff may be related to the eruption of an underlying coarser tuff-flow unit, and others may belong to independent eruptive episodes, even from separate, more distant sources.

The bedded rocks show cleavage refraction. The fine-grained tuffs with a closely reoriented chlorite fabric show a steep-angle slaty cleavage, but the coarser tuffs (>1-2 mm) having only a relatively sparse network of oriented chlorite are poorly cleaved (that is, having less frequent partings and at a less steep angle). Notice, though, that the very fine dust-tuffs do not always show close cleavage; they were probably indurated by silicification.
Plate 1. Soft-sediment deformation in laminated tuffs, Locality 3, north of Old John. Note how sliding on planar surfaces has disturbed the bedding (centre of photograph, left and right of lens cap), but beds below and above are undisturbed.
Plate 2A. Soft-sediment deformation structures in tuffs of the Old John Member, Locality 3. The disturbed unit shows disruption and contortion of the original bedding. Beds are undisturbed below and above.

Plate 2B. Sedimentary depressions in tuffs of the Old John Member, southwest of the Memorial. These depressions, possibly due to collapse after dewatering, are in structureless medium-grained tuff, and infilled by fine, laminated tuff.
before the cleavage developed. In places you can see dislocations due to small-scale movements along cleavage planes.

On a clear day there is a very fine view from Old John. The wooded hill to the north-west is Benscliffe (where coarse rhyolitic and lapilli tuffs are taken as the lowest member of the Beacon Hill Formation). Benscliffe lies on the axis of the main Charnian anticline, and to the left the rocks are dipping to the south-west, while those to the right are on the north-eastern limb. A more distant hill to the left, with a wooded crest, is Timberwood, with Bardon Hill to the left beyond it (these are in the area of Charnwood believed to be closest to a volcanic eruptive centre, characterised by very coarse agglomerates and intrusive porphyritic dacite). To the right of Benscliffe, the high hill to the north is Broombiggs with Buck Hill beyond it to the right, both in the Beacon Hill Formation, and dipping north-east. To the right is Swithland Reservoir, with the hills of Buddon Wood behind it, formed by the Mountsorrel granodiorite complex, Caledonian in age and younger than the Charnwood rocks. Just to the right, and this side of Swithland Reservoir is Swithland Wood; here, outcrops of the Swithland Formation (the uppermost Charnian rocks) were quarried for slates. (The wood is open to the public, and it is possible to reach it by footpath from Bradgate to examine the Swithland Slates, which are not exposed in Bradgate Park.) In the Park east of Old John is the Sliding Stone Spinney, and the crag with a small oak growing out of it which marks the Sliding Stone Slump Breccia at the base of the Bradgate Formation; these rocks form a succession of craggy outcrops dipping to the south. Dale Spinney is seen to the right, beyond which is Cropston Reservoir on the south-eastern edge of the park. In the distance is the city of Leicester. Many of the valleys in Charnwood Forest are old Triassic wadis; much of the Trias is covered by drift, but an outcrop of red Triassic marl can be seen in the Park south of the river (M in Fig.2).

On the south side of Old John, above what was once the back wall of a stable, a smooth worn surface of rock shows good examples of graded bedding, and the crags just to the west are worth examining for varied sedimentary structures.

For the next locality (4), head first towards a seat at the eastern edge of Old John Hill and, turning to your right you will see a line of separate outcrops on the hill below, to the south-east.

Locality 4. This group of outcrops extending down towards the central valley is formed by the spectacular Sliding Stone Slump Breccia. Some 3 to 4 m of massive coarse-grained tuff enclose large clasts (up to 1.3 m) of light-coloured laminated tuff, showing all gradation from slightly bent to plastically contorted. On the most westerly crag of the group, a large raft of bedded tuff, though irregularly contorted, plunges now in the general direction of bedding to the south. After correcting for subsequent tilting the direction of movement of the breccia has been calculated to be 217°. Only a small number of such structures can be measured, and the results so variable that averages are not really useful, but six of fourteen measurements carried out within
1 km indicate slumping or sliding in a direction between 161° and 166°. Measurements of current directions indicated by other cross-stratified bedded units, however, do not coincide with the sliding – most lie between 007° and 021°. Thus, whilst the general direction of currents on the sea-floor was to the north north-east, the palaeoslope down which the breccia flowed was probably inclined from north-west to south-east. The breccia therefore probably came from the volcanic source region that lay to the north-west.

Cleavage is poorly developed in the coarse tuff matrix, but penetrates just a few of the fine-grained blocks. One can see why it was once called 'Slate-agglomerate' but careful consideration of the manner of formation of this deposit will show why the old term was not satisfactory. The enclosed laminated tuff clasts were obviously not slates – i.e. they were not indurated, and certainly not cleaved, at the time of their incorporation in the deposit. Neither the base nor the top of this massive unit is seen here, but there is evidence (in the easternmost crag) that the large clasts occur mainly in the lower part of the unit, the upper part consisting of massive coarse tuff.

The position of the outcrops relative to those on the Memorial hill to the west and the Sliding Stone crags to the east indicates the presence of two faults, more or less N-S, at each end of the line of crags. Notice the late development of quartz-filled tension gashes that cut across the fragments. Cross over to the Sliding Stone crags, but before examining these outcrops a short detour can be made to the northern edge of the Park near some birch trees (Locality 5).

Locality 5. Here are bedded tuffs of the Old John Member, about 1.5 m to be seen, in which a bed of breccia contains fragments of laminated tuff up to 12 cm long lying parallel with the bedding. It is a matter for discussion whether the fragments belong to a bed of tuff only slightly disturbed by movement on an unstable slope (pull-apart breccia), and were the product of wet-sediment boudinage, or were transported as part of a debris-flow. (Plate 3A, from perhaps the same horizon on the Memorial hill, is comparable.) This is the horizon mapped by the Geological Survey as the 'Park Breccia' (Coalville Sheet 155).

Sliding Stone Outcrop

Locality 6. The Sliding Stone Slump Breccia Member at the base of the Braggate Formation was named by Moseley & Ford (1985) after this well-known locality, long known as the Sliding Stone crags (Plate 3B). The origin of the name 'Sliding Stone' we have not been able to discover, but some of the large rocks at the outcrop have obviously fallen at some time. The Breccia itself may have formed geologically as a 'slide' on the Precambrian sea-floor – but the name of the locality in this connection is purely coincidental.

The base is not exposed here, but the lower 4 m of breccia passes up into massive coarse tuff, 5.1 m thick, in which cleavage is poorly developed but jointing well seen. Both here and on the west side of the Park below the Memorial (Locality 16), the unit, together with the overlying beds, can be examined in detail. It is
Plate 3A. Pull-apart structures in tuffs of the Old John Member. This example is between the Memorial and Old John spinney, but compare Locality 5.

