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Wind - source of energy

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Hallgates Geology
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CONTENTS

Page

Presidential Address: Down to the Basement
by Trevor D. Ford
1

The language of objects
by Stephen Bayley
15

The Queen's Canalettos
by J.R. Links
24

Mesmerism
by Brian Johnson
27

Healing sanctuaries of the Graeco-Roman world
by J. Ferguson
30

Wind - an alternative source of energy
by Peter Musgrove
33

The earliest well-preserved fossils
by H.B. Whittington
35

Lesser known Australia
by Dorothy Bovey
40

A history of Leicester University Botanic Garden
by R.J. Gornall
42

The Hallgates story
by A. Newton
49

Geological interpretation of records and photographs
of Hallgates reservoirs
by H.E. Boynton
67

Annual Reports
74

List of Members
80

Cover photograph: Laying the 54 inch diameter water main
through Hallgates Wood, by A. Newton

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DOWN TO THE BASEMENT

Presidential Address Delivered on 4th October 1982
by Trevor D. Ford

Senior Lecturer in Geology, University of Leicester.

My first task is to thank the President and Council for the honour they have done me by inviting me to take on the Presidency for the coming season. It is just 30 years since I came to Leicester as an Assistant Lecturer in the Geology Section of the Geography Department of the University College. I was soon introduced to the Geology Section of the Lit. & Phil. by George Snowball, then the Museum's Geologist, and I have enjoyed an association with both the Geology Section and the parent Society for most of my 30 years in Leicester. I follow in a tradition of former presidents who have been geologists. Though I never met him, F.W. Bennett was both President of this Society in 1904-5, and was a prime mover in setting up the University College soon after World War I. A medical man, his hobby was geology, and I wonder what he would have made of both the University as it is now and the subject of geology which has seen such an information explosion and development of new theories in recent years. I am sure he would have been delighted with the University, particularly in the building which bears his name, and highly intrigued by such modern geological developments as plate tectonics. One of the mentors of my student days was Peter Sylvester-Bradley; a lecturer in Sheffield University, a few years later he followed me to Leicester and took the Chair founded in memory of Dr. Bennett. Professor Sylvester-Bradley's drive and enthusiasm laid the foundations of the geological sciences in today's University and, of course, he was President of our Society in 1974-5. Last year, in fact, our University's Geology Department lay third in the whole country's 'league table' of some 40 institutions measured in research funds raised and output of research publications. Peter Sylvester-Bradley and I co-operated in a book summarising the state of knowledge of the geology of our county and its surroundings, published in 1968; it emphasised some of the gaps in our knowledge and, of course, these are now in the process of being closed, as new techniques or discoveries give us more data. Even so, new gaps appear as others are closed, and new ways of interpreting old data have arisen from plate tectonic theory.

The title of my address is 'Down to the Basement': this was deliberately chosen so that I could use it for any one of five topics I had in mind as possible material before even I made my mind up! I could refer to the chronic problems of storage, and retrieval, of specimens and data in the basements of our Museums and Universities. I could discuss my favourite pastime of cave exploration and take you to the bottom of some deep cave. I could offer a travelogue of the Grand Canyon, that great incision through the Earth's crust to some of the oldest strata in the U.S.A. I could take you back to the earliest fossils, some of which were found in Charnwood; they constitute the 'basement' of life on Earth. My choice has been, however, to take you back to our own geological basement, to take a fresh look at what lies hidden beneath our feet.
LOOKING BENEATH OUR FEET

In recent years there has been intense interest in what lies concealed below the Mesozoic rocks of Leicestershire. We have heard much about one aspect of the concealed geology, namely the Northeast Leicestershire coalfield. A small oilfield has been found in the same area, around Plungar, and the search for other oilfields continues. Elsewhere in the county the Carboniferous rocks are exposed as in the Leicestershire and South Derbyshire coalfield, in the Carboniferous Limestone inliers around Breedon-on-the-Hill. Older rocks, mostly of igneous origin, occur at Mountsorrel, in Charnwood Forest and in the southwest Leicestershire inliers. But what would the geological map of our county look like if we were to lift off all the Jurassic and Triassic strata, which now make up more than three quarters of its surface? And what would the significance of such a palaeogeological map be? For such a map is but a tool in forecasting what lies still deeper. The late Professor L.J. Wills has published such palaeogeological maps (1973 and 1978) for most of England and Wales as it would have seemed to a palaeogeologist walking about in pre-Permian (270 million years ago), pre-Carboniferous (360 m.y.) and pre-Devonian (400 m.y.) times, but Wills' maps are broad scale and contain little information less than 10 years old. The task I have set myself is to look much more closely at Leicestershire as it would appear to that palaeogeologist in those ancient periods and also still earlier in the late Precambrian to early Palaeozoic era, say some 700-500 million years ago.

The geological techniques for 'X-raying' our former geographies are many. We can look at the covering strata for evidence that they were deposited on an irregular landscape, as shown by thickness variations or pebble content. We can look at directional features in sedimentary rocks or at the rock types represented by the pebbles to see if they indicate potential source areas. But, apart from the immediate margins of Charnwood Forest, where the Triassic Mercia Mudstones (formerly known as the Keuper Marl) lie in ancient wadi channels eroded into the old rocks, there is little evidence. The underlying Sherwood Sandstone pebble beds (formerly the Bunter Pebble Beds) are not exposed in Leicestershire, although they extend into the subsurface from Nottingham Castle southwards just into the N.E. Leicestershire coalfield area where they thin out to nothing close to the county line. The source of the dominantly quartzite pebbles in the Sherwood Sandstone pebble beds is uncertain. Sometimes thought to have been derived from a concealed East Midland to East Anglian land-mass, boreholes have so far failed to demonstrate the presence of quartzite masses of appropriate type or extent. Both the quartzite and the sparse igneous and metamorphic pebbles match outcrops in Brittany and Normandy, but there are problems in reconstructing a river system flowing from northern France to the English Midlands.

If purely geological arguments tell us little, we must resort either to deep boreholes (Fig. 1), a very costly exercise, or to geophysics, with attendant problems of interpretation. Boreholes are sunk only by large organisations such as the National Coal Board, the Institute of Geological Sciences and by oil companies and, although public money is frequently put into these, the
results are sometimes kept secret for years. My geophysical colleagues in the University have been conducting studies of hidden structures in the East Midlands for some years, and I am indebted to them for data and discussion of its significance. Using such data as I have been able to amass from N.C.B., I.G.S., oil companies and University colleagues, I propose to take the geological lid of Leicestershire and look at what lies below, working progressively backwards in time.

THE COAL MEASURES SWAMPS

Firstly, turning the geological clock back 270 million years, we have the Coal Measures: the strata of the exposed coalfield in the Coalville-Ashby area thin southwards towards Desford where they also turn upwards and are truncated by the sub-Triassic surface. West of Measham the Coal Measures are faulted down and it was hoped they would extend further southwards, towards Nuneaton, where geophysical surveys suggested a possible coal basin. Boreholes sunk in the 19th century near Market Bosworth, however, penetrated Cambrian shales and so limited the possible extent of concealed Coal Measures to but a few square kilometres at best. North of Charnwood Forest it was long ago felt possible that there were hidden coals, but a scatter of boreholes soon discouraged the search. More recently, Spink (1965), in our own Transactions, suggested that there could be a hidden coalfield to the north.
of Loughborough, possibly even lying conveniently beneath Ratcliffe-on-Soar Power Station, but subsequent investigations by I.G.S. and N.C.B. soon showed that the hidden coalfield lay somewhat further to the east. It is one of the largest discoveries of unworked coal in Western Europe for many years, and the environmental planning problems its exploitation raises are fresh in our minds. If we constrain ourselves purely to the geological analysis, the productive Coal Measures lie in a synclinal basin some 12 km wide roughly centred on Hose, and bounded on the south by a line roughly between Melton Mowbray and Grantham. Between Asfordby and Saltby the Coal Measures are covered by about 400m of flat-lying Triassic and Jurassic strata. To the west the coalfield is bounded by faults bringing older Carboniferous rocks up to the sub-Triassic surface; to the north there is partial continuity with the Nottinghamshire coalfield; to the east the Coal Measures are progressively replaced by a pile of contemporary volcanic rocks and associated minor intrusions — the Grantham "high" detected by the geophysicists; to the south the Coal Measures thin somewhat and are apparently banked against a much older concealed granite mass beneath Melton Mowbray, an eastward equivalent of the Mountsorrel granite. This leaves the southern half of our county — are concealed Coal Measures hidden there? No boreholes within the county help us, but old ones in Northamptonshire gave some encouragement when they found Carboniferous Limestone beneath the Jurassic and Triassic. More recently a geophysical survey (Alsop & Jones 1980) suggested a concealed coalfield might be present from near the county border to Rugby, but an N.C.B. borehole south of Market Harborough at Hollowell, Northants, has proved that hopes were misplaced. Much of the southern tip of the county around Lutterworth and Market Harborough remains uninvestigated but overall the indications are not encouraging.

Also, if I may digress briefly, it seems that every proposal for a new deep borehole is promptly followed by a howl of protest from the local residents, as though a grimy Victorian colliery will certainly follow in a few days. Wouldn't it be better to get on with the borehole and know whether we have anything worthwhile? The majority of boreholes produce negative results, so that we would then know which areas were safe from exploitation in the future, and people would not constantly be looking over their shoulders.

A palaeogeological map of the Coal Measures period would thus show tropical swamps over much of the northern part of the county, volcanoes pouring out basaltic lavas to the east, around Grantham, and the ancient pre-Carboniferous rocks, including the Mountsorrel and Melton Mowbray granites, the Precambrian rocks of Charnwood Forest and the Cambrian rocks of Market Bosworth, Desford and Evington forming an upland region with moderate relief across central and south Leicestershire (Fig. 2).

THE MILLSTONE GRIT DELTA

In middle Carboniferous times, some 300 million years ago, the deltaic sandstones and shales of the Millstone grit were laid down. The represent the detritus derived from the Scottish Highlands poured out by rivers into the general region of the English Pennines. Only the extreme limits of these deltas
reached north Leicestershire, but other, smaller, deltas were
formed by rivers flowing northwards from the land-mass in the
East Midlands. The two series of deltas coalesced in the
general region of the Trent Valley. From limited outcrops
near Ashby-de-la-Zouch, the Millstone Grit rocks extend
southwards beneath the Leicestershire Coalfield as far as Desford
where they thin out. Similarly in the east of the county
the Millstone Grit sandstones thin southwards, being represented
by only 20 metres of shale near Melton Mowbray, but along the
county border some lens-like masses of sandstone have sufficient
porosity to trap oil, and at Plungar we have a small productive
oilfield. Discovered more than 20 years ago by geophysical
surveys, it may well have analogues in north Leicestershire as
yet undetected. In fact it is possible that we may find that
we have oil reserves beneath the N.E. Leicestershire coalfield,
with interesting production problems arising where steel-cased
wells pump oil up through mineable coals!

THE CARBONIFEROUS LIMESTONE SEA

The Carboniferous Limestone tells a similar story. Well
seen in the massif of the Peak District limestones, it disappears
from view beneath the Trent Valley, to reappear briefly at
Breedon-on-the-Hill and the small associated inliers in North
Leicestershire. At Grace Dieu the outcrops are tantalizingly
incomplete in that barely 100 metres separate exposures of
limestone and Charnian rocks, but the nature of the contact is
hidden. An ancient shoreline is generally assumed to have lain there but the evidence is equivocal. Westward, few boreholes have revealed the Carboniferous Limestone, but one at Desford showed it to be very thin, supporting the shoreline concept. At Fillongley, in Warwickshire, limestone pebbles in a late Carboniferous conglomerate suggest that the limestone was exposed to erosion somewhere nearby, but we don't know where. East of Charnwood, the Carboniferous Limestone has been penetrated in a number of oil company and NCB boreholes, which show that it extends beneath the N.E. Leicestershire coalfield and eastwards towards the North Sea (Ineson & Ford 1982). What is perhaps more interesting is the demonstration of a relatively deep-water gulf in Carboniferous times centred on Widmerpool (Falcon & Kert 1960) extending eastwards from the Middle Trent Valley (Fig. 3). The limestones of Breeden were apparently deposited as reefs and in lagoons on the southern margin of the Widmerpool Gulf, whilst early in the Carboniferous a shoreline of sabkha (saline mud flats) character heralded the marine transgression over a landscape not unlike that of the present day Trucial coast of the Persian Gulf. The resultant anhydrites were penetrated in the Hathern boreholes. Away to the south there is limited evidence of Carboniferous Limestone in boreholes near Northampton and Cambridge, but these may have been on the southern side of the Midland land barrier, commonly called St. George's Land.

At this stage in our look back towards the basement it is apposite to take stock and see what our deductions of the Carboniferous scene mean in global terms. The Carboniferous period is dated by radio-active means as between 360 and 270 million years ago, a mere fraction of Earth history. But how could Britain have had the densely vegetated swamps which gave us our coals, how could it have enjoyed a seascape of coral reefs and lagoons, preceded by evaporite-rich desert shores? Certainly not in our present latitude and climate. Our geophysical colleagues have come to the rescue here with their studies of palaeo-magnetism, which show that Britain lay more or less astride the equator in Carboniferous times, and has been drifting slowly northwards ever since. And if the palaeo-magnetic records of different continents are compared it is possible to demonstrate that there was no Atlantic Ocean then, and Britain's coal swamps were contiguous with those of North America.