Plate 3B. The Sliding Stone outcrop at Locality 6, the type-locality of the Sliding Stone Slump Breccia Member (the Sliding Stone Breccia). You can see some of the chaotically disposed clasts on the block in the foreground.
Plate 4A. Close-up of the Sliding Stone Breccia at Locality 6. (View is about 1.5 m, lens cap scale.) Note the angular fragments, broken and bent, of laminated fine tuff, enclosed in a matrix of very coarse tuff of assorted volcanic granules a few mm in diameter. The deposit is probably a submarine debris-flow, composed of volcaniclastic material brought down from the slopes of a volcano.

Plate 4B. Close-up of rolled-up clast of bedded tuff enclosed in the breccia at Locality 6. The clasts were obviously semi-coherent when caught up in the debris-flow. (Lens cap for scale).
clearly the product of mass flow, as we have seen from the unsorted deposit exposed at Locality 4. Notice again here that the lower part is characterised by chaotically disposed fragments of laminated tuff suspended in a matrix of coarse tuff (Plate 4A); the enclosed clasts of tuff were coherent enough to break up into blocks, yet plastic enough to roll up (Plate 4B). Were they likely to have originated as regularly bedded rocks within the unit, which became disrupted by sliding, or should they be interpreted as strips torn from the underlying strata in the path of the flow? It may be advisable to call the rock more simply the Sliding Stone Breccia, leaving questions such as slumping versus sliding, and debris-flow versus pyroclastic flow, open to discussion. The overlying massive tuff, though somewhat less coarse, is, by the continuity of the matrix, clearly part of the same unit, and it passes up into thinly bedded tuff. This pattern is characteristic of both high-concentration debris-flows of sedimentary origin and submarine pyroclastic flows from a volcanic eruption (see Fig. 4).

The restriction regarding taking of specimens means that there are few thin sections in existence. Those that we have are conspicuously volcanic in character, with an abundance of fresh feldspar, trachytic to felsitic volcanic fragments and pumice, with much chlorite and epidote. The amount of juvenile pyroclastic material (pumice, and not necessarily all the crystals) may, however, amount to only about half the fragments, the rest being assorted lithic material. This could be evidence for redistribution of previously erupted material by debris-flow. Primary pyroclastic flows might, if hot enough, have shown signs of welding. Occasional boulders can be found (e.g. near locality 6a) which show parallel alignment of dark chloritic blebs, but note that, in general, parallelism of chlorite is related to cleavage and cannot usually be interpreted as following the eutaxitic texture of an ignimbrite; undoubted ignimbrites, however, do occur elsewhere in the Forest.

The tuffs overlying the Sliding Stone Slump Breccia are designated the Hallgate Member of the Bradgate Formation. The excellent exposures can be followed to the southern bluff of the hill overlooking Dale Spinney; there are good examples of refracted cleavage, and sharply angular outcrops, typical of most of the Charnian rocks, defined by the intersection of bedding and fracture-cleavage. There are also several more beds of breccia (from the Sliding Stone crags to locality 6a, and up to the top of the hill), varying in thickness, texture and size of fragments, and it can be observed that thick flows (e.g. the Sliding Stone breccia) contain the largest clasts and are the most coarse-textured. There are also graded turbidite flows of medium thickness (<30 cm), some having laminated tops, but lacking any breccia clasts. Chemical analysis (by JM) has shown that the Hallgate Member includes both andesitic-dacitic and rhyolitic tuffs.

The recommended route then takes you eastwards towards the Hallgate corner of the Park.

Locality 7. On the SE slope of the hill is a conspicuous rock surface of unusual form; one can deliberate whether this might be an ice-worn surface (close jointing but no recognisable scratch
Figure 4. a. Typical sequences through mass-flow deposits: sedimentary turbidite (left) and subaqueous pyroclastic flow (right); typical sequence in a Charnian unit (centre).

b. This is how either type of flow might have formed in the context of a Charnian volcano. Mass-flow of sediment (left) includes a range of possibilities from dense debris-flows to more watery turbidity flows.
marks), or merely a large, undulating bedding plane. From here, cross the unexposed ground to the north of Coppice Plantation; near the Park boundary is one of the underground reservoirs of the Severn-Trent Water Authority.

Continue towards the Hallgate entrance, and turn up the small hill south-east of the coppice.

Hallgate

**Locality 8.** Here, a group of small outcrops in the upper part of the Hallgate Member shows minor folding in the nose of the Charnwood anticline. Bedding can be seen on the sides of some rock surfaces, as bands of varying colour or grain size. In the first two adjacent outcrops where bedding can be measured, the strike is 287°, dip 26° NE, and 302°, dip 30° NE. The cleavage direction is E-W, and is steeper than the bedding; notice that it varies from 70° N to almost vertical in different layers. Notice, too, the presence of quartz-chlorite veins, mainly in two directions, one following the cleavage, and the other following a splayed, antithetic set of fractures. The small amount of native gold found in Charnwood probably originates from mineralization veins of this kind.

At the second group of outcrops further south, you will see that the bedding dips at 35° to the south; we have traversed a small fold. The cleavage is still steep to the north.

**Locality 9.** Down the hill to the south, facing the reservoir and sometimes hidden in bracken is a small but interesting exposure of conglomerate and coarse-grained tuffaceous greywacke. Lithologically the rocks are quite unlike the Bradgate Formation; there are oval pebbles up to 4 cm long, some smooth and water-worn, others rough and more angular (Fig. 5). They include igneous types such as porphyritic andesite and coarser plagioclase-rich rocks along with metaquartzites, in a matrix of detrital quartz and feldspar. Bedding is difficult to detect in the conglomerate; the most obvious feature is the alignment by rotation of some of the pebbles and fragments into the direction of cleavage, but a bedding plane is probably represented by the junction between the less coarse sandy tuff on the left (to the south) and above the conglomerate.

The relationship between these rocks and the Hallgate Member tuffs that occur topographically higher on the hill has to be considered. The Hallgate tuffs dip various ways, as we have seen, owing to minor folding, but it is difficult to reconcile the dip of bedding in the nearest outcrops, and their topographical level, with a conformable passage into the conglomerate and arenaceous beds of this outcrop. If these deposits are the basal beds of the Brand Group, there seems to be a case for suggesting that erosion of the Bradgate Formation occurred, with the deposition of basal conglomerate in a scoured out trough or channel. This would be equivalent to the Hanging Rocks Conglomerate at the base of the Brand Group elsewhere in the Forest. But it is also worth considering whether the outcrop could be within the Bradgate Formation, conformably underlying the rocks of the prominent cliff.
on the hill above, which from this angle can be seen to be folded into a shallow syncline.

Make your way up to this outcrop.

**Locality 9a.** Notice the attitude of the bedding, downfolded into a gentle syncline. These are good examples of medium- and thinly bedded turbidites, in which sedimentary structures include graded bedding, ripple lamination, seen as cross-lamination on a small scale, and convolute bedding caused by liquefaction and deformation of wet sediment. It is worth examining the surfaces showing refracted cleavage (Plate 5A). Does a curved cleavage-plane reflect graded bedding, or is it due to adjustment across beds of different lithologies? If the fine-grained layers have undergone relatively more shortening perpendicular to the plane of cleavage, is there any sign of movement on the bedding planes?