An early Carboniferous palaeo-geological map of Leicestershire might thus show a relatively deep-water "gulf" in the north, around Widmerpool, flanked by fringing reefs along a line through Breeden eastwards towards Grantham, and margined by evaporite-rich lagoons and saline mud flats to the south (Fig. 3). The reefs are potentially interesting to the oil geologist and, again, some may lie beneath the N.E.Leics. coalfield. The southern half of the county would, as in Coal Measures times, be a land area of moderate relief. The equator lay close to the north meaning that both land and sea areas would be enjoying a tropical climate.

The transition during Carboniferous times from the clear tropical seas of the Carboniferous Limestone, through the delta-margined muddy seas of the Millstone Grit to the swamps of the Coal Measures reflects events outside the county generally known as the Hercynian orogeny. In plate tectonic terms, however, this
is the climax of the closing of the ancient Rheic Ocean stretching across central Europe as the Southern European plate collided with the Northwest European plate. The effects of this collision are best known in Britain and Cornwall and Devon, where intense folding and metamorphism have affected the sediments. In much of England, including Leicestershire, the effects were less dramatic, but no less important, for the folding and faulting of the Carboniferous rocks gave us the disposition of our coalfields in the Midlands and Pennines.

THE SILURIAN AND DEVONIAN INTERLUDE

Turning the clock further back, there are no sediments of Devonian age known in Leicestershire, though a small outcrop lies just over the border near Atherstone, but geophysical evidence suggests that there might be some representative of the Old Red Sandstone deep in the Widmerpool Gulf. There are no Silurian or Ordovician sediments known in Leicestershire (allowing for the fact that some geologists regard the topmost division of the Cambrian as strictly lowest Ordovician, depending on how this period of geological time is defined). Any attempt at a palaeo-geological map after the Wills style for Devonian or Silurian times would be meaningless as the whole of our county would be a land area of undifferentiated older rocks.

THE CAMBRIAN SEA

There are no outcrops of Cambrian rocks within Leicestershire, but they are well known at Stockingford, near Nuneaton, where thick mudstones with trilobites and brachiopods overlie a thin limestone and thick quartzitic sandstones at Hartshill. These last contain numerous burrows, tracks and trails left by soft-
bodied organisms including annelid worms and early arthropods. The quartzites represent the beaches and in-shore sediments margining a shallow sea, with sand derived from an unknown source area. The quartzites are followed by thin limestones with a variety of fossils, some of uncertain biological classification, and then by thick mudstones, the highest of which contain early graptolites. These mudstones indicate relatively deep quiet-water sedimentation which appears to have extended across much of southern Britain. The same rocks have been penetrated in boreholes near Market Bosworth, in a colliery drift at Desford, and in boreholes beneath Evington (sunk in an abortive 19th century search for coal!). The Cambrian strata thus appear on both flanks of Charnwood Forest but, as the contacts have never been seen and could be either faults or unconformable, we do not know whether the Cambrian seas once covered Charnwood’s Precambrian rocks, or whether these stood out as an island.

At first sight the Cambrian seas of Leicestershire suggest a somewhat monotonous interlude when our county was covered by a uniform sea, but a wider view of the Cambrian scene, some 570-500 million years ago, presents a different picture. The Leicestershire and Nuneaton Cambrian sequence of strata and fossils is closely comparable with those in Shropshire and South Wales, and these in turn are closely comparable with the sequences in eastern Newfoundland and Scandinavia, though contrasting with the details of the Cambrian rocks of Scotland, Northwest Newfoundland and other parts of North America. Using the deductions of palaeo-magnetism and plate tectonics, it emerges that England lay on the margins of an ancient continent Gondwana, then lying well down in the southern hemisphere, and far separated from a northern continent of Laurasia (see Le Bas’ contribution to the Transactions, 1982, p63). Between them lay an ancient Ocean of Iapetus (Iapetus in classical mythology was the father of Atlantis) and the continents drifted slowly towards each other during Cambrian, Ordovician and Silurian times, until they collided and were sutured together roughly along the Scottish border. But suturing is only one part of the story, so let us return when we have looked at some other evidence of the past history of our county.

LOWER PALAEozoIC IGNEOUS ROCKS

There are a number of masses of igneous rocks in our county, much quarried for roadstone and aggregate. At Mountsorrel there is the granite (strictly granodiorite with subsidiary diorite and gabbro) and in the southwest are the dioritic masses of Narborough, Croft, Enderby and Sapcote. A granite comparable to that at Mountsorrel has been penetrated in a borehole near Melton Mowbray, some 400 m beneath the Jurassic, Triassic and Carboniferous cover rocks. Radio-active dating methods have given somewhat varied results according to the methods used, but it seems that the emplacement of both the Mountsorrel and the Melton Mowbray granites and the southwest Leicestershire intrusions took place in mid-Ordovician times, about 450 million years ago. Their chemistry shows that they are related in the deep sources, and my colleague, Dr. Le Bas, has argued a case for a much wider extent than the present outcrops suggest (Le Bas 1968 & 1982). One can go further and speculate that these intrusions formed the roots
of a volcanic chain, like that in Snowdonia, which has been totally eroded away. The problem is that they are the tops of ancient mountains unconformably blanketed by later Carboniferous and Triassic sediments, so that we can see little of their relationships. It is as though the Ordovician volcanic mountains of Snowdonia were revealed to us only by the summits, isolated from each other by younger strata filling in all the valleys. The crux of the problem is - into what were such masses of igneous rock intruded? A few isolated outcrops of baked sediments are known, but whether they were Cambrian mudstones or not is uncertain. Another question is at what depth in the crustal sediments did the magmas come to rest and cool? Certainly not less than one kilometre down, and probably 2 or 3 km is more realistic. More than likely this cover included a volcanic chain like that now seen in Snowdonia, but which was eroded away from Leicestershire before the Triassic period, along with most of the associated Cambrian (and Ordovician?) mudstones. Whatever the cover rocks were, the implication is that there was a mountain range of Lower Palaeozoic sediments and volcanics cored by large intrusive masses lying across Leicestershire, on either side of Charnwood Forest, and that the mountain range suffered intense erosion in post-Ordovician times, probably before the Carboniferous, by which time low-lying lagoons and swamps flanked the roots of the mountain range (Fig. 4).
Apart from the current use of the exposed igneous rocks for roadstone and aggregate, does this ancient mountain range contain any potentially economic deposits? The equivalent mountain range in North Wales has been mined for copper, manganese and lead and small quantities of gold are still obtained. The Coed-y-Brennan porphyry copper deposit could have yielded large quantities of metals, had it not lain within the Snowdonia National Park, so that the planners prevented mining and forced us to continue to import the metals. Equivalent ore deposits could well lie hidden beneath Leicestershire and indeed minor and uneconomic deposits of copper have been found in Charnwood Forest and lead and molybdenum minerals occur in the Mountsorrel granite. However, geochemical prospecting techniques have not yet reached the stage of looking through the cover of Triassic rocks into the Lower Palaeozoic with sufficient accuracy to merit boreholes. And even if an economic deposit could be found, would our planners and environmentalists allow its exploitation?

THE ANCIENT VOLCANIC ROCKS OF CHARNWOOD FOREST

Turning the geological clock back to Precambrian times, more than 600 million years ago, we have the oldest rocks in Leicestershire - those of Charnwood Forest. Broadly, they represent a volcanic archipelago with lavas, ashes and sediments derived therefrom. They have yielded the oldest known macro-fossils in Britain; Charnia masoni and its associates represent both pelagic and bentonic soft-bodied organisms probably related to modern day jellyfish and primitive corals, living at a time when there were no hard-shelled animals, probably around 700 million years ago. This is no place to go into the details of Charnwood Forest's geology which has been told variously by my illustrious predecessor Presidents, F.W. Bennett and E.E. Lowe, as well as by W.W. Watts and many others. However, certain aspects of Charnwood should be aired here: what lies beneath it? The rocks of Charnwood are of late Precambrian age and more than three quarters of Earth history preceded their formation. How far do the Charnian rocks extend laterally? Can they be placed in a plate tectonic environment?

The lateral extent is the easiest of these problems to discuss. Small outcrops at Nuneaton are clearly closely related, and further west there are similar rocks of a comparable sedimentary and igneous environment in Shropshire and in the Malvern Hills. To the east, boreholes near Grantham and Peterborough and in Norfolk indicate a continuation of Charnian-type rocks, and there is some suggestion that they occur to the south in northern Northamptonshire as well. On a global scale such a set of scattered outcrops can easily represent a moderately deep ocean receiving both muddy sediments and layers of eruptive ejectamenta from nearby volcanic islands, some of them showing evidence of turbid flows such as are well documented in the Atlantic today.
IAPETUS OCEAN, PLATES AND SUBDUCTION

But on what do the Charnian rocks rest? Volcanoes can usually be expected to bring up bits of the underlying rocks as "bombs" but no such derived fragments have been found in Charnwood. All the blocks in the agglomerates are derived from rocks directly comparable with those exposed, i.e. parts of the same volcanic and sedimentary pile on the ocean floor. Seismic experiments by my geophysical colleagues using the CWF seismograph station at Charnwood Lodge have indicated a velocity increase at a depth of some 2 km beneath Charnwood Forest, consistent with the possible presence of ancient basaltic ocean floor. The general deduction may be made that the rocks of Charnwood Forest are but a fragment of the accumulation of lavas, ashes and sediments on the floor of the Iapetus Ocean, and once again there are closely comparable rocks (and fossils) in Newfoundland and the Baltic region.

Extending our deduction that Charnwood Forest is made of volcanic rocks erupted on to the Iapetus ocean floor and of sediments derived therefrom, together with intrusions representing the now-exposed former magma chambers, it seems likely that they collectively formed part of an island arc flanking an ancient continental plate. Such arcs are known today in, for example, Japan and the Philippine Islands where the western part of the Pacific Ocean floor is being subducted beneath the Chinese plate. Comparable examples may be found in other parts of the geological record in Mesozoic and Cainozoic times, but when we go back to the Precambrian the evidence is sparse and we have to rely on subtle clues to reconstruct the ocean-continent configuration and, more particularly, what was being subducted and in which direction. My colleague, Dr. Le Bas, has discussed such hypotheses in geochemical terms in recent issues of our Transactions (1981 and 1982). Taking his ideas into account, and adding geophysical clues, it seems that the Charnwood Forest volcanic arc lay close to a proto-European plate, part of the ancient continent of Gondwana, with ocean floor being subducted nearby, melted in the subduction zone and the resultant magma rising to the surface at intervals up to Ordovician and possibly Silurian times. The other great continent of Laurasia lay far to the northwest and took no part in the early stages of this process. At first the direction of subduction is uncertain, but if one turns onwards to the Silurian, with the S.W. Leicestershire intrusives and Mountsorrel "granite" emplaced in thick Cambrian shales, one can see that the subduction process continued as the Iapetus Ocean closed.

Geochemical gradients, detected by Dr. Le Bas, suggest that the direction of subduction changed during the 300 million year period from the late Precambrian to the Silurian, but seemingly no more so than the changes from Miocene subduction normal to the present coastline of California to the strike-slip regime now represented by the San Andreas fault. In Late Ordovician and Silurian times the two great continents of Laurasia and Gondwana collided; the Iapetus Ocean floor was either subducted beneath the margins of these continents or was squeezed as in a vice between them. Much of the folding, faulting and metamorphism of the rocks in the Scottish Highlands, Southern Uplands, Lake District and North Wales came to a climax in this, the period of the Caledonian orogeny. And the ancient rocks of
Charnwood Forest and the rest of the Leicestershire basement
were not excepted. The suturing of the continents together took
place in a zone of crumpled oceanic sediments roughly along the
present Scottish border; either side of this the crumpled ocean
floor sediments and associated igneous rocks were accreted to
the continental margins, Charnwood to the edge of Gondwana. The
subducted material melted and rose as granites, including
Mountsorrel, by the end of the collision process.

Leaving aside the plate collision and the Caledonian orogeny
and returning to the Precambrian, we have come to a situation
some 700 million years ago, when the "basement" of Leicestershire,
seen now as the rocks of Charnwood Forest, and inferred to extend
far beyond the bounds of our county, was a volcanic archipelago
or island arc in an oceanic setting, with global geography far
different from that seen today (see the global reconstructions in
Le Bas, 1982, p. 63). Theoretically, the Charnwood volcanic pile
should rest on ocean floor basaltic lavas, but these have not yet
been seen either at outcrop or in boreholes. We have only the
global physical determination of rocks with higher seismic
velocities, and thus higher densities, at a depth of some 2 km
beneath Charnwood. To see such old rocks we would have to go to
the northwest of Scotland or to Scandinavia, where rocks up to
2.8 billion years old now outcrop, four times as old as Charnwood.
And even they are little more than half the age of the Earth!

Attempting to reconstruct a palaeo-geological map of
Leicestershire in late Precambrian times is a highly speculative
exercise, and we can do little more than suggest a chain of
volcanic islands and submerged tops of eroded volcanoes broadly
across Charnwood Forest and extending away to both east and west.
The problem remains of what lies beneath Charnwood. As noted
earlier there is a geophysical discontinuity some 2 km beneath
Charnwood Forest suggesting earlier ocean floor material, but we
know nothing of its constitution or age. One of the most
outstanding features of the plate tectonic theory is that ocean
floor is constantly being renewed by eruption at the mid-ocean
ridges, so that the ocean floor rocks beneath Charnwood need not
be very much older than the Charnian rocks themselves - they may
indeed have been erupted at a mid-ocean ridge in the initial
phases of the Iapetus Ocean, perhaps some 800-1000 million years
ago. If that is so, then we need have no early Precambrian
basement beneath our county. This argument is speculative but
based on reasonable scientific comparisons, and it raises the
question of whether we can ever go much further in obtaining
factual data to improve our argument. Ideally, a deep borehole
beneath Charnwood to at least 2 km could provide us with
samples of the dense, high velocity rock for analysis and dating,
but at present the costs are prohibitive and there seems little
likelihood of any economic return, so we must look to future
means of remote sensing.

If the "sub-basement" of Leicestershire is ocean floor
material, what lies below it? Geophysical results to date suggest
that the depth to the Moho discontinuity at the base of the
Earth's crust is on average about 30 km. Below the Moho is the
mantle of the Earth, the upper part of which is the slightly
plastic asthenosphere of ultrabasic rocks on which the
continents "float". Finally, deep within the mantle lies the
metallic core, but this is not my concern here.
THOUGHTS ON THE FUTURE OF GEOLOGICAL STUDY

Geological maps record the distribution of outcrops of different rocks and their interpretation allows us to forecast the subsurface distribution of many concealed strata. Without such interpretive research many of our concealed coal and oilfields would be unknown; but such research is often imperfect, due to inadequate evidence. Geological remote sensing attempts to look through the cover of younger strata to "see" the distribution of the concealed older strata. An ever-increasing arsenal of "black boxes" has come to the aid of the exploration geologist. He uses analytical geochemistry to plot minute proportions of trace elements in soils and stream sediments. Large ore deposits have been found by such means overseas, and in Leicestershire this line of research has had agricultural applications in discovering that certain trace metals, such as molybdenum, affect the chemistry of the vegetation and hence the health of the animals grazing thereon, fortunately only affecting a few fields.

The geophysicist uses variations in the physical properties of rocks to deduce the distribution of concealed rocks. Variations in the attractive force of gravity as little as a thousandth allow us to plot where low density rocks are concealed; variations in the Earth's magnetism may show up anomalous areas of highly magnetized rocks; resistivity profiles indicate changes in the electrical conductivity of rocks; seismic studies measure the responses of rocks of different densities to the shocks caused by minute artificially created earthquakes. These techniques, particularly the last, have been widely used by both the National Coal Board and by the oil companies in defining the concealed coal and oil fields both in Leicestershire and elsewhere. Comparable studies at the University, constrained by finance and manpower problems, have extended these studies into the "basement" beneath the coal and oil fields, helping us to understand the extent of the totally concealed Melton Mowbray granite, and of the subsurface extensions of Charnwood Forest.

Aerial photography and satellite imagery are further tools in our attempts to look through the cover to the basement. As yet they have not been used much in Leicestershire and results have not been encouraging.

The application of the sophisticated new techniques has yielded results which in turn stimulate exciting new ideas. These lead to development of new techniques but one of the problems which the universities face is the length of time between the conception of an idea and the commissioning of the instruments. And we must remember that the theory of plate tectonics is but 15 years old. The theory caused a revolution in geological thought; its applications have brought about an economic revolution in the search for mineral resources (regrettably without finding much in Leicestershire). It brought together a vast array of lines of geological thought and put new perspectives on studies of vulcanism, sedimentation and orogeny, bringing them into a global picture, without which a small area such as Britain cannot be fully understood. Data are pouring in from geochemical and geophysical studies, not to mention deep boreholes, ocean floor studies, and even the geological history of other planets. Geological literature has gone through an information explosion and our journals are packed with
re-interpretations of the history of various parts of the world. Data storage and retrieval have become problems, and our museums and libraries are seeking new ways of keeping the data available.

What will the next 15 years bring? The pace of research is increasing; the need for mineral resources is becoming more critical; the necessity of understanding the whole geological history of our world is becoming more and more critical, even when interpreting a small area such as Leicestershire. The geology student of today has a vast amount more knowledge to pack into his three-year degree course than I ever had 30 years ago. And the parochial syllabus of that time, when one hardly looked beyond the English Channel, has been superseded by a global view of Earth history. So what happens? At a time when the most exciting developments are taking place in our science, we are still constrained by the traditional three-year degree course though trying to pack far more into the syllabus. The geology syllabus is constantly being modified in an attempt to meet the requirements of employers of geology graduates, employers who in turn constantly change the emphasis on what they regard as the best training. The resources to carry out fundamental research are ever dwindling. For many of us in the academic world the freedom to get on with the job is being eroded daily: we become administrators filling in forms or sitting on committees and we have to look to the younger generation to take over our research, if only resources can be found to maintain them.

My predecessors as President would indeed find the subject of geology greatly changed, but one thing they would find little altered is the lack of appreciation of what the subject can do for our understanding of the history of our own surroundings. Geology is still taught only in a few schools; it is almost completely misunderstood by politicians and educators. I hope that tonight I have brought a little enlightenment to those present, and that I have spread the gospel that for those who can read the story of the rocks there is both a new and an ancient world open at their feet.

REFERENCES


THE LANGUAGE OF OBJECTS

Stephen Bayley

(lecture delivered on 1st October 1982)

Sponsored by Leicester City Council Recreation Committee

If you look at two hundred years of the history of taste, one central phenomenon is very apparent: While in the middle of the 18th century Sir Joshua Reynolds, President of London's Royal Academy, was able to say that there is a standard of taste and that any 'reasonable' man can achieve it, a hundred years later his successors were by no means so sure. And a hundred years after that we have lost all certainty about the rules of taste: today we are in an age of helplessness for the designer. The influential Milanese designer, Ettore Sottsass Jnr, has said:

"If today somebody comes to me for a new lighting fixture, we will work on it for at least 2-3 months. There was a time when I would have known at once what this fixture should look like. It was enough to know what the product was supposed to do and what were the production facilities and ... avanti! Today I am not sure I know what to do and in which style to work .... The relationship with the public which is going to use the product has grown so complex...that I simply don't know how to touch people I am not familiar with...."

This two hundred year cycle of
* one standard of taste in the 18th century
* multiplicity of choice in the mid-19th century
* period of helplessness during the late 20th century
is the reflection in the world of design of the industrial revolution. When Reynolds spoke of there being one standard of taste, the processes of mass-production which were brought about by the industrial revolution had hardly yet affected, or even created, consumer products (except for the ceramics of Staffordshire which began to employ power-machines, moulds and transferprinting in the early 18th century). A hundred or so years later when Sir Charles Eastlake, Director of London's National Gallery, published his book, Hints on Household Taste (1868) industry had more provision for such a panoply of style (which the Victorians demonstrated to the world in the famous Great Exhibition of 1851, that there was an emergent sense of a craving for order, a taste for the moral and critical certainties which sustained classical thinkers like Reynolds. Eastlake, bewildered by the speed of development made possible by mass production, wrote:-

"Is good taste so rapidly progressive that every mug which leaves the potter's hands surpasses in shape the last which he moulded? In that case, how superior our modern crockery would be to that of the Middle Ages...."
"This absurd love of change ... is carried to such an extent that if one desires to replace a jug or a table cloth with another of the same pattern, even a few months after the first has been bought, however good the style may have been, it is extremely difficult, sometimes impossible to do so."

The excesses displayed at the Great Exhibition had a stimulating influence on reformers: as early as 1856 the Welsh architect, Owen Jones, published his huge and impressive compendium, The Grammar of Ornament with the admonitory rubric that "the principles discoverable in the works of the past belong to us; not so the results. It is taking the end for the means". Another kind of reform was being urged by Henry Cole, Director of London's South Kensington Museum, (foreunner of the V & A) who established a "chamber of horrors" by selecting and displaying from the huge catalogue of Victorian industry those artefacts which he felt employed "false principles" in design. In less than a hundred years, standards of taste had multiplied.

These reforming ideas in the theory of design were the necessary basis for the Arts and Crafts movement, which, via the influence of William Morris on Muthesius and Gropius, became an integrated part of the Modern Movement. Critical views of achievements of the heroic modern architects and designers are presently going through a period of revisionism, but seen in the perspective of two hundred years of industrial change one thing becomes clear: whatever else its purpose and values might have been, in terms of the history of taste, it was clearly an attempt to re-establish the formal, academic order of the 18th century which the age of industrialisation had denied us....

It was necessary in the struggle to clear the air for the Modernists to overstate their case. This was parodied by the American designer T. H. Robsjohn-Gibbings when he wrote in his book Homes of the brave (1954) about America's William Morris, the sculptor, H. Greenough. Robsjohn-Gibbings says:- "Greenough believed that form should follow function as in nature and as in the sailing ships. Though hardly news to American shipbuilders, to American architects it was a startling idea."

It is easy now to satirise the simple half-truths which sustained the Modern Movement, as many recently made reputations have shown. For instance, truth to materials is all very well when you are dealing with elemental substances like marble, wood, iron and glass, but it is philosophically impossible to determine what particular kind of truth a sophisticated material like chromium-plated vinyl, or kevlar, begs to express.
Of all the aspects of the Modern Movement which have recently been pilloried it is Functionalism which has had the most critical treatment. When Gaetano Pesce noted that: "...Function is only one facet of the material which men use and achieve..." it was a summary of all those criticisms which had accumulated to mean that the days of too literal an interpretation of functionalism were over.

In search for some new beliefs there has been a minor, although significantly consistent characteristic. The vocabulary of language is frequently evoked: Owen Jones chose The Grammar of Ornament as a title; Moholy-Nagy's book, Vision in Motion, was known in German-speaking countries as Der Sprache des Sehens and even Henry Ford (who cared more about history than is popularly thought) declared (about his own museum at Greenfield Village, outside Detroit): "I am collecting the history of our people as written into things their hands made and used ... a piece of machinery or anything that is made is like a book, if you can read it..." and to the Post-Modernist architects, a pop interest in linguistic science has been a fashionable crutch to support their own views on taste.

There is, in fact, nothing so very new or unusual about employing symbolism in material culture so that cold artifacts - whether buildings or products - can be kept like books: the Vitruvian tradition in architecture is based on a semantic morphology which identifies the Doric order with manly beauty and the Ionic with feminine charm and anthropomorphism. Even the American architect, Eliot Noyes (who as much as anybody inherited the Bauhaus tradition from his teachers, Gropius and Breuer) was aware of the importance of using meaning in his architecture: when he first came to work for IBM he actually commented that their buildings lacked symbolic value and during the next 20 years, without betraying his modernist principles, he applied the Bauhaus to Big Business, to use Ursula McHugh's memorable trope, and turned the German Modern Movement into the corporate style of modern America.

We can see clearly now that it was only the rustic provincialism of the Arts and Crafts - where Lethaby declared that "in machine products (the) specific character vanishes" - and the fanaticism of the Modern Movement that followed it which denied that machines can have a life, and can speak a language of their own.

If we look briefly at a handful of successful current products and contemporary designers it is clear that the invention of metaphorical values plays an important part in the design process.
PORSCHE

Everyone knows that Porsche is one of the best modern sportscars, but few are aware that the bulk of Porsche's business comes from its enormous R & D Centre (Entwicklungszentrum) just outside Stuttgart, where a quarter of the entire workforce are engaged on automotive and aerospace research for customers in Japan, USA and USSR.

Everyone knows that Ferdinand Porsche designed the Volkswagen for Hitler as the 1000 mark Strength-Through-Joy car. The Volkswagen was, deservedly, a huge technical and popular success. Few people are aware that Porsche's engineering consultancy extended to designing the Leopard tank for the Panzers as well as the appalling Vergeltungs-waffe, better known to Londoners over 50 as the V-1 buzz bomb.

I mention these things to emphasise that Porsche has unimpeachable engineering credentials. Furthermore, the company does everything it can to promote its image as a team of white coated, Olympian Teutonic engineers, teasing out designs by applying the inflexible and inevitable laws of physics to specific transport problems. (Like bombing suburban London or winning the Le Mans 24 Hours). Surely there can be no element less than purely scientific in any Porsche design? So it is a surprise to learn that the head of the Porsche Studio, with responsibility for the appearance of all the cars, was not trained at Munich University's Centre for Gear Research, but learnt his art or craft or trade, call it what you will, at the feet of General Motors' great wizard of kitsch, Harley Earl. It was Detroit in the 1950s. The head of the Porsche Studio is Anatoile Lapine. He is fearlessly provocative about the designer's work.

There was a time when the use of the word 'style' in the company of European designers would have produced a reaction rather like the sprinkling of Holy Water over the personification of the anti-Christ. But Anatoile Lapine says: "What is the difference between a stylist, a designer or a what-have-you? I don't think it's so important what we call each other, but what we do and what we have to show for it... I know just as many bad designers as I know good stylists..."