The outcrop below the syncline to the south dips more steeply, perhaps indicating the asymmetric character of the minor folding on this limb of the main Charnwood anticline.

![Field sketch of conglomerate](image)

**Figure 5.** Field sketch of the conglomerate at Locality 9, possibly the Hanging Rocks Conglomerate occupying a channel eroded in the Hallgate Member. The outcrop is about 3 m wide.
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*Figure 5. Field sketch of the conglomerate at Locality 9, possibly the Hanging Rocks Conglomerate occupying a channel eroded in the Hallgate Member. The outcrop is about 3 m wide.*
Plate 6A. Boudinage (pinch-and-swell) structures in associated quartzite and pelite, Stable Pit, Locality 11. (See Fig. 6). This is tectonic boudinage (extensional 'necking' of quartzite; note fibrous quartz, reddened by hematite, developed between boudins).

Plate 6B. Diorite, exposed near Breidjat House ruins, Locality 12. It shows jointing, but no cleavage.
Plate 5A. Cleavage-refraction in bedded tuffs, Locality 9A.

Plate 5B. Ripple lamination in thinly-bedded turbidites, locality 10.
Locality 10. A small disused quarry in moderately cleaved tuffs of the Hallgate Member of the Bradgate Formation shows, as in the syncline exposure just examined, excellent sedimentary structures produced by low-energy turbidity currents, such as ripple lamination (Plate 5B) and graded beds, in very thin to medium-bedded units.

Follow the roadway south-west towards the ruins of Bradgate House. The house was built c. 1490-1505 by Thomas Grey, father of Lady Jane Grey (the Queen for nine days, who was born here). The house fell into decay after 1739. Cross the bridge over the Lin and make for the massive outcrop on the south side of the stream.

The Stable Pit.

Locality 11. This is the type-locality for the Stable Pit Quartz-arenite Member of the Brand Hills Formation (Table 1), formerly known as the Trachose Grit and Quartzite (Watts, 1947). Most of the outcrop is of massive quartzite in shallow, undulating folds; it is possible to detect the bedding and cross-bedding on the north side, and the folds are well seen on the top. Slickensiding on the bedding planes coincides with the direction of flexural slip of competent beds during concentric-type folding. Notice, too, the pattern of quartz- and chlorite tension gashes. The steep south wall is also slickensided; this is a fault, the horizontal grooves indicating that it is a wrench fault. Along the fault is a narrow dyke of altered and sheared diorite; it is scarcely recognisable, especially as one is not allowed to hammer or obtain specimens, but it occupies the hollow about a metre wide, against the steep fault plane (Fig. 6).

Some samples of quartzite from this locality are variably affected by crushing, shearing and recrystallisation into a fabric of elongate, fibrous, strained quartz with sericite. Where it is less tectonised the quartzite consists of fairly well sorted, subrounded detrital quartz, with some composite metaquartzite grains and a little plagioclase and perthite, grain size varying from about 0.3 mm to 0.6 mm, in a sparse matrix containing recrystallised quartz, chlorite and sericite. The quartz grains are mostly strained, and crystallisation of overgrowths has resulted in a well-bonded fabric showing some elongation with the cleavage direction of oriented chlorite and sericite.

On the south side of the Stable Pit there are first some pelitic rocks intercalated with quartzite, then pelite with a steep slaty cleavage, and more quartzite characterised by open folds (Fig. 6). The pelite-quartzite zone shows steep boudinage structures and quartz veining (Plate 6A). This complicated zone may be a fault-breccia.

The pelites are visibly reddened, and it will be appreciated that we must here be close to the Triassic land surface. Within the pelites can be found (on a low east-facing vertical surface) several narrow (c. 5 cm) bands of sandy sediment, which have been described (Moseley, 1979) as clastic (i.e. sedimentary) dykes. They are worth examination and discussion. One cannot envisage the intrusion of wet sediment from below into the cleavage, because cleavage would certainly have developed long after any wet sediment could still be present to be squeezed up. Could they perhaps be original quartz-arenites interbedded with pelite? Does the bedding in fact steepen from the shallow folds in the south towards
Figure 6. Field sketch (a) of the Stable Pit outcrops, viewed from the grassy bank on the east side, and diagrammatic section (b). (Locality 11). (Q=Quartz-arenite (quartzite), P=pelite (slate)).
the zone of steep boudinage, where pelite and quartzite are closely intermingled? Or could the 'dykes' have formed in Triassic times by sediment falling into cracks in the cleaved Charnian underneath?

Return over the bridge towards the House.

**Locality 12.** The crags to the left of the House are of intrusive diorite (Plate 6B), part of a sill-complex emplaced in the Charnian near the junction between the Maplewell Group and the Brand Group; no intrusive contacts can be found in the Park and junctions may in fact be faulted. The rock, which has long been known as markfieldite, after the village of Markfield nearby, is characteristically speckled greenish (owing to the presence of secondary epidote and chlorite) and pink (from the iron oxides in the altered feldspars). It is a monzonitic quartz-diorite; in thin section are seen zoned plagioclase crystals, often euhedral, having turbid and sericitised cores, surrounded by abundant micrographic intergrowth of quartz and alkali feldspar, with patches of relict green to brown hornblende, heavily chloritised, and magnetite, apatite needles, epidote and sphene. The diorite is well jointed but shows no cleavage.

From here, walk a short distance to the south-west and look across the river, where a cliff (M) of red and green mottled marl interbedded with siltstones can be seen. The hilly landscape of Charnian rocks was buried by these Triassic deposits of Mercia Mudstone (Keuper Marl). The typical red colour is due to the abundance of ferric oxide, the green to reduction patches of ferrous oxide.

**Locality 13.** Follow the line of diorite crags westwards towards Newtown Linford. The crags mark the course of a small gorge, some 500 metres long and up to 40 m high, known as 'Little Matlock', which is followed by the River Lin. Various explanations have been put forward for the origin of the gorge: 1) a Triassic wadi (a desert water-course), exhumed in recent times; 2) a river course superimposed by downcutting into ancient rocks, having been initiated in overlying Triassic mudstones; 3) diversion by glacial till from a former mid-Pleistocene course flowing south from Newtown Linford; and 4) a fault-guided valley. In the absence of any real evidence, one can only speculate. The small dam and waterfalls serve to trap silt and oxygenate the water before the river reaches the reservoir. Cropston Reservoir was constructed in the late 1860s.

**Locality 14.** This locality is included primarily for those who may be entering the Park from the Newtown Linford car park. The first exposure encountered is of diorite (for description, see Loc. 12), in a very small old quarry. Notice the jointing, and slickensiding on some surfaces. The upper metre or so is in shattered rock, perhaps a result of Pleistocene frost action, with more massive rock below. Higher on the hill the outcrops are good, and though lichen-covered there are broken surfaces that show the coarse greenish grey and pink crystalline texture. Geochemically, the diorites differ from the NW Charnian lavas (which in any case
are earlier), having higher K₂O and FeO/MgO.

From the top of the first knoll of diorite, go through the gap in the wall by a group of old oak trees, and head up the hill towards the group of limes and chestnuts on Tyburn Hill. The boulders are all of diorite. North of the Tyburn trees, the path is joined by another from the left; at the convergence of the two paths, look for the nearest outcrop some 25 m east of the path.

**Locality 15.** We have now crossed the contact of the diorite, and these are the nearest exposures in the country-rock. They are of very thinly bedded (< 1.5 cm) mostly fine- to medium-grained graded tuffs, dipping south at 60°, and with marked refraction of cleavage on steep surfaces. They belong stratigraphically to the Hallgate Member of the Bradgate Formation. There is no sign of hornfelsing, despite the proximity of the diorite, and it is therefore concluded that the junction may be faulted. (Intrusive - and faulted - contacts are seen at Cliffe Hill quarry, where the country-rock tuffs include spotted hornfelses.)

Continue up the hill northwards to the crags below the Memorial.

**Locality 16.** The group of exposures south of the Memorial are continuous stratigraphically down the succession through the lower beds of the Hallgate Member to the underlying Sliding Stone Slump Breccia Member as you go up the hill. The dip is about 50° to the south, and the outcrops are defined by a prominent fracture-cleavage that dips about 50° to the north. The steeper slaty cleavage can be seen through some of the fine-grained tuff layers. In suitable light, traces of *Charnsodiscus* and other markings may be visible on a smooth bedding plane, but you are urged not to let anyone mark or otherwise damage them. The presence of these fossils suggests a water depth of perhaps only 30 m.

Within the succession are several thicker beds of relatively coarse tuff, having a rough texture, and poorly penetrated by more than one cleavage (trending 095° and 105°) along with westerly-sloping joints (trending 010°). Quartz veins run parallel with the 105° direction.

The outcrop shown in Plate 7 and Figure 7 lies on the east side of the more westerly path below the Memorial. The succession in this exposure is listed in Table 2, and the sequences grouped mainly into what are considered to be flow-units. The typical Charnian unit is shown in Figure 4a (centre); the thickness of units is variable, but within each unit the lower massive (A) zone of somewhat graded tuff is relatively thick, and passes up into a thin, vaguely laminated B zone, which, in the absence of any recognisable cross-lamination, merges with D. This is overlain by very fine-grained dust-tuff (E) which settled out of suspension, sometimes passing up into grey, siliceous fine-grained cleaved rock that may be tuffaceous sediment (E'; see Plate 7B). This has most of the elements of the characteristic sequence pattern for turbidites recognised by Bouma (1962), with the conspicuous development in the upper division of cream or pink-weathering
dust-tuff; it may therefore be compared with the sequence in subaqueous pyroclastic flows (Fisher & Schminke, 1984; Yamada, 1984; Fig. 4). The Charnian situation was probably a combination of these processes; whilst we cannot be certain of any actual hot pyroclastic flows in the Bradgate area, the volcaniclastic sediments were undoubtedly closely associated with pyroclastic eruptions, which provided the huge volume of ash, triggered off the movement of submarine debris-flows, and threw up finely shattered pumice in the form of glassy dust.

The lowest unit here (1 A to E) is the Sliding Stone Breccia. It is best to go up first to the breccia unit, and even to drop down below the path on the west side to see more of the breccia and the large clasts in it. The clasts, some almost 2 m long, are concentrated in two levels in the lower half of the exposed 10 m of the flow, about 5m apart; the base is not seen. The clasts of laminated tuff are bent or contorted and tend to lie roughly parallel with bedding. The coarse tuff matrix, though generally structureless, is less coarse in the upper part of the flow, and vaguely laminated for the top 0.5 m. It should be noted that the clasts occurring in the lower part are exactly like the laminated upper beds of many units; they are quite unlike the lithic, pumice, crystal-tuff matrix of the breccia. This evidence suggests that the clasts are more likely to be strips of tuff from the top of some underlying unit than to be 'slumped' portions of the bed itself.

Above the Sliding Stone breccia unit (1), the flow-units are thinner (the more obvious flow-units are recognisable by their structureless, coarse to medium 'A' horizons - flows 2, 3, 5 and 7), each passing up into fine-grained deposits dropped from the waning flow and overlain by dust-tuff and tuffaceous pelite fallen from suspension. Units numbered 8 and 9 consist only of the fine-grained upper zones (D and E), possibly the distal parts of flows. Unit numbered 4 in Table 2 is a simplification of a succession of alternating D/E zones, probably a number of distal flows similar to 8 and 9. A flow-unit can be envisaged as a single, often rapid, depositional event, occurring perhaps in a matter of minutes or hours. Grey pelite intercalated between some units may be fine sediment deposited between eruptive episodes, (when, at times, various forms of life were able to find a habitat).

North of the outcrop of the Sliding Stone Slump Breccia the underlying succession in the Park constitutes the Old John Member of the Beacon Hill Formation (see Locality 3). The 'pull-apart' structures shown in Plate 3A are seen between the Memorial and the spinney. A short walk leads to the Hunt's Hill exit of the Park.
Figure 7. Outcrop about 75 m SW of the Memorial (Locality 16), showing the succession from the Sliding Stone Breccia (left). (The letters refer to divisions of the Bouma cycle).

Table 2. Measured section of the crags below the Memorial.

<p>| | | | | | |</p>
<table>
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<tbody>
<tr>
<td>9</td>
<td>E'</td>
<td>3 cm</td>
<td>cleaved grey pelite</td>
<td>D</td>
<td>14</td>
</tr>
<tr>
<td>8</td>
<td>E'</td>
<td>9</td>
<td>cleaved grey pelite</td>
<td>D</td>
<td>13-21</td>
</tr>
<tr>
<td>7</td>
<td>E'</td>
<td>23</td>
<td>cleaved cream-weathering tuff or pelite</td>
<td>E</td>
<td>15-20</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td></td>
<td>thinly laminated tuff</td>
<td>A</td>
<td>10d-9d</td>
</tr>
<tr>
<td>6</td>
<td>E'</td>
<td>15-19</td>
<td>cleaved grey pelite</td>
<td>E</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>E</td>
<td>5</td>
<td>dark pelite or tuff</td>
<td>E</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>50</td>
<td>laminated fine tuffs</td>
<td>E</td>
<td>33-41</td>
</tr>
<tr>
<td>3</td>
<td>E</td>
<td>20</td>
<td>pink dusts-tuff</td>
<td>D</td>
<td></td>
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<tr>
<td></td>
<td>A-C</td>
<td>40</td>
<td>medium-grained tuff, part cross-bedded, white clasts</td>
<td></td>
<td></td>
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<tr>
<td>2</td>
<td>E'</td>
<td>0-10</td>
<td>cleaved silty pelite</td>
<td>E</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>44</td>
<td>laminated tuff</td>
<td>A</td>
<td>44</td>
</tr>
<tr>
<td>1</td>
<td>E</td>
<td>25</td>
<td>pink laminated dust-tuff</td>
<td>D</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td></td>
<td>laminated tuff</td>
<td>A</td>
<td>750</td>
</tr>
</tbody>
</table>

Base not seen

Measurements in centimetres; letters refer to divisions of the Bouma cycle (see Figure 4).
Plate 7A. Outcrop at Locality 16, as sketched in Figure 7.