The specifics of Porsche, according to Lapine, are the tradition deriving from the VW Beetle and the conscious need that the cars should express... speed. There is a large envelope within which the designers can work to satisfy these requirements. "The shape of a car doesn't have to be. There is sufficient room to be aerodynamically sound and to express yourself. All the aircraft that fly have similar performances, yet they all manage to look somewhat different". 18
Each Porsche car is deliberately designed to evoke an affinity with previous models. Even the racing cars Lapine says are given "The winning look which weapons have". His assignment at Porsche is to design a car that will still be visually interesting in twenty years time. So far, he's had no problems with this. His dictum, however, turns on its head Mies van der Rohe's classic Modern Movement declaration that he did not want to be interesting, he wanted to be good...

ETTORE SOTTSASS, Jnr

Ettore Sottsass began his career immediately after the War, during the Italian industrial revolution which they call the period of ricostruzione. Symbolism has always been of immense significance to his work - he sees the Vespa scooter as a powerful emblem of the new Italian democracy of the years after Fascism - and he has followed the idea through to the 1980s when with it he has become the designer most admired by the younger generation.

This success has depended on a conscious injection of what he calls "more colourful, joyful, optimistic" characteristics into home fittings. In fact to give a typist's chair or a portable typewriter a sense of humour and to give them a sense of being out of context so as to force a fresh awareness of the nature of machines onto the consumer.

Sottsass has continued this process of irreverent reference and audacious context in his latest furniture for the avant-garde (how quaint that sounds) group of Milanese designers who call themselves Memphis. (In conscious double reference to the Egyptian city and the home of the rock and roll).

The point of Memphis, however, is that it derives its force from the Italian landscape. The references the extraordinary furniture makes both in shape and in colour could be understood from a drive around the northern outskirts of Milan.

Sottsass says that he is "quoting from suburbia". It is the freedom to be able to do this which contributes to the force of the Memphis furniture.

SONY

Memphis is deliberately avant-garde. It is not actually meant to be bought and used and sat upon. It is a suggestion of what might be. Japanese industry, however, shows us exactly what is. The Japanese, it is said, are short of inventiveness, and then it could be argued that the flood of products with which they inundate western markets hold up a mirror to our values. The Japanese achievement in understanding consumer
psychology has been remarkable. Although there is no
gainsaying the Japanese ability in miniaturisation,
quality control and production engineering, in general
it can be said that the Japanese do not excel in what
we in the West would call design. Except by diligent
study of what the West admires and buys they have learnt
from us some elements of the language of objects. They
know how to make artifacts speak to consumers. For
instance, although the basic technology and the basic
form of the SLR camera was established by Contax just
after the War, the Japanese have made this so much into
an international visual code for 'The Camera' that when
Sony revolutionised photography by introducing a 'camera'
which used solid state electronics instead of light-
sensitive film to capture images, they cautiously
maintained the traditional shape.

It is Sony perhaps more than any other Japanese
manufacturer which has led the carrot of design before
the consumer. Being smaller than other companies, Sony
has been forced to compete by not only complementing the
product lines of its rivals, but specialising in consumer
psychology. Sony was the first Japanese company, and
perhaps the first mass-market producer anywhere in the
world, to realise how appealing the semantics of
technology were to the customer. First of all the company
pioneered the selling of unusual new products (often not
containing any particular technological novelty, but
usually employing a novel synthesis): tape recorders,
transistor radios, transistor televisions, video cassette
recorders) and complemented this marketing strategy by
bold innovations in appearance. Always, these innovations
evoked a mystique. They gave the product a special presence
denied to other manufacturers which they soon copied.

For the first domestic stereo tape recorder Sony
provided VU-meters so that your drawing room would look
a little bit like a studio console. Sony virtually
invented the satin finish steel hi-fi amplifier with its
familiar array of knobs, flick switches, tumblers, levers
and dials which, while they fully satisfied the customer's
taste for symbolism, often paid no attention to the
Newtonian (or for that matter any other) mechanism within.
Sony designers understand to the full how to arouse a
customer's curiosity. They do this by knowing exactly what
detail to include here or there, by adding a willful
degree of complexity, a certain finish and a certain
texture here or there... these accumulate to make even
sophisticated customers want to touch to hold and to buy.

Japanese car manufacturers have learnt the same
trick. Their culture's traditional taste for miniaturisa-
tion has given to cameras and other expensive consumer
durables an almost obsessive attention to tiny detail and
the more successful Japanese car manufacturers make direct
use of this in their interior design. But most of all, whether it is a car, a camera or a television or a tape-recorder the single element in Japanese products which appeals most strongly to the Western consumer is the allure of professionalism which they give.

**BRAUN**

German product designers, more than any others, have acquired a reputation for working with the inflexible rules of function. Inheriting some of the ideas of the Bauhaus, boosted in the 50s by the celebrated Hochschule fur Gestaltung – the Germans have been able to maintain the widespread belief that the study of the end-use of a product and a consideration of the materials available will, somehow, reveal ... perhaps by a mystical process ... perfect form, a timeless unimprovable design.

The evolution of Braun razors over the past thirty years (during which time there have been neither fundamental changes in the mechanism of the razor or in the human face) betrays this philosophy and shows that even functionalism is subject to the shifting influences of ... taste.

Recently Dieter Rams admitted to making last minute adjustments to a razor design because the almost finished product did not achieve the required effect he had had in mind. He didn't say that he had styled it, but that was what he meant! The fact that German functionalism is a style and not an austere complement to engineering is fully indicated by the latest Braun hifi and calculator. Both are impressive and attractive machines which exert a fascination for the consumer. But the "functionalism" is here just a form of decoration, or 'language'. The designer cannot claim to have studied at any very great length the engineering components within either the hifi or the calculator and to have evolved from them these (almost) perfect forms .... both the hifi and the calculator use innards bought in from Japan.

**FORD SIERRA**

When it came to replacing the extremely successful Taunus/Cortina, Ford faced special problems. The Cortina had been an extremely successful product because it embodied the language of objects. To a package of European dimensions in terms of space and efficiency, Ford added the superficially attractive idioms of Detroit. (The same designer had, incidentally, been responsible for the doomed Edsel). They compounded this already attractive imagery by naming the car in the English market (not after old university towns like Oxford or Cambridge which its rivals did) but after the Italian ski resort
that was the home of the 1960 Winter Olympics. Thus it
gave the first generation to experience the benefits of
cheap jet travel a souvenir of continental Europe to park
in the drive. Twenty years later, by the time the Sierra
was introduced to the British market, the preoccupations
of the customer and of the industry had changed. While
the Cortina could satisfy the market by providing allusions
to American glitter and cosmopolitan travel, today's
customer is more concerned about fuel efficiency.

For sure, Ford's engineers are well enough able to
find technical solutions to this problem, but it was up
to the designers to make this goal of efficiency apparent
to the public in the car's exterior ... but also in its
interior where the new found commitment to technology and
responsibility produced a management objective that was to
"make the driver feel more important" .... These are not
purely scientific goals, susceptible to a single perfect
solution. In a sense they are irrational. They are more
intuitive than scientific. That is not to say that they
are misguided, but more to say that they might best be
affected by a strong personal vision of symbolic form.

In the case of the Sierra, the body was to be the
semantic vehicle for announcing Ford's new commitment to
technology and design. Aerodynamics were known to be
technically important and also to have a dramatically high
profile in terms of public relations. Yet, the very matter
of aerodynamics itself is not very scientific. As Anatole
Lapine said, all those planes fly the same, but they do
look different .... The general physics of airflow are well
known, but the specific behaviour of air over a moving
vehicle is not well understood. It is a very grey area
and this means that when it comes to combining efficiency
with marketable appearance, the designer has a lot of
interpretivescope.

The whole design process in the motor industry involves
much more creative freedom than is popularly imagined.
From the original concept sketches, craftsmen make clay
models. The procedure is that of the sculptor. By the time
a full size clay model has been made up, no engineering
drawings are in existence. Only after the shape of the
car has been approved is the model passed through a
computerised bridge called a scan mill and accurate
technical drawings are generated.

The degree to which even a technically successful car
body design like the Sierra's is the product of intuition
is underestimated by the public. The Ford Vice President
of Design, Uwe Bahnsen, speaks in terms that would be
familiar in the fine art studios at an art college.
Sympobism, allusion and metaphor form the basis for a
discussion about the shape of a car. The question of how the light falls on curved surfaces, of how 'gentleness, tautness and strength' can be invested in a windscreen pillar and how the transition from a complex curve to a flat plane can best be managed to give an impression of sinew under lean flesh .... are everyday considerations in Ford's studio.

Bob Lutz who was Chairman of Ford of Europe during the time the Sierra was being developed is a devoted car industry man, and I don't know whether it is despite or because of it that he is a firm believer in the irrational: "There's a very fine line between doing a movie that gets out there and fails and doing a movie that's Star Wars... and yet the celluloid's the same, the actors are the same and so is the amount spent on special effects. One film's good, the other isn't, because there is that creative and psychological content in any product programme that defies a totally systematic approach."

In looking at a handful of extremely successful designs it is evident that intuition, symbolism and metaphor play important parts in the imagination of designers and that the same qualities are commercially important in that consumers are drawn to the products, attracted by the appeal that the symbolic language exercises. In the case of some manufacturers, Porsche for instance, the use of metaphor is highly self-conscious. In the case of others, Braun for instance, it is not.

A fuller understanding and use of the language of objects will not reproduce the single standard of taste of the 18th century, nor will it necessarily reproduce the promiscuity of the century which followed, but it may well help to achieve a richer and more interesting dialogue between designer and consumer. Serious discussion about design has long been bedevilled by the lack of a proper vocabulary: when we learn the language of objects and when objects actually begin to speak like books then it will be another distinct episode in the history of taste.

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THE QUEEN'S CANALETTONS
J. R. Links

(Joint meeting with the Royal Society of Arts, East Midland Region; lecture delivered on 1st November, 1982)

Although the pictures I am going to talk about are the Queen's, they were not brought together by her ancestors, like most of the rest of the Royal collection. It would be better to call them Joseph Smith's Canalettos. It was he who collected them and sold them to George III. But he did more than collect them: he commissioned them, provided the inspiration for them, and indeed made Canaletto the artist he became, although whether that was a good or bad thing we shall see.

While Smith was in Canaletto's life he dominated it, but he came into it only when Canaletto was already a successful artist. They stayed together for twenty years and for another twenty Canaletto was more or less on his own. We shall therefore have to go outside the Queen's collection to understand and enjoy what is in it.

Canaletto was of course a townscape, or view, painter, pre-eminently a painter of Venice views. A Frenchman who was no friend either of Canaletto or Smith wrote in their lifetime that he surpassed everyone there had ever been in that field ... and 200 years later I suggest the same might still be said.

Giovanni Antonio Canal was born in Venice in 1697. His father was Bernardo Canal, a theatrical scene painter, and the son was called Canaletto, the little Canal. Scene painters of course are concerned with the art of deception by which such artists as the Bibiena family used to make a small stage look like the interior of a huge palace. Canaletto worked with his father in Rome for a few years and there could be no better training in the art of perspective. When he was in his early twenties he returned to Venice and took up view painting. But the theatre was in his system and to begin with he was still dominated by it. (Illustrations of the artist's early work followed, including paintings from the collections of the Prince of Liechtenstein, the Elector of Saxony and Stefano Conti).

An engaging Irishman called Owen McSwiney in about 1725 had the idea of diverting Canaletto from the European connoisseurs who were his only patrons (the Venetians of course had no interest in Venice views; they had the city itself) and selling his work to Englishmen on their Grand Tour. But he realised that he would be catering to a different taste, to people who were really more interested in horses
than art, and who were interested in Venice views simply as a memento of their travels.

McSweiney's type of picture sold well (examples) but he did not know how to handle a difficult artist such as Canaletto. At this point Joseph Smith, a business man who had lived in Venice for many years and who was a great collector of books and gems as well as pictures, took over. Less likeable than McSweiney, Smith had patience, experience, and contacts with virtually every Englishman who passed through Venice. He also had taste and, before setting Canaletto to paint small, sunny and topographically accurate pictures of the Grand Canal for the English, he commissioned for himself six of the large, undoubted masterpieces such as those that had made the artist's reputation. (Examples with selected details for comparison). He then displayed the Grand Canal pictures in his own Grand Canal palace and invited orders based on them from the tourists. He also catered for those not visiting Venice by having the pictures engraved and published. What the buyers received were not copies, but different versions and, since Canaletto was an artist of supreme competence and originality, with a genius for blending realism with a sense of atmosphere, every picture was a work of art. Naturally, the imitators followed, particularly as they had the engravings available for copying if they were unable to see the originals. View painting became a considerable industry in Venice and Smith and Canaletto prospered together.

The prosperity lasted for ten or twelve years. Then the War of the Austrian Succession spread to Italy; the flow of tourists slackened and finally ceased, and Canaletto was left with only one patron, the loyal and appreciative Smith. By 1746 Smith had in his collection fifty paintings by his protege which he either could not or would not sell—doubtless some of each category. He also had 150 drawings, none of which he had ever sold. He could take no more and it was decided that Canaletto should go to England where his reputation already stood so high.

At first Canaletto was as successful in England as in his early days in Venice and he remained nine years, with some months at home in between; on this visit he either took with him, or executed in Venice, several drawings and paintings of London which Smith added to his collection. By 1755-6 he had supplied all that the English were willing to take from him. He returned to Venice and lived there for another twelve years. By this time much of his work had become mechanical and mannered, but he was still the unique Canaletto, as can be seen in everything he did.