Plate 7B. Locality 16, below the Memorial. Refer to Table 2. Close-up of dust-tuff (7B) overlying laminated tuffs (7D); note that the dust tuff infills a small depression in the laminated tuffs, also somewhat eroded, the uneven surface perhaps caused by dewatering before the dust-tuff settled from suspension. The dust-tuff lacks slaty cleavage (probably due to silicification), but passes up into cleaved, tuffaceous sediment (7E').
GLOSSARY

Agglomerate. Pyroclastic rock whose fragments, > 64 mm, consist of volcanic bombs.

Arid rock. An igneous rock containing abundant silica, having >20 o/o free quartz.

Andesite. Volcanic rock having plagioclase >2/3 of total feldspar, and SiO₂ 52-63 o/o.

Back-arc basin. Sedimentary basin alongside an active continental margin, behind the volcanic island-arc.

Basic rock. An igneous rock poor in silica (SiO₂ 45-52 o/o), relatively rich in mafic minerals (e.g. basalt).

Boudinage. Tensional thinning and fracturing of a competent bed of rock, resulting in a row of disconnected lenses (boudins).

Breccia. Poorly sorted rock containing angular rock fragments >64 mm.

Calc-alkaline. Suite of igneous rocks having plagioclase>alkali feldspar, characteristic of orogenic regions.

Clast. Fragment of rock.

Cleavage (in rock). Parallel partings produced, under pressure, by recrystallisation of flat, flaky minerals in parallel orientation.

Cleavage refraction. Alternation of steep slaty cleavage and lower-angle fracture cleavage in alternately fine-grained and coarser grained sediments.

Conglomerate. Sedimentary rock composed of rounded, water-worn granules >2 mm and/or larger pebbles - a cemented gravel.

Dacite. Volcanic rock having plagioclase >2/3 of total feldspar and SiO₂ >63 o/o.

Debris-flow. Gravity-flow of sediment in the form of a dense sediment-water slurry.

Diorite. Coarse-grained, intrusive equivalent of andesite.

Euhedral. Well-formed crystal shape.

Drift. Superficial deposits (e.g. glacial, alluvial) overlying bedrock.

Eutaxitic. The texture of a hot, welded ash-flow tuff in which flattened lenses of glassy pumice lie parallel with the bedding.

Felsite. A fine-grained (possibly recrystallised) quartz-feldspathic igneous rock.

Flexural-slip folding. Undulations in a series of competent beds (e.g. sandstone) which are accommodated by lateral slip on the bedding planes.

Fracture cleavage. Relatively wide-spaced partings in a competent bed (e.g. sandstone), often nearly perpendicular to bedding.

Graded bedding. A change from relatively coarse to relatively fine grainless in a single bed. Normal grading fines upwards.

Greywacke. An arenaceous rock (1/16 mm to 2 mm) composed of angular grains, many being rock particles, with feldspar and quartz, either graded or unsorted and having a muddy matrix.

Hornfels. A rock recrystallised by heat near the contact with an igneous intrusion.

Ignimbrite. An ash-flow tuff, generally recognised by eutaxitic texture.

Lahar. A mud-flow composed of mainly volcanic material, often carrying large boulders, set in motion by water-saturation on the flanks of a volcano.

Lapilli-tuff. Pyroclastic rock composed of volcanic rock fragments 2 mm. to 64 mm.

Markfieldite. A potassic diorite named after Markfield, 3 km from Bradgate Park.

Metaquartzite. Metamorphosed sandstone, having recrystallised, interlocking quartz grains.

Micrographic intergrowth. An intricate intergrowth seen under the microscope, of quartz and alkali feldspar.

Monzonite. An intrusive rock having plagioclase between 1/3 and 2/3 of the
total feldspar, and <20 o/o quartz. (Between a syenite and a diorite.)
Pelite. A fine-grained, lithified mud.
Porphyritic. Igneous rock containing a generation of larger crystals set in a finer-grained groundmass.
Proterozoic. The period of time between the Archaean (2500 Ma) and the beginning of the Cambrian (580 Ma ago).
Pull-apart breccia. A rock containing fragments of a bedded rock lying parallel with the bedding, as though disrupted by extensional lateral movement.
Pyroclastic. Erupted in fragmental condition from a volcanic source, e.g. ash or pumice (as distinct from a lava flow). Also describes a sedimentary rock containing >50 o/o pyroclastic material.
Quartz-arenite. Sandstone or sedimentary quartzite, composed of quartz grains 1/16 mm to 2 mm in size.
Radiometric. Measurement of radioactive isotopes and their products, a technique for calculating the age of a rock.
Ripple lamination. Small-scale (<1 cm) cross-bedding.
Rhyolite. Quartz-rich volcanic rock having plagioclase up to 2/3 of total feldspar.
Sedimentary dyke. A sheet of sediment (e.g, sandstone) occurring in a different rock-type; the dyke has either been injected up as water-saturated sand from below, or fallen into fissures in solid rock from above, examples of the latter sometimes being called Neptunian dykes.
Sill. Igneous intrusion emplaced more or less conformably with bedding of country-rock.
Silty cleavage. Steep, close-spaced partings in pelitic rocks, induced by pressure related to folding.
Slickensiding. A set of parallel striations or grooves on a rock surface, caused by differential movement of the rock on each side of the surface, (e.g. faulting).
'Slump-breccia'. Perhaps the Charnian examples are more correctly termed 'Slide-breccia': A chaotic assemblage of clasts, some of which may show convolution, set in a coarse to fine sedimentary matrix, produced by sliding or mass-flow on an unstable slope; beds above and below either flat-bedded or independently 'slumped', precluding any attribution of structures to later folding. (Technically, slumping involves backward-rotational movement.)
Subduction zone. A zone in the earth's crust, generally along the margin of a continent, where two crustal plates are moving towards each other; one plate, usually oceanic crust, descends under the over-riding continental plate at an angle, resulting in an 'active' zone characterised by earthquakes, volcanism, igneous intrusion, folding and faulting.
Tuff. Rock formed from volcanic ash, 1/16 mm to 2 mm in grainsize.
Tuffaceous. Describes a sedimentary rock containing some, but technically less than 50 o/o, pyroclastic detritus. In practice, used to describe rocks of unknown, probably high, ash content.
Turbidite. Sedimentary rock deposited as a flow-unit in the form of a water-borne slurry or more dense debris flow, generally showing graded bedding.
Volcaniclastic. A clastic rock composed largely of volcanic material, whether deposited directly from volcanic eruption, or redistributed by sedimentary processes.
Wadi: A desert valley, water-course.
Wrench-faulting. Lateral, or horizontal, movement of rocks along a fault-plane.
ACKNOWLEDGEMENTS

This Guide has been produced by the collaborative efforts of members and associates of the Department of Geology in the University of Leicester. The authors are grateful to K.T. Pickering, B.F. Windley and C.A. Boulter for advice in the field and for critically reading the manuscript. We also acknowledge timely help from the Geography Department in the preparation of Figures 1 and 2. Mr A. Newton (formerly of Soar Division of the Severn-Trent Water Authority) kindly provided more information than we could include here about the underground and surface reservoirs.