As for Smith, he was well into his eighties by 1750 although he had only recently married for the second time.
He retired from the post of British Consul, to which he had been appointed just before Canaletto's departure for England, and began negotiations for the sale of his superb collection to George III. He died in 1770, two years after Canaletto, and since 1765 Smith's Canalettos, together with most of his other pictures and books, had become the King's for a payment of £20,000. That is how the Queen became the owner of the greatest collection in the world of Canaletto's paintings, drawings and etchings, a collection of which my slides, abundant as they have been, can have done no more than suggest to you its richness and variety.

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MESMERISM

(lecture delivered on 29th November, 1982)

The antiquity of the hypnotic or trance state can be traced from the times of ancient Egypt, through the medical practice of Aesculapius and Hippocrates, the priests of Chaldea and the Druids up to the times of Franz Anton Mesmer in the nineteenth century.

Although there were many theories about the mode or action of hypnosis, greater emphasis was put on its phenomenology - how the state was produced; what could be done under its influence. If some sort of definition should be demanded, perhaps "an induced state of hyper-suggestibility" might do.

There were several methods of inducing the hypnotic state most of which contained elements of concentration and relaxation coupled with suggestion from the operator. Patients varied with regard to susceptibility, some 15% being able to pass reality into deep trance, while with most, only light trance could be achieved. But for therapeutic purposes, light trance with total awareness on the part of the patient, was all that was required.

In deep trance the phenomenon of post-hypnotic suggestibility could be demonstrated and, although this had a limited use in the therapeutic field, it usually wore off. Self hypnosis, by whatever name it might be called, was of great use in many conditions.

Regression to an earlier time in life, e.g. childhood, could often be produced, and the ability to relive past events or recall hidden traumas was of great use. This might be called "hypno-analysis" and is a useful weapon in the psychiatrist's armamentarium.

On the sensory side, pain could often be relieved, whereas only a few could undergo major surgery. Under hypnosis alone great help could be given in dentistry, frequent and painful dressings on the burned patient and often in labour.

Certain other conditions can often be greatly helped by hypnosis, such as bed-wetting and stuttering. Certain skin conditions, such as eczema can often be ameliorated and Mason's celebrated case of the cure of Ichthyosis became well-known internationally.

Help can frequently be given in what might be called minor tension states and in phobic and compulsive conditions. If the reaction of a patient to a minor stimulus is excessive or if he suffers from certain phobic conditions the patient can frequently be helped if he can be taught to "turn on" his own relaxation and tranquility. The same technique can be employed in cases of
pathological fears such as undue fear of spiders or air-planes etc. The patient is taught how to "turn on" his own peace of mind before he enters a phobic situation.

Sometimes the degree of relaxation and tension can be measured audibly by an instrument known as a "Relaxometer". This makes use of sweating and the so-called "Psycho-galvanic reflex". If a patient becomes tense, sweat will moisten the skin of the fingers and alter its electrical resistance, and this alteration can be monitored audibly. This is one function measured by the polygraph or lie detector.

The ability to "turn off" tension can also be used in the treatment of headache and insomnia and is a weapon put into the hands of the patient who more fully becomes master of his own situation.

Much time is spent by medical hypnotists in ridding patients of the "music-hall" idea of hypnosis gained from the performers who use the technique to produce ludicrous and often ignominious situations. Patients often fear losing all control of themselves. As has been pointed out, most patients are treated in the lightest stage and remain totally aware of their situation. The use of a legitimate medical technique to make fools of people is totally condemned. There must be total trust between operator and the patient and total professional confidentiality must always be observed.

To this end most medical hypnotists demand that the technique be used only by qualified personnel, and this exclusive demand has caused some resentment on the part of lay hypnotists.

The reason for this demand is simple. Symptom relief can frequently be achieved as, for example, in the case of chronic headache. But no medical hypnotist would undertake such an exercise without first being sure that the underlying cause of the headache was not for example, a cerebral tumour. There are many similar situations where a medical examination must be made to rule out organic and, perhaps, surgically treatable disease.

By the same token, hypnosis can be used in psycho-therapy, but it must be remembered that it is the operator who is treating the patient and using hypnosis to this end.

Unless he is qualified to treat his patient AS A PSYCHIATRIST, he should not use the technique unless it is backed up by clinical knowledge and experience.

In fact, it might well be said that no one should treat a patient with hypnosis unless he is qualified to do so without it.

As far as the use of hypnosis in the forensic field goes, whereas it may profitably play a part in the re-call of past and forgotten events, information gained under trance cannot be
considered admissible first class evidence and will find no place in criminal proceedings unless the facts disclosed are totally corroborated. Thus a lead towards identification of a forgotten or not consciously remembered face may help the police in tracing a criminal. The identification under hypnosis would have no standing as evidence on its own.

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HEALING SANCTUARIES OF THE GRAECO-ROMAN WORLD

Professor J. Ferguson

(lecture delivered on 13th December 1982)

There were wars in plenty among the ancient Greeks, and there must have been pragmatic understanding of treatment of wounds and even surgery from ancient times. Indeed on a Greek vase we can see a picture of a soldier having his wounds bandaged. Scientific medicine is associated particularly with the island of Cos. Here in the fifth and fourth centuries BC lived Hippocrates. The great Hippocratic corpus does not all go back to him. But we can see some of the principles he introduced or stressed. These include: the collection of meticulous clinical descriptions of the progress of illnesses with a view to successful prognosis and identification of the crisis; the elimination of superstition, as when it is suggested with gentle irony that epilepsy was called the Sacred Disease only because it was not understood; the discovery of environmental hygiene, and an interest in geographical and climatic effects; the establishment of moral standards for the medical profession, as in the still famous Hippocratic Oath.

On the island of Cos there was also a healing sanctuary, dedicated to Asclepius. The first healing god of the Greeks was Apollo, for he who has the power to destroy has also the power to save. Asclepius was not in origin a god but a hero, like Heracles, in myth the son of Apollo by a mortal, who might be made a god for his services to mankind. No doubt he was in origin a historical person whose healing powers attracted reverence to him. He seems to have come from Trikka in Thessaly.

The sanctuary in Cos dates from the late fourth century BC, and stands two to three miles from the city. It is well supplied with water, and healing springs seem to have been a feature of most such sanctuaries; the sanctuary of Sulis at Bath is another. It is organised in three terraces, with a sacred cypress grove at the top, temples, a monumental altar and draw-wells on the middle terrace, and below, a monumental entrance, and impressive baths of the Roman period. Curiously we do not know the relationship between the school of medicine in the city and the healing sanctuary.

On the mainland of Asia Minor the main sanctuary of Asclepius was at Pergamon. This city was a notable capital and cultural centre in the third and second centuries BC, with a library to rival Alexandria. Parchment, which is named from Pergamon, was invented when the Egyptians refused
to export papyrus to their rivals. High on the citadel stood the Altar of Zeus, the Throne of Satan in Revelation, and one of the steepest and most spectacular theatres of antiquity. The healing sanctuary lies far below, a little to the south-west. It is of special interest for its association with the great medical polymath Galen. A magnificent Sacred Way leads to a ceremonial entrance, which opens on to a rectangular courtyard 130 x 110m, enclosing the Sacred Well and two other healing springs. In the north-east corner stood a library; in the north-west a delightful little theatre, whether for entertainment or Sacred Drama we cannot tell. In the south-west are latrines, more elaborate for the men than for the ladies. In the south-east corner a finely built two-storey building with an excellent water-supply, adjoining the temple, has been identified as a hospital. Most exciting of all is a tunnel leading from this building to the centre of the courtyard. Its purpose is quite uncertain - access to the Sacred Well in bad weather, a cool retreat for the priests in summer heat, a private way for carrying out the dead, or making miraculous appearances before patients?

The greatest of the mainland sanctuaries is at Epidaurus. Epidaurus has the finest theatre of antiquity, but it was there because first Apollo Maleatas and then Asclepius was there. A Sacred Well offers water with an alkaline content. Hard by is the temple of Asclepius, and his altar, a tholos or round building (perhaps for the sacred snakes), and the abaton or encoemeterion where patients slept under the influence of a mild drug or hypnotic experience. At Epidaurus we have a remarkable series of records of cures. Usually the god appears as the patient sleeps. Sometimes the treatment involves surgery. Sometimes there is treatment with a salve or ointment. Sometimes an animal, snake or dog or goose, is involved. Sometimes the treatment is psychological. Some of the stories are entertaining, as the boy who offered ten knucklebones to be cured, or the lame man whose crutches were stolen, and who found himself chasing the thief. Few are totally implausible, as the woman who had been pregnant for five years and gave birth with the god's aid to a four-year-old son.

Other important sanctuaries in mainland Greece are at Athens, under the south side of the Acropolis, near the theatre of Dionysus, and at Corinth where a remarkable collection of limbs modelled in terracotta have been found, 125 feet, nearly as many feet, 65 female breasts, 35 penises, numerous ears, though curiously only a few eyes. The sanctuary at Athens by contrast was noted for the treatment of eyes.

One sanctuary may be mentioned of those dedicated to other healing powers. This was controlled by the prophetic hero
Amphiarus at Oropus on the borders of Attica and Boeotia. It is in an enchanting situation in a grove by a river and sacred spring. Some of the sleeping benches survive. Here too we have records of gratitude. The sanctuary seems to have specialised in diseases of the chest and lungs.

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WIND - AN ALTERNATIVE SOURCE OF ENERGY

Dr. Peter Musgrove

(lecture delivered on 14th February, 1983
sponsored by the University Bookshop)

There is no doubt as to the technical feasibility of harnessing wind energy; that was demonstrated many centuries ago. But can wind energy make a significant contribution to energy needs in the late 20th century; is the resource large enough? How do we use such an 'unreliable', intermittent power source? And if we can answer these questions to our satisfaction, is wind energy competitive with energy from other sources?

Since about 1% of the incoming solar energy is converted to wind energy, via atmospheric convection currents, simple calculations suffice to show that the global wind energy resource is indeed very large. More detailed and localised assessments confirm this general statement. For example, a detailed study undertaken for the Commission of the European Communities in 1982 identified sites for large wind turbines, and concluded that, even after allowing for the many siting constraints that exist in developed countries, there were sites in Europe for about 400,000 multi-megawatt wind turbines, which could, in principle, provide up to about three times Europe's present electricity consumption.

Although the wind is not a reliable source of power from one day to the next, it is a reliable provider of energy, year by year. Traditionally wind turbines have been used for water pumping, where continuous operation is not required. Such applications will continue in appropriate locations; however, modern wind turbines will find their major applications producing electricity, and operating in parallel with conventional power stations or - in smaller, more isolated communities - diesel engines. The coal or oil burnt in the power stations or the diesel engines provides the hour by hour certainty that there will be sufficient power to meet the demand; the wind turbines contribute energy to the system, as and when the wind blows, so that the overall fuel consumption can be significantly reduced. Recent studies, for example, indicate that the U.K. grid system in its present form could accept an approximately 20% contribution from wind energy, though with some adjustment to the future plant mix (i.e. by providing an increased proportion of low cost, rapid response, gas turbine generating plant) the potential wind energy contribution is substantially greater. Similar studies of wind-diesel systems for isolated communities have shown that fuel savings up to about 50% are feasible.
The primary value of the energy output from wind turbine is consequently the value of the fuel that they save; diesel oil in small, isolated communities, and fuel oil and/or coal for larger scale applications. The cost of wind energy, which includes the amortisation of the wind turbines' capital cost as well as their direct operating and maintenance costs, must therefore be competitive with the costs of these fuels. Available data on wind turbine costs was reviewed in the lecture. Although it is frequently assumed that large (multi-megawatt rated and 80 to 100 metres diameter) wind turbines will offer the best economics, the evidence so far is that smaller wind turbines, in the size range 15 to 30 metres diameter, and with power ratings in the range 50 kW to 300 kW, provide the lowest cost energy. Commercial applications are now commencing in a number of countries, most notably Denmark and the U.S.A. Currently available wind turbines in Denmark offer payback periods of about 5 to 7 years to the farmers who purchase them, and present production is about 200 machines per year, mostly about 15 metres diameter and with rated outputs of about 50 kW. Tax credits in the U.S.A. have encouraged the recent, rapid development of wind farms, some of which now have more than 100 operational machines; the production of wind turbines, primarily for wind farms, is expected to exceed 3000 in 1983, mostly 10 to 20 metres diameter and with rated outputs in the range 25 kW to 100 kW.

Though the economics of wind energy are already encouraging in many locations, further operational experience is required to show which machines are capable of operating reliably over prolonged periods. As this experience is gained, and as the cost benefits of quantity production are achieved, the market for wind turbines will expand rapidly, and by the end of the 1980s wind energy will be starting to make a significant contribution to the energy needs of both developed and developing countries in many parts of the world.

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THE EARLIEST WELL-PRESERVED FOSSILS

Professor H.B. Whittington, F.R.S.

(lecture delivered on 28th February, 1983; joint lecture with the Geology Section)

What is meant by "well-preserved" was illustrated by a series of photographs of trilobites. An internal mould and a latex cast of a complete but slightly distorted example of *Flexicalymene* from the Ordovician of North Wales showed details of the exoskeleton. An undistorted example of *Isotelus* (Ordovician, New York State) showed the facial sutures, eye lobes, and muscle impressions. Silicified Ordovician material of *Cerurinella* from Virginia showed the outside and inside of the exoskeleton, the hypostome in place, and details of the articulation of the thorax, as well as blade-shaped infolds (apodemes) to which muscles were attached. An enrolled Devonian *Phacops* shows the eye lenses, which are unique in the animal kingdom, each of crystalline calcite with the c-axis directed outward. In *Triarthrus* from the Upper Ordovician of New York State the exoskeleton is replaced by pyrite, and also the antennae and both branches of the limbs. These limbs may be studied by X-rays, which are absorbed differently by the matrix and by the pyrite. The best detail is revealed by specimens of *Olenoides* from the Middle Cambrian Burgess Shale (Plate 1). The jointed, spinose walking legs, the gill branches and their lamellae, are revealed in detail, as well as the basal segment (the coxa), armed with many spines. From such specimens the animal may be reconstructed (Figure 1), and the way in which it walked, ploughed and dug in the mud, and captured food of small, soft-bodied animals or preyed on carcasses, may be suggested. The study of exceptionally well-preserved fossils thus enables the behaviour to be deduced of an animal 530 million years old.

The Burgess Shale outcrop is on the steep slope of a ridge 7000 feet high in the Rocky Mountains of southern British Columbia, in western Canada. It was discovered in 1909 by Dr. Charles D. Walcott, then Secretary of the Smithsonian Institution in Washington D.C., U.S.A. He quarried the Shale, working for five seasons, and amassed the huge collection now in the U.S. National Museum of Natural History. Photographs were shown of the expedition made in 1966 and 1967 by the Canadian Geological Survey when the quarry was re-opened and new collections made. These investigations showed that the animals living on and in the sea floor were caught up in under-water mud slides, carried down slope and buried in an oxygen-poor environment. This catastrophic burial killed and buried animals whole, and there was little decay, so that soft-bodied animals retain traces of the gut and of muscles, as well as limbs. During
transport in the turbulent cloud of mud, the sediment penetrated between parts of the body and branches of the limbs. This sediment is now a layer of rock, and under the microscope a layer may be removed to show what lies below. It was shown that in Naraolia, for example, the dorsal shell could be removed and entire limbs exposed below it (Plate 2). Naraolia thus proved to have trilobite-like limbs, and was indeed a soft-bodied trilobite, and not an animal related to Limulus.

Opabinia, with its flexible frontal process for grasping food, its five eyes, and lateral flaps but no limbs, was shown as an example of one of the strange animals in this ancient deposit, not related to any living group (Plate 3). A variety of worms were described by Walcott, including polychaetes and priapulids. One, Aysheaia, was not a worm but shows resemblances to living land animals of the southern hemisphere, the onychophorans (Plate 4). It is the kind of animal from which onychophorans and insects may have been descended. Hallucigenia shows a unique combination of characters, perched on its pairs of spines and with tentacle-like projections on the upper side. Pikaia shows muscle blocks and a notochord-like rod, and may well be the oldest known chordate animal. More familiar are the inarticulate brachiopods (with mantle setae preserved), sponges and algae.

The Burgess Shale fauna includes the hard-shelled animals - trilobites, sponges, brachiopods, rare echinoderms, hyolithids and cap-shaped molluscs - found in Cambrian rocks everywhere. But the exceptional preservation shows also twice as many kinds of soft-bodied animals, not found usually because they decayed and left no trace. Modern marine faunas also show twice as many kinds of soft-bodied animals as kinds with hard shells likely to be preserved. Hence it is the preservation that makes the Burgess Shale so exceptional, in revealing more completely than any other locality the variety and strangeness of early marine animals. The evolution of multi-celled animals had, by Cambrian times, resulted in a far greater variety of kinds of animals than we customarily acknowledge.

It was a great privilege to be invited to join the Canadian Geological Survey's project on the Burgess Shale, and a unique experience in palaeontology to direct the work on these exciting fossils.
Plate 1. Olenoides serratus, Middle Cambrian, Burgess Shale, British Columbia. Posterior portion of specimen showing jointed walking legs, gill branches with lamellae, and posterior cerci. Geological Survey of Canada Collection, photograph by H.B. Whittington, x 1.7

Plate 2. Narasia compacta, Middle Cambrian, Burgess Shale, British Columbia. Lectotype, showing antennae projecting from beneath distorted anterior shield, and many pairs of biramous appendages projecting from beneath the anterior and posterior shield. Smithsonian Institution Collection, photograph by H.B. Whittington, x 1.6
Plate 3. *Opabinia regalis*, Middle Cambrian, Burgess Shale, British Columbia. Lectotype, showing on left the head with the curved frontal process and some of the eyes on top, and the body with flaps hanging down at the sides and projecting up at the back. Smithsonian Institution Collection, photograph by H. B. Whittington, x 1.3

Plate 4. *Aysheaia pedunculata*, Middle Cambrian, Burgess Shale, British Columbia. Individual flattened obliquely from the side, showing the limbs of the left side, the annulations on body and limbs, and the left and right anterior appendages projecting respectively below and above the head. Smithsonian Institution Collection, photograph by H. B. Whittington, x 1.6
Figure 1. *Olenoides serratus*, Middle Cambrian. Restoration in dorsal view, dorsal exoskeleton of right half removed to show hypostome and appendages, gill branches of first seven limbs removed to show attitudes of walking legs in a particular gait. Black dots opposite tips of limbs on the sea bottom.

For further information and illustrations, see:


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Cambridge.
LESSER KNOWN AUSTRALIA

Dorothy Bovey
(lecture delivered on 14th March 1983)

Many people, when they think of Australia, see pictures of Sydney Harbour Bridge, the Opera House, or Koalas and Kangaroos. While I have been to the Opera to hear Joan Sutherland and I've helped to foster orphan koalas and kangaroos, I've been very lucky and my various journeys in Australia have covered far more of the continent than many Australians do in their lifetime. In my lecture and with my slides, I tried to show some of the tremendous variety of the landscape and the architecture and to pass on some of my pleasure in the wide open spaces, the brilliant blue sky and the fascinating and very different flora and fauna and geology.

Starting with Darwin which was a one horse shanty town before the terrible Cyclone Tracey of 1974 but is now a handsome modern state Capital, my photographs showed my journeys across the top on the Barkly Highway towards the east coast. The arrow-straight road runs for hundreds of miles across the endless plains of golden Mitchell and Flinders grasses with only distant black specks of the mobs of cattle. In the small boom towns which were started at the turn of the century when the atmosphere was full of prosperous optimism, suddenly one comes on a house or a hotel with an elegant elaborate lace ironwork balcony or a line of canopied shops.

There is also the 'outback homestead' of the legends and films and I showed one picture of Yelvertoft. In England, Yelvertoft is the historic grey stone village near Rugby; on my Times Atlas map of Australia, scale 1:500,000 Yelvertoft is clearly marked - so I expected at least a small township with Northamptonshire connections. When we turned off at the signpost, we came to a lone homestead with Brahmin and Santa Gertrudis bulls in the paddocks, stock horses tied up under the Hakea trees and three stockmen barbecuing their steaks on shovels over a wood fire.

Another of my journeys took me on the Warburton Trail, which is the only direct landroute from Alice Springs to Perth. Only about a dozen vehicles a year do the crossing from Ayers Rock to the Gold Fields on the rough red dust track past the two remote Aborigine settlements of Warburton and Docker River. In the gold fields I saw the abandoned desolation of Cawalla and the bustling prosperity of Kalgoorlie. My journey took me on to Perth and finally down to Albany which looks and feels like the Hebrides. Interspersed with the other photographs, I showed slides of some of the unique animals, such as goannas and spiny
lizards (*Molochus horridus*) and the incredible and totally different flowers and trees that may only grow on one hillside in all the world.

I love travelling in Australia and I hope that I was able to show some of the tremendous variety and beauty in the remoter regions.

Dorothy Bovey  
Kellock House Gallery  
Laughton  
Lutterworth, Leics.
A HISTORY OF LEICESTER UNIVERSITY BOTANIC GARDEN

R. J. Gornall

(based on a lecture to the Natural History section on 1st Dec. 1982).

FOUNDATION AND PRE-WAR YEARS

Botany can lay claim to special status at Leicester in that it was one of only five subjects offered by the then Leicester, Leicestershire and Rutland College during its inaugural academic year of 1921-22 (the other four were English, Latin, French and Geography). The roots of the Botanic Garden go back a year earlier, to 6th October 1920, when the officers of the Botanical Section of the Leicester Literary and Philosophical Society were invited to undertake the work of establishing such a garden in the grounds of the College. These grounds comprised about six acres adjacent to the imposing edifice of the former Leicestershire Mental Asylum which had been built in 1837 (now the University's Fielding Johnson Building). After the First World War the building and land were bought by Mr. Thomas Fielding Johnson and donated in 1918 to provide a site for the proposed College.

Construction and layout of the Botanic Garden began early in 1921 under the principal guidance of Mr. A. R. Horwood, the Honorary Secretary for scientific and technical aspects — in essence the first curator. He was aided a great deal by Miss Measham (the first Lecturer in Botany at Leicester), Mrs. B. Ellis (one of the main driving forces behind the creation of the Garden), Mr. C. Gaskin, Mr. W. Ball and latterly by Mr. Bradshaw.

When completed in 1925, the Botanic Garden comprised a woodland garden (designed to display the typical flora of the Charnwood Forest), sections devoted to medicinal plants, culinary herbs and dye plants, a rock and water garden, British order beds (arranged on the Englerian system), an experimental area planted with various grasses on different soils, and a general planting of interesting specimens. Plants were donated not only by many local people but also by the Botanic Gardens of Cambridge, Chelsea, Edinburgh, Kew and Oxford. Altogether it was a remarkably modern Garden in the wide variety of features which it displayed, although a minute from an early Garden Committee meeting reveals that the aims were primarily restricted to education (by serving the Botany Department) and amenity (by enhancing the beauty of the College grounds).

Dr. E. N. Miles Thomas was appointed as Head of the Botany Department in 1922/23. She had a rather dominant personality by all accounts and it was under her administration that the Garden was to develop steadily over the next decade. Notable events during this period included the addition of a Rose Garden
in 1926, with plants donated by Mr. Percy Gee, and the planting of a Maidenhair Tree (Ginkgo biloba) by the Prince of Wales (the future King Edward VIII) during his visit on 10th March 1927; this tree may still be seen on the lawn in front of the Fielding Johnson Building. Other trees dating from this early period include the Weeping Silver Lime (Tilia cv. Petiolaris) and the Black Mulberry (Morus nigra). In the same year, 1927, it was decided to increase the number of families represented in the Order Beds to seventy, by offering prizes to children in local schools in return for specimens; the scheme failed miserably! Presumably the prizes were not sufficiently attractive because there was not a single entry for the competition! Also at that time the first (and so far, only) catalogue of plants in the Garden was produced. Restricted in scope to the Rock Garden, it was prepared by Mr. Sayer, the Head Gardener, and listed nearly 1000 plants including approximately 600 alpines and 230 shrubs. Unfortunately, this catalogue has since been lost. In the summer of 1928 an experiment in opening the Garden to the public began: four Sundays were designated as open days and they proved to be so popular that in subsequent summers the number of open days was increased to fourteen. Nowadays of course, the Garden at Oadby is open to the public five days a week throughout the year in the belief that the University should share such an important amenity as much as possible with the local community.

From about 1933 until Dr. Miles Thomas' retirement in 1937, the general upkeep of the Botanic Garden declined somewhat. However, when Dr. C. T. Ingold was appointed Head of the Department in 1937, this decline was reversed and under his guidance much of the garden was replanted. By 1938 the Order Beds contained 200 species and included special tubs for algae and liverworts.

The Second World War years saw little further development, indeed quite the reverse: because no gardeners were employed the grounds became overgrown. In 1944 T. G. Tutin became Head of the Botany Department and at his instigation the Garden's first Superintendent, Mr. Alfred J. Hopkins, was appointed in 1946. Mr. Hopkins, who had been in the army during World War II, had had previous horticultural experience at Cambridge University Botanic Garden, and at Kew (where he took a training course) and had worked in several private gardens in France and Italy. His first job was to restore the Garden after the ravages of its wartime neglect. The Garden's first display greenhouse was commissioned in 1946 and stocked with tropical plants donated by the botanic gardens of Cambridge and Kew. The Garden remained at the College until 1947 when it was transferred to its present site in Oadby.
THE OADBY SITE

The present Botanic Garden occupies an area of about sixteen acres, and comprises the grounds of four houses: Beaumont, Southmeade, Hastings and The Knoll. The Garden lies south of Beaumont Gate and is bounded by the London Road to the south and by Stoughton Drive South and Glebe Road to the east and west respectively. In 1947, when the Garden was first established on this site, only the grounds of Beaumont and Hastings were included, but during the next twenty years it was expanded in two stages with the addition of Southmeade and The Knoll.