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Boulter, C.A. & Yates, M.G. 1987, "Confirmation of the pre-cleavage emplacement of both the Northern and Southern Diorites into the Charnian Supergroup". Mercian Geol. (in press).


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ANNUAL REPORT FOR 1986/7

Each session of lectures presented by the Literary and Philosophical Society is the product of the initiative of the Programme Secretary and this year the Council of the Society has shown its appreciation of the work done in the 145th Session by Dr. Aftab Khan, in inviting him to become its President when the new session opens on Monday October 5th, 1987. Dr. Khan has given me outstanding support in my year of office, especially on those occasions when my lack of recent Presidential experience has caused me to stumble in my duties. The Society will be in good hands next session.

What has struck me, as a comparatively new member of Council, has been the generous willingness of its members to perform, when invited to do so, the organisational duties necessary to keep this ancient Society in the forefront of the intellectual life of the City. My predecessor, Mr. L. Lloyd-Smith, has ever been ready with help and advice, as indeed have all those elder statesmen and women who have occupied the Presidential Chair in the past and are still active in our councils. Our Vice-Presidents, Mr. M.A. Baatz, Dr. T.D. Ford, Mr. L. Lloyd-Smith and Dr. P.J. Boylan, have all contributed in different ways to the running of the Society, and with them all stands the lady whom I venture to call the embodiment of the Lit. and Phil., our Life Vice President Miss Norah Waddington. She joined the Society in 1950 and has served us in many capacities for 37 years.

I want to pay tribute to the present "Power House", those executive officials without whom no organisation can succeed. Our Secretary, Dr. D.G. Lewis, has a tremendously full professional life to fulfill but is still able to spare time to perform his secretarial duties with enthusiasm; Mr. P.R. Goodwin reveals, as a true accountant should, in guarding our financial resources and, as will be seen later this evening, is ever mindful of our financial prosperity. Our Membership Secretary, Mrs. M.C. Rablen in the course of her regular duties is the first official to greet members at the door at our fortnightly meetings and she is ever alert to cover any gap in our social arrangements. The work of Dr. Trevor Ford, the Editor of the Annual Transactions, is very valuable to those of us who treasure the records of our lectures and he is quietly persistent in his pursuit of the scripts which are the basis of these records. Our Honorary Auditor, Mr. M.H. Bailey is to relinquish this office at the end of the current session and we offer him our thanks for his services, performed in the true tradition of Auditors, quietly, sympathetically and thoroughly. His place will be taken by Miss J.E. Staples, a Member of Council. I would like to pay tribute to the conscientious courtesy of the Museum Staff and to our own Mr. Mann who presided over the coffee at the end of each meeting and who, regretfully will no longer be able to carry out this service to our members.

The inclement weather of last winter does not appear to have made an appreciable difference to the attendance at our lectures. Efforts have been made to supplement the acoustics of this hall by the Loop System which has proved a great boon to those whose hearing is not what it was. Not all our lecturers have mastered the technique of the microphone and your Council is aware of the need for trying to improve the audibility of some of our speakers which is so essential to the success of our meetings. Three of our lecturers have been sponsored by outside interested bodies. They were Dr. Brigid Boardman by the Leicester City Council Recreation Committee, Mr. Alan Gayton, a personal friend of many members, by the Leicester Mercury, and the distinguished scholar, grammarian and lexicographer, Dr. Robert Barchfield, C.B.E., by the University of Leicester Bookshop. A number of our lecturers have local associations; they were the Vice Chancellor of the University of Leicester, Mr. Maurice Shock, Miss Heather Couper, President of the British Astronomical Association and a Graduate of Leicester University, and Professor J.R. Watson of the University of Durham who was for many years a Member of the Lit. and Phil. and took the place of Captain Bennett of Airship Industries who died in a flying accident.
Dr. Anthony Stuart addressed a meeting held jointly with the Geology Section, while another meeting was similarly shared by the Natural History Section for a lecture by Dr. Malcolm Coe. We were pleased to welcome Mr. Eli Prins who had lectured to the Society in 1945 at its first meeting after the War and he does not appear to have lost any of his enthusiasm for his subject in those 42 intervening years!

Our next Session opens on Monday October 5th, 1987 in an Open meeting for our new President's Address at which we hope to receive Civic and other Dignitaries at a Social Gathering at which we hope as many members as possible will be present. Our provisional list of lecturers contains a number of local people and I hope that your new President and Council will continue to attract the support which has held together the Leicester Literary and Philosophical Society since its foundation in 1835.

A.F. Orton
President, 1986/87

PROGRAMME OF THE ONE HUNDRED AND FORTY FIFTH SESSION 1986-87

6 October 1986
- President's address. OPEN MEETING to be followed by a social gathering. The Lord Mayor and Lady Mayoress will be present.

20 October 1986

A COMET'S TALE - Heather Couper. President, British Astronomical Association, Author and Broadcaster.

3 November 1986

LEICESTER UNIVERSITY SINCE 1977: ACHIEVEMENT AND TURBULENCE - Mr. Maurice Shock, Vice-Chancellor, University of Leicester.

17 November 1986

THE RAVENNA MOSAICS - Mr. Eli Prins, R.O.M., Art Expert and Lecturer.

1 December 1986

LEICESTER MERCURY LECTURE: Mr. Alan Gayton: Communication, the Good News and the Bad News.

5 January 1987

*LANDSCAPE AND TEXT* - Professor J.R. Watson, Durham University.

19 January 1987


2 February 1987

2 March 1987

ICE AGE MAMMALS – Dr. A. Stuart, Asst. Keeper, Castle Museum, Norwich. With Geology Section.

16 March 1987


6 May 1987

AGM. Followed by a musical entertainment by the Halcyon Singers.

Report of the Geology Section

Officers and Committee for 1986-1987

Chairman: Mr. Michael Howe
Vice Chairman: Mr. John Martin
Secretary: Dr. Peter Crowther
Treasurer: Mrs. Pat Maraden
Field Secretary: Mr. Chris Collins
Assistant Secretary: Dr. Diane Thurston
Committee: Dr. Andrew Saunders

Summer Excursion Programme 1986

June 7th. Caledonides of Nuneaton. Leader: Dr. M.J. Le Bas.
June 18th. Welsh Borderlands. Leader: Paul Pollicott.
September 6th. Lias of Holwell. Leader: John Martin.