Before the land enclosures, the Oadby area was part of the Stoughton Grange Estate and was used primarily as pasture or meadow land. With the Enclosure Act of 1760, hedgerows were planted and remnants of these may still be seen in the Garden. The central, roughly north-south axis of the Garden (Hedgerow Walk) follows the line of an old hedgerow and some of the trees, e.g. the Field Maple (Acer campestre) and the Ashes (Fraxinus excelsior) still exist today. Several English Elms (Ulmus procera) which also belonged to this hedgerow, but which contracted Dutch Elm Disease during the epidemic of the 1970s, were felled between 1975-8. They averaged about 100 years old. A second hedgerow ran roughly east-west through the length of the Summerhouse Bed to the Limestone Rock Garden (then the site of a small pond), and from there on eastwards through the Spinney and beyond. A third hedgerow followed a line from Hedgerow Walk eastwards through Hastings House and beyond. The solitary Oak (Quercus robur) on the lawn of The Knoll is shown on the 1885 Ordnance Survey map as standing by a pond, which is now sited some 25 yards further east.

The development and landscaping of the grounds of the four houses early this century have almost obliterated the ridge and furrow topography so characteristic of Leicestershire grazing land, although traces of it may still be seen in the Meadow and around the Heather Beds.

THE HOUSES AND THEIR GARDENS

Three of the houses, Beaumont, Southmeade and Hastings, were designed by the architect Stockdale Harrison. The first to be constructed was Hastings House (known as "Nether Close" until 1947) which was built in 1902 for Mr. Stevens, a hosiery manufacturer. Its design is something of a copy of Old Ragdale Hall, near Rotherby in Leicestershire. Mr. Stevens was responsible for the development of the original conifer collection, most of the planting dating from about 1904, and it is thanks to his botanical interest that our comparatively young Botanic Garden can display so many mature trees, prominent among which are the Giant Redwoods (Sequoiadendron giganteum). In the early 1920s the house was bought by
Mr. J. Batten who lived in it with his family until 1930 when it was purchased by Mr. James Eastwood Pickard, Jnr. (Leicester City Councillor 1928-1939 and Alderman 1939-45). It was finally bought by the University in February 1947.

Beaumont Hall (known originally as "Middlemeade" until 1947) was built for Mr. F. S. Brice, another Leicester hosiery manufacturer, in 1904 and was later (1929) acquired and occupied by Mr. S. H. Driver until the University bought it in June 1947. The Beaumont garden has remained almost unchanged since it was originally laid out in about 1905. It was greatly loved by Mr. Brice and the indications are that it was constructed over a considerable period of time, with the Water and Sunken Gardens being completed last, around 1920. The Sandstone Rock Garden, built in Carboniferous sandstone from Derbyshire, dates from the original layout. It is apparently modelled on the stone gardens perfected some 500 years earlier by the Buddhist priests of Kyoto in Japan. Indeed, Mr. Brice is reputed to have been advised personally by visiting Japanese experts on how to create the massive sculptural effects by the careful placing of groups of rocks. The stone bridges and central canal are also of Japanese influence. In contrast, the small cave and waterfall in the main rockwork are a survival of the Victorian tradition of grotto construction. The Limestone Rock Garden was apparently added in 1930, during Mr. Driver's residence. It was built in waterworn Westmorland limestone in an early version of the "outcrop style" in which an attempt is made to show the rocks rising from the ground naturally. There is, however, still a strong influence of the older 'terrace style' in which courses of rocks are used to support beds of soil. In its heyday, the Beaumont garden was reputed to have been "the finest garden in and around Leicester"; it employed ten gardeners - five outside and five in the greenhouses! Today, for economic reasons, the glasshouses and grounds of all four houses are maintained by a total of only five gardeners.

Southmeade was built in 1928 for Mr. Brice when he retired and left Beaumont. The terrace and garden of Southmeade are a late (1928) example of the Gertrude Jekyll style of Edwardian garden and were originally designed to provide an echo of the formal plantings at Beaumont. In 1934, after Mr. Brice's death, the house and garden were bought by Mr. Arthur Hawkes (Leicester City Councillor 1913-34 and Alderman 1934-45). He had a great interest in horticulture and was determined "to have the best garden in Stoneygate". To help fulfill this ambition he employed three full-time gardeners. However, the grounds deteriorated during the Second World War and were virtually derelict when the University acquired the property in February 1956.

The Knoll is perhaps the most attractive of the four houses and was both designed and constructed by Mr. William
Winterton, a local builder, for himself and his family. It was built in 1907 with specially made tudor bricks and roofed with the now almost unobtainable Swithland slates, from the local quarry. The main planting of the garden dates from about 1910 or slightly later. The house was later occupied by Mr. E. S. Fox (of Fox’s Glacier Mints) and was bought by the University in March 1964.

During the War, parts of the gardens of Beaumont and The Knoll (the area of the present Heather Beds) were turned over to vegetable production. Records show that a two acre plot at Beaumont produced crops worth about £1000 per annum - no mean sum in those days! The Meadow at Hastings was planted as an orchard from about 1935 up until 1950. All four houses are now used as University residences, and it is interesting to note that the arrival of resident students in the area was considered by some to be very lowering of the tone of the neighbourhood, which had been extremely exclusive ("almost private roads") until the Second World War.

POST-WAR DEVELOPMENT

From 1947 until 1964 the activities of the Botanic Garden were mainly confined to the grounds of Beaumont and Hastings. Beaumont Garden was overgrown when acquired by the University in 1947 and reclamation was difficult as there was little money available and, at first, little machinery. Only through the hard work of Mr. Hopkins and his gardeners did things improve. Waist-high grass, brambles and weeds were cut by hand using scythes and shears, and when the bamboo which had over-run the Sandstone Garden was eventually cut away, a fox’s lair was exposed! Gradually, the garden was restored and has been maintained in the style and condition that it was in when Mr. Brice lovingly cared for it in the 1920s.

The orchard in the Meadow at Hastings was removed in 1950/51 because successful fruit production had proved impossible owing to the predations of Bullfinches. The old Quince tree (Cydonia oblonga) now remains as the lone survivor. Some tree planting was carried out to replace the orchard trees, the plants being obtained from the Botanic Gardens of Oxford and Cambridge as well as from more local nurseries and donors.

When Southmeade was acquired by the University in 1956 its garden too was more or less derelict. For the first time since its transfer to Oadby however, the Botanic Garden now occupied a continuous strip of land. Many trees were removed to reduce the jungle effect and the Order Beds were transferred from Shirley House, (now Gilbert Murray Hall on Manor Road), where they had been planted after their removal from their original site in Beaumont’s Kitchen garden.
UNIFYING THE GARDENS

With the purchase of the Knoll in 1964, the Botanic Garden now occupied all the land within the boundary roads. A programme to unify the four constituent gardens began. This programme was supervised initially by a new superintendent, Mr. E. F. Sheppard, together with a specially appointed taxonomist, Mr. P. D. Brown. During the next three years the hedges and walls between the houses were removed as far as possible and a number of new developments were started. The first of these was the erection of the main glasshouse at Hastings and the replanting of the Bottom Border following the loss of the southernmost strip of land as a result of the widening of the A6 in 1965.

In 1967, a new Professor of Botany was appointed following the retirement of Professor Tutin. Although his main interest was in plant physiology, Professor H. E. Street took a keen interest in the rapidly developing Garden and became its first official Director. Up until then, the responsibility for the Garden had not been formally separated from that relating to all the other land owned by the University. In the years that followed, many developments took place: the Knoll Heather Beds were laid out and planted on the site of the old paddock (1968); the historical Rose collection was developed between 1972-76; the Cactus House and Bryophyte House were laid out in 1976, and the Herb Garden followed in 1977. Sadly, Professor Street died at the end of that year and the Directorship fell vacant until the current occupant, Professor H. Smith (another plant physiologist with an interest in horticulture), was appointed in 1979. There were in fact two other personnel changes at around this time: following Mr. Sheppard's retirement, the present Superintendent, Mr. B. Frankland, took over in 1975 and in 1980, following Mr. Brown's departure, I took on the new post of Curator of the Botanic Garden and the Botany Department Herbarium.

RECENT DEVELOPMENTS

In addition to its educational responsibilities, the Botanic Garden has roles to play in the fields of botanical research, conservation and amenity, and it is in these last three areas that significant recent developments have occurred.

In 1980, an association of Friends of the Garden was established, whose principal aims are to help improve the amenity value of the Garden and to encourage interest in horticulture in the county. Partly as a result of the association's efforts, the Garden is now the proud possessor of a new Alpine House. The Botanic Garden has also regularly supported various charities over the years, and in 1981, a special porcelain rose was presented to the Garden to mark
the fact that it had held an Open Day every year for twenty-five years in aid of the Royal Gardeners' Benevolent Fund, a tradition which still continues.

Among other recent developments has been the construction of a Conservation Garden, begun in 1982, and designed to house the National Collections of garden varieties of Viola and Hesperis. These collections were established in cooperation with the National Council for the Conservation of Plants and Gardens because it has become clear recently that many members of the garden flora are threatened with extinction. The comprehensive display of Skimmia species and cultivars at Leicester has also been designated to form the basis of a National Collection.

Two other major developments occurred in 1982. The first of these involved the installation of a new research laboratory with extensive growth cabinet facilities. This will provide a significant boost to the current research work in plant physiology and systematics. The second development involved the initiation of a new plant documentation system, whereby information relating to plants grown at the Garden is stored on a computer file so that access to it can be made more easily and effectively.

ACKNOWLEDGEMENTS

I should like to thank the following people, without whose recollections many details relating to the Garden's development would have been lost: Dr. H.B. Martin, Mrs. M. Overton, Professor T.G. Tutin and the present Garden staff (Mr. B. Frankland, Mr. B. Arnold, Mr. G. Benskin, Mr. G. Burton and Ms. P. Jenks).

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THE HALLGATES STORY

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Abstract
An account is presented of how part of Leicestershire known as Hallgates, lying between Bradgate Park and Roecliffe Road, has been developed since the turn of the century to become the strategic centre of water supplies for Leicestershire and the East Midlands.

"Do you know anything about the reservoir at Cover Cloud?"
"If you mean the one I call Field Head Service Reservoir, yes, I built it 25 years ago."

A casual conversation which was to initiate both this article and the associated one by Dr. Helen Boynton. Her question derived from personal researches into the Charnian rocks and I was able to tell her of the existence of a mass of information, photographs, boring logs, specialist reports, even rock samples, which were to prove of great interest.

Originally, I had expected only to provide a few notes to explain the waterworks records and to relate them to her paper, but the notes became a fully-fledged article describing the development of the Hallgates area for waterworks purposes, and its present importance in the water supply system of Leicestershire and the East Midlands.

Despite seeming to have its fair share of rivers, reservoirs and other open water areas, the county is lacking in natural water resources suitable for water supply purposes. It is a relatively dry area, with rainfall varying from 23 inches per annum in the east to 29 inches in the west. Normally, only one-third of the "dry weather" precipitation in this part of the country is considered to be available for water supply purposes (Anon. 1969). The rest evaporates directly or is taken up by plant life and returned to the atmosphere by transpiration through foliage.

Being largely covered by clay or impervious rock and with large parts of neighbouring counties similarly protected, there are only small isolated pockets (Richardson, 1931) of underground water. Much of this is not suitable for drinking water without expensive treatment which could not be justified in Britain. The Soar, the county's only major river, is nowhere suitable for impounding, nor, particularly downstream of Leicester, is the quality suitable for use for public water supply purposes. In any case, considerable difficulties would arise because the river has been governed for upwards of 200 years by legislation relating to its use for navigation.
At this stage, some of the terms used later in this article should be explained. When a dam is built across a valley to hold back the waters which run off the land as a result of rainfall, an "impounding reservoir" is created. A similar dam, such as that at Staunton Harold, where run-off is negligible, or a barrier totally encompassing an area of level land, such as can be found around London, and which is then charged with water brought from elsewhere, is known as a "(pumped) storage reservoir". In each case the purpose is identical, to provide stocks of "raw", i.e. untreated water, to be drawn upon throughout periods of drought or low rainfall. Such reservoirs also provide the primary treatment for water supply purposes. There occurs a natural improvement in the quality as bacterial contamination dies off to a very low level and as sediment and silt gradually settle on the floor of the reservoir. In the past, such reservoirs were said to have a "reliable" yield, namely the average daily quantity which could be drawn throughout the whole of three consecutive "dry" years matching the driest comparable period on record; in a dry year rainfall is up to 20% below the long term average. Today, the preferred term is "maintainable yield".

A "service reservoir" (S.R.) is a covered structure having artificial walls and floor. Its function is to hold stocks of potable water following treatment. Pumps and treatment plants operate most efficiently and economically at steady rates of throughput. Consumer demand or "draw", on the other hand, fluctuates throughout the day and throughout the week. The first purpose of the service reservoir is to meet this fluctuating demand on the output side, whilst the input remains steady. The second purpose is to hold a stock of water to maintain supplies in the event of a breakdown or other temporary interruption in supply. A third purpose in many cases may be to act as a "break pressure" tank, to avoid subjecting a system to unnecessarily high pressures which would increase both wastage and installation costs. A "terminal" reservoir (T.R.) is a specific form of service reservoir, a relatively large one, located at the end of the aqueduct bringing water into supply from the treatment works (T.W.). For all reservoirs, of whatever type, there exists an individual relationship between capacity, peak and average output, maintainable input and the assumed length of input failure. In particular, as "demand" or "draw" grows, greater reservoir capacity is needed. This relationship is fundamental to waterworks practice.