Winter Programme 1986-7

October 8th Michael F. Stanley, Derbyshire Museum Service. "Geology and Wine".

October 22nd Richard W. Jotham, University of Nottingham (Dept. of Adult Education), "Geology of the Planets".

November 5th John Martin, Leicestershire Museums Service. "Old softies - the Barrow-upon-Soar ichthyosaurs".

November 19th Andrew C. Lingham, British Coal Opencast Executive. "Prospecting for Opencast Coal in North-West Leicestershire".

December 3rd Michael P. Searle, University of Leicester. "Across the High Himalaya and Karakoram Mountains".


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January 31st  Saturday School at Vaughan College. "Extinctions".
Prof. A. Hallam, Birmingham University: Introduction to Extinction Events and Theories.
Dr. L.B. Halstead, Reading University: Mass Extinction: Myth and Reality.
Dr. S. Conway Morris, Cambridge University: Precambrian and Palaeozoic Extinctions.
Dr. M.J. Benton, Queens University, Belfast: Permo-Triassic Events: The biggest mass extinction and dinosaur origins.
Dr. A. Charig, British Museum, Natural History: Disaster Theories of Dinosaur Extinctions.
Prof. R.J.G. Savage, Bristol University: Mammal Extinctions.

February 11th  Members Evening.

February 25th  Barry Scott, University of Leicester.
"The Minerals Industry".

March 2nd
(Monday)
Joint Meeting with Parent Body.
Tony Stuart, Norfolk Museums Service.
"Ice Age Mammals".

March 11th  Annual General Meeting and Chairman's Address by Michael Howe.

Peter R. Crowther
Secretary, Geology Section

ANNUAL REPORT OF THE NATURAL HISTORY SECTION FOR 1986

President: I.M. Evans, M.A., F.M.A.
Chairman: J.D. Cooper, M.A. (retired March 1986)
Vice-Chairman: P. Lucas (Chairman from March 1986)
Hon. Treasurer: Miss E.I. Clay
Hon. Secretary: Mrs E.C. Loosmore
Hon. Asst. Secretary: Mrs D. Thompson, B.Sc.
Hon. Programme Secretary: Miss J.E. Dawson, M.A., A.M.A.
Hon. Editor: Mrs D. Thompson, B.Sc.
Committee:
Mrs J. Allen
M.R. Baker, B.Sc. (elected 1986)
M.T. Billing (retired 1986)
Mrs T. Brown (retired 1986)
Mrs M. Gillham (Vice-Chairman, March 1986)
H. Godsmark
Mrs V. Hennessey
W.R. Morris, B.Sc. (elected 1986)
E.J.W. Venable, B.A. M.Ed.
Mrs G. Warren
S.F. Woodward, B.Sc.
During 1986 there were two issues of the Newsletter under the editorship of Doreen Thompson.

Our winter lectures were, as usual, interesting and varied. The Joint Meeting with the Parent Body was held in the Art Gallery, when Tim Whitmore of the Forestry Institute spoke on 'Tropical Rain Forests, are they really disappearing?'. The 14th Sower Memorial Lecture 'Where have all the Grasslands gone?' was a joint effort by Pat and Ian Evans. Other members of the Section who gave lectures were Stephen Woodward on 'The Landscape of Groby, Past and Present' and Jenny Owen on 'Australia, Land of Contrasts', a vivid account of the safari she made with her son. Martin Withers treated us to a succession of superb slides in a 'Wildlife Photographer's Year' and Chris Smith of the N.C.C. gave a back-up talk to our proposed summer visit to the Chilterns.

The Chiltern visit (a full day excursion) was led by Nigel Phillips, Warden of the Warburg Reserve and the second full day excursion (much later than usual, on 25th October) was a joint effort with members of the Loughborough Naturalists' Club to the Arboretum at Westonbirt. There was also a weekend visit to the New Forest, organised by J. Dennis Cooper.

Once more we are grateful to Jan Dawson for all the hard work she undertook to provide us with such enjoyable winter and summer programmes.

6th January, 1986  Dr T. Whitmore  Tropical Rain Forests - are they really disappearing?
8th January  Dr P. Hart  The Predatory Behaviour of Pike - the Truth by Degrees.
22nd January  S.F. Woodward  The Landscape of Groby, Past and Present.
5th February  Miss J. Dawson  Kashmir.
19th February  Dr B. Grant  The Limits of Microbial Colonization and the Origin of Life.
5th March  Dr C. Smith  The Natural History of the Chilterns.

The Annual General Meeting was held on the 19th March after which we had a social evening with refreshments and a natural history quiz set up by Jan Dawson.

The Section's Summer Programme of outdoor meetings was as follows:

26th April, 1986  Sadlington, Gumley and Smeeton Westerby  Miss J. Dawson
10th May  Wardley Wood  I.M. Evans
24th May  Groby Quarries and Lady Hay Wood  S.F. Woodward
8th June  Full day excursion to the Chilterns  N. Phillips
18th June  Narborough Bog Trust Reserve  W. Lemmon
21st June  Holly Hayes and Coalville Meadows  H.J. Mousley
5th July  Dunton Bassett Quarry  S. Grover
19th July  Moira  L. Fletcher
23rd July  Aylestone Meadows and Great Central Way  E.J.W. Venable
1st - 3rd August  Weekend excursion to the New Forest  J.D. Cooper
8th August  Burbage Wood - moth trapping  W.R. Morris
23rd August  Pillings Lock and the River Soar  D.A. Lott
13th September  Braunston and Manton  I.M. Evans
4th October  Martinshaw Wood - fungus foray  Dr T.F. Hering and Mrs E. Hesselgreaves
25th October  Full day excursion to Westonbirt Arboretum  Mrs M. Barton

Winter Programme
29th October  Dr J. Owen  Australia: Land of Contrasts
12th November  I.M., and Mrs. P.A. Evans  Where have all the Grasslands Gone?
26th November  M. Withers  The Fourteenth Sower Memorial Lecture
10th December  Dr B. Davis  A Wildlife Photographer's Year

Mrs E.C. Loosmore, Hon. Secretary
Mrs D. Thompson, Minutes Secretary
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<td>White House, North Avenue, LE2 1TL.</td>
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1935 Holme, Mrs. H.J.E.
1951 Humphreys, Prof. A.R.
1986 Humphreys, Mr. E.H.
1986 Jacobs, Mr. M.E.
1976 James, Mr. P.J., J.P.
1982 Johnson, Mr. C.A.G.
1962 Johnson, Miss F.M.
1953 Judge, Miss B.M.
1986 Kelly, Miss M.M.
1974 Khan, Dr. M.A., Ph.D., F.G.S., FRAS.
1974 King, Dr. N.W., BSc., LRCP., MRCS., MB., BS., FFARCS.
1968 Kirkby, Rev. A.H., MA., BD., PhD.
1983 Knibb, Mr. E.C.
1986 Koffman, Dr. D., MD., FFPCM., DPH.
1982 Laine, Mr. J.R.
1976 Lamb, Miss F.M.
1971 Lane, Miss D.
1984 Lapworth, Mr. L.W.
1924 Laws, Miss G.
1976 Lawson, Dr. B.
1963 Le Bas, Dr. M.J., BSc., PhD., FGS.
1984 Le Messurier-Ritchie, Mr. A.W.
1980 Leslie, Dr. D.R.S.
1975 Lewis, Dr. D.G.
1976 Lloyd-Smith, Mr. L., JP., Dip.Arch., FRIBA.
1964 Long, Mrs. G.K., BSc., FLA.
1963 Long, Mr. R.H.
1982 Loosmore, Mr. R.G.
1985 Loveitt, Miss E.
1967 Lowe, Mr. L.A.B., FIPlantE.
1981 Ludlam, Mr. B.A.
1986 MacDonald, Mr. A.
1969 McLaughlan, Mr. J.K., LLB.
1957 McLaughlan, Mrs. P.M.
1975 Mclearie, Mrs. M.E.
1972 McNeil, Dr. D.A.C., BSc., PhD.
1986 McWilliam, Prof. G.H.
1975 Majut, Dr. H.G.K.
1977 Mann, Mr. S.J.
1986 Marsden, Mr. S.
1959 Martin, Miss K.E.
1983 Martin, Miss K.R.
1983 Martindale, Miss E.B.
1979 Marvin, Mrs. G.M.
1974 Miller, Mr. N.H.
1985 Moore, Mrs. L.M.

43, Morland Avenue, LE2 2PE.
92, Shanklin Drive, LE2 3QE
7, Springfield, 2, St. Mary’s Road, LE2 1XA.
Quoits House, 102, Hinchley Road, L.F.E., LE3 3JS.
54, Stretton Road, LE3 6BJ.
52, Kirkland Road, LE3 2JP.
6, Upperton Rise, LE3.
98, London Road, Oadby, LE2 5DJ.
15, North Avenue, LE2 1TL.
The Coppice, Church Walk, Thorpe Satchville, LE14 20G.
144 Evington Lane, LE5 6DG.
White House Farm, 22, Main Street, Barkby.
27 Westminster Road, LE2 2EH.
76, Kingsmead Road, LE2 3YD.
30, The Broadway, Oadby, LE2 2HE.
46, Kimberley Road, LE2 1LF.
5, Parley Road, LE2 3LD/1971 Lane, 112, Queens Road, LE2 3FL.
64, Hilders Road, LE3
40, Nevanton Road, LE3 6DR.
27, Brookside, Rearby.
1, Carrisbrooke Avenue, LE2 3PA.
284, Victoria Park Road, LE2 1XZ.
9, Mosse Way, Oadby, LE2 4HL.
3, Shirley Road, LE2 3LL.
16, Higher Green, Great Glen, LE8 OGE.
46, Wintersdale Road, LE5 2GT.
38, Hedington Way, LE2 6HF.
1, Roundhill Road, LE5 5JR.
31, John Woolman House, 20, Rawson Street, LE1 6UN.
45, Knighton Drive, LE2 3HD.
74, Hough Hill, Swannington, Leics.
20, Wakerley Road, LE5.
166, Evington Lane, LE5 6DG.
38, Knighton Church Road, LE2 3JH.
39, Ashfield Road, LE2 1LB.
175, Byron Street, Loughborough.
Dept. of Italian, The University, LE1 7RH.
4, Evington Court, 180, Evington Lane, LE5 6DH.
12, Palmerston Boulevard, LE2 3YR.
17, Shanklin Avenue, LE2 3RF.
75, Pine Tree Avenue, LE5 1AL.
158, Harborough Road, Oadby, LE2 4LD.
91, Shanklin Drive, LE2 3QF.
14, Dalby Avenue, Busby.
62, Saffron Lane, LE2 6UN.
2, St. Andrew’s Drive, Oadby, LE2
1956  Stevens, Mr. I.G.
1976  Stewart, Dr. K.A., MB., FFARCS.
1980  Sutherland, Dr. T.A.
1976  Swales, Prof. J.D.
1959  Sylvester Bradley, Mrs. J.E.M.
1963  Tarratt, Mrs. B.M., BA.
1984  Thompson, Mr. J.L.
1982  Tomlinson, Mr. J.B.
1976  Turner, Mrs. M.H.
1976  Turner, Dr. W.D., MB., ChB., FFARCS
1977  Vearncombe, Mrs. M.M.
1966  Vine, Mrs. D., BA.
1950  Waddington, Miss N., MA.
1961  Waldrom, Miss S.C.
1984  Walker-Palin, Mrs. F.J.
1986  Walker, Mr. L., ACMA., ACIS.
1980  Walspole, Mr. M., FCA.
1985  Watterson, Mrs. E.E.
1983  Watte, Miss E.M.
1968  Weinmann, Mr. A.
1952  Whitaker, Dr. J.H., MA., BSc.,
      PhD., FSG.
1984  White, Mr. M.E.
1986  Williams, Mr. J.E., BA.
1986  Williams, Mr. K.J., BSc.
1978  Wood, Miss D.J.
1983  Worn, Mr. T., BA.
1985  Wykes, Mr. D.L., BSc.
1985  Corporate Member: Leicester Grammar School, 7 Applegate, LE1 5LB

9, Oliver Court, 324, London Road, LE2 2PQ.
436, London Road, LE2 2PP.
21, Pope Street, Knighton.
21, Morland Avenue, LE2 2PE.
10, Church Lane, Stoughton, LE2 2PJ.
11, Towers Drive, Kirby Muoloe, EE9 9EW
7, Hannah Court, Charles St., LE1 3FT.
66, Northdene Road, LE2.
126, Evington Lane, LE5 6DX.
25, Ashfield Road, LE2 1LB.
30, High Leys Drive, Oadby, LE2 5TL.
2, Swale Close, Oadby.
32, Morland Avenue, LE2 2PE.
57, Leicester Road, Groby, LE6 0DG.
4, Stoughton Avenue, LE2 2DR.
46, Hollies Way, Bushby, LE7 9RL.
68, Oxtwoods Road, Loughborough.
113, Groby Road, LE6.
36, Edward Road, LE2 1TF.
15, Kingscliffe Cres., LE5 6PQ.
11, Guilford Road, LE2 2RD.
3, Firs Road, Houghton on the Hill,
LE7 9GH.
56, Dorset Avenue, South Wigston,
LE8 2WD.
7, Glebe Close, Glenfield, LE6.
26, Greengate Lane, Birstall, LE4 3DJ.
78, Leicester Road, Quorn,
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