Leicester was the first town in the county to find its wells, bores and watercourses inadequate for its needs. In a Private Act of Parliament of 1847, the newly formed Leicester Waterworks Co. (Newton, 1974) was granted the powers necessary to provide a water supply to the people of the Borough and to some of their neighbours. The Company was able to construct a dam and filters across the Rothley Brook at Thornton, lay an 18 inches diameter iron gravity main to a brick service
reservoir at New Parks and a 24" iron gravity main into High Street, (Newton, 1974). These works are still in service today, and, together with 20 miles of distribution main, were commissioned in time for Christmas, 1853. The reliable yield of Thornton was considered to be one million gallons per day (mgd).

The piped supply proved popular; the town and its industry grew. Bradgate (now Cropston) impounding reservoir, its pumping station and the service reservoir at Gilroes, were built under powers granted in 1866, and had a reliable yield of 2 mgd. Even this proved insufficient and the Company was soon looking for a new source, at Black Brook in fact. At this stage, 1878, the Corporation was to acquire the Company and its assets (Storey, 1895).

Meantime, Loughborough had been next to develop a water supply system. The Local Board of Health had called for a report from Thomas Hawksley (1852), the Engineer who had built Thornton and Cropston Reservoirs for Leicester. Initially the report was shelved, but ultimately, Loughborough built Nampanton Reservoir (Hodson, 1868), commissioned in 1870 and, like Leicester, soon found more water was needed. It too decided to look to Black Brook, and in 1885, both Boroughs had deposited Bills in Parliament. Blackbrook Reservoir is another story, but Parliament found in favour of Loughborough and Leicester had to look elsewhere.

This is where the Hallgates Story starts, but had Leicester won in 1885, things might have been so much different.

Leicester, of course, chose Swithland (1.5 mgd), obtaining the necessary powers in 1890 (Newton, 1974). The Act required Leicester to make available a bulk supply of water to the Quorndon Local Board of Health and also to take into its area of supply, the township of Barrow-on-Soar. Up to this time, Thornton via New Parks S.R., and Cropston via Gilroes S.R., which was at the same elevation as New Parks, had only been able to supply by gravity the lower parts of the area in and around the Borough, probably reaching at most to Victoria Park Gates. The town had prospered. The population had grown; one good reason was that fewer people died as a result of drinking polluted water! In order to provide supplies to those living in the salubrious areas of Stoneygate and Knighton, a steam-powered pumping station (P.S.) had been built in 1888 at the corner of Charnwood Street and Nedham Street to send water along a 12 inches diameter main up Melbourne Road, and thence along London Road to Oadby S.R. built on Oadby Hill. Oadby and Wigston also received supplies from this system.

Swithland being in the same valley, but lower than Cropston, necessitated a new pumping station, together with additional service reservoir capacity, preferably capable of serving Quorn and Barrow as well as Leicester. The Corporation decided that
the new reservoir should be at Hallgates Wood. Ideas were changed more than once and the reservoir finally built (see Map), under powers granted in 1894, was not the one authorised in 1890 (Storey, 1895). Hallgates No. 1 S.R. is set at an elevation sufficient to gravitate to Oadby, making the Charnwood Street Pumping Station redundant: it holds two million gallons. It was the decision to build this reservoir on this particular site, which was to have such far-reaching and unforeseen results, for 70 years later, Hallgates had become the focal point of water supplies to the whole County, and a population some five times greater than originally envisaged.

On completion of Swithland and Blackbrook reservoirs, Charnwood Forest had contributed all it could to the county's water supplies, about 7 mgd. in all. Whilst the rest of the county was developing minor local sources, only Leicester appeared still to have problems. 1893 had been a year of prolonged drought and the Corporation, realising that Swithland would do no more than recover the time lost in the abortive Blackbrook Bill, decided to look further afield, to North Derbyshire in fact. Here, Sheffield, Nottingham and Derby were all likewise engaged. The four towns agreed to join forces, and under an Act of 1899, the Derwent Valley Water Board (DVWB) came into being, the first bulk supply Water Authority in the country (Baum, 1949).

Initially, the Derwent Valley Supply (DVS) was thought to be good enough not to require treatment, but it turned out frequently to be discoloured and peat-stained. Leicester and Nottingham both decided to build treatment works, Leicester's was built in 1920 at Hallgates, fronting Roecliffe Road, and extended in 1930. Eventually, the DVWB built its own.

The DVS was to meet Leicester's continually growing needs for half a century and of course needed a terminal reservoir of its own. The natural line of the aqueduct, originating at Bamford near Sheffield and crossing the Trent at Sawley (the pipebridge can be seen to the west of the M1) passes close by Swithland. Hallgates was thus the logical place for the reservoir and the No. 2 reservoir, also of 2 mg. capacity, was built, attached to the first, in 1911.

No doubt to ease the financial burden it had assumed, Leicester entered several agreements to sell supplies of water to its neighbours. Much of this water had to be transported on from Hallgates, which thus began to acquire its strategic role.

As water usage grew, additional storage, as well as a second Derwent pipeline alongside the first, became necessary. The No. 3 reservoir with a capacity of 5 mg., was built in 1936. All three reservoirs had to be interconnected to act as a single, compartmented tank. This meant that all have to be at the same elevation, otherwise the lowest would constantly over-
flow. The main problem of constructing reservoirs in an area such as Hallgates, is the cost of excavating into the hard Charnian rocks, since, for a variety of reasons, reservoirs of this type need to have about half their depth underground. Hallgates Nos. 1 & 2 S.R. seem to have been built on some sort of ledge, on the north side of an outcrop. There being no more room, No. 3 was built a short distance away (see Map) and its unusual shape, like a slice of a loaf, is probably attributable to avoiding undue rock excavation. A number of photographs exist which were taken during the construction of No. 3 reservoir, but they are not sufficiently clear to make a positive identification of the rocks, though there is a distinct impression of some near to Bradgate Park wall (Plate 1). Plates 2 and 3 are from recent photographs. Unfortunately, no photographs are known of the earlier reservoirs under construction.

The final major development of the DVS was the building of Ladybower Dam which went on throughout World War II, and increased Leicester's ultimate entitlement from the scheme to be 15.7 mgd. Despite having trebled the available resources inside 50 years, they were still adequate only for contemporary needs. Possessing virtually all the sizeable resources of the county, Leicester had been called upon to increase many of the supplies to its neighbours, particularly in respect of extensions of supplies to rural areas and to the military establishments and airfields built during the war. By the end of the war, therefore, new proposals had been prepared for meeting yet further growth of demand.

A Bill was deposited in Parliament describing a scheme to develop the Manifold Valley. Opposition came from the Ministry, who foresaw that if Leicester obtained powers for itself alone, the remainder of the county would be faced with an almost insuperable task. The petition failed and Leicester was sent away, to consult with the neighbouring water undertakers, with a view to promoting a joint scheme to meet all their several needs (Baum, 1949).

The delay came at a time when 19th century plant at Cropston and Swithland was approaching the end of its working life, and which in any case was unsuited to modern conditions of manpower and economics. Electric plant replaced steam and pumps were installed at Thornton to provide water to Markfield. The filters at Hallgates, abandoned when the DVWB commenced its own treatment, were recommissioned, to treat water from Cropston and Swithland, whilst twelve units were transferred to Thornton. The purpose was to achieve greater flexibility and output in the critical years until a new scheme could be prepared and commissioned.

The discussions which were held led to the formation in 1955, of the River Dove Water Board (RDWB). The Board included representation from every Local Authority in Leicestershire and Rutland bar one. The initial Dove Scheme was planned to develop
in three stages, providing first 5 mgd. by 1959, then 14 mgd., and finally a total of 20 mgd. By the mid-1960s and before the scheme was complete, it was discovered that the proposals were going to be totally inadequate. The individual membership of the Board had amalgamated, so that by 1965, there were only two, Leicester Water Department (LWD) and the North-West Leicestershire Water Board (NWLWB). It then became apparent that earlier forecasts of need had been hopelessly low and work immediately began on the planning of Phase 2, a twin scheme. Both schemes are now completed and have a combined output of 40 mgd. as a maintainable yield, but with capability of delivering up to 55 mgd. in extreme conditions.

The Phase 1 scheme was to draw water from the River Dove near Burton and to transfer it to a pumped storage reservoir at Staunton Harold. From there it would be extracted for treatment in the Melbourne Treatment Works before being pumped into supply. An essential requirement of the project was that water was to be delivered into various new service reservoirs which would command the areas of supply of the several members of the RDWB. Having regard to the urgency of meeting the target date of October 1959 (and older readers will remember the slogan throughout that year of drought - "the Dove is coming") it was clear that much would be gained in speed and cost, by siting the terminal reservoir alongside those at Hallgates. The location was right for a distributing centre and Leicester's reservoirs could be utilised on an interim basis whilst the new one was being built. Further, it would enable water from the several sources, Dove, Derwent and Charnwood, all with differing characteristics, to be blended to ensure so far as practicable, one standard water would be supplied throughout much of the county. This would be a matter of great importance to the many industrialists whose processes require stability of water quality.

The terminal reservoir, of 10 mgd. capacity had to be built in Bradgate Park to have any chance of avoiding rock (Plates 4 and 5) and it was in the course of laying the mains linking the reservoirs and to distribute the additional water, that most of the photographs herein came to be taken.

Initially, six pits were excavated in the Park to the requisite foundation level. Using the information gained (Boynton's Fig. 1) the reservoir was sited to minimise rock excavation which proved to be unavoidable. Having fixed the reservoir site, work started on the necessary mainlaying so that water from the Dove scheme could be put into supply, with some intermixing, as quickly as possible. At the same time, a new main was laid across the Park to Leicester Forest East, and eventually on to Hinckley. This was called the Western Trunk Main (WTM) (Plate 6).

Apart from short lengths showing how the DVS reaches the
Plate 1. Hallgates S.R. No.3. View of excavation looking ESE towards the northern boundary of Bradgate Park.

Plate 3. Hallgates S.R. No.3. View across completed reservoir looking west towards Old John.

Plate 4. Hallgates S.R. No.4. View across foundations looking west towards Old John. The wadi appears in the face of the excavations immediately left of the access road.
Plate 5. Hallgates S.R.No.4. View across Bradgate Park looking west towards Old John with proposed site of reservoir superimposed. (Sliding Stones Enclosure has since been planted with trees—see also Plates 4 & 9).
Plate 6. Western trunk main, laying 30 inches internal diameter concrete pipes across Bradgate Park. Looking towards the site of Hailgates S.R. No. 4.

Plate 7. Laying 60 inches diameter main. View of excavation from tunnel exit looking east to the junction with the 54 inches main.
Plate 8. Ballgates link main. Laying 45 inches internal diameter steel main, looking east towards the No.1 reservoir valve house.

Plate 9. Laying 60 inches main. View of excavations from tunnel entrance looking southwest to Old John.
Plate 10. Laying 50 inches main. View along tunnel looking east as steel pipes were being laid.

Plate 11. Laying 50 inches main. View of steel pipes in tunnel being encased in protective concrete which is pumped in to fill the gap between pipe and rock.
original reservoirs, to minimise detail only the new mains have been indicated on the Map. They include one laid in the mid-1970s across the Park to Newtown Linford and Markfield, and which provided yet more geological information.

After the WTM the next pipeline to be laid was of 54 inches diameter, ultimately to be the outlet main from the terminal reservoir. Initially it operated in the reverse direction to improve supplies to Hinckley, conveying Derwent water from Roeciffe Road for the purpose. Although the optimum route was selected, the pipeline had to be laid through solid Charnian rock. Some idea of the conditions can be gleaned from the cover photograph.

Once this main was working and with the new Dove main from Melbourne connected into the existing pipework system conveying water into and out of Hallgates Nos. 1, 2 and 3 reservoirs, work started on the new interconnections and the link which would finally transport the various waters through to the terminal reservoir where mixing would be completed.

The link main starts as 24 inches diameter then increases firstly to 45" diameter and then to 60" diameter. Plate 8 shows a view of the 45" length being laid in shattered rock, with the valve-house to No. 1 reservoir in the background.

In addition to conveying water to the No. 4 (terminal) reservoir, the 60" section also by-passes it to link up with the 54" section. This enables the reservoir to be taken out of service for inspection, maintenance and cleansing, without there being any interference with supplies. The by-pass arrangement means that at no point can the crown of the pipeline come above the level of the floor of the reservoir. At one stage, therefore, the underside of the pipes are some 26 feet below ground level, and some 200 feet were laid in tunnel through solid rock. Plates 7, 9 and 10 were photographed during the work.

Leicester was of course, always the major partner in the Dove scheme and their Water Engineer & Manager, Hal Wallhouse, C.Eng., F.I.C.E., M.I.Mech.E., F.A.S.C.E., F.I.W.E.S., was also appointed to hold the position of Engineer & Chief Executive to the RDWB. His dual role enabled great savings in time and money to be made, since he could plan on the basis of joint use and operation, subject to renting arrangements, of a very extensive and costly network of mains. Without this, the Hallgates arrangements would not have been feasible.

When No. 4 reservoir was completed in 1964, Hallgates had become the centre of the present county’s water supply system. Only a small number of consumers in the Ashby and Smisby area were not in some way dependent on it. Indeed, such was its importance, that when the Phase 2 scheme came to be designed,
it was decided that no more eggs should be put into that particular basket. The new treated water aqueduct was therefore laid in tandem with the first only as far as Belton. It then goes eastwards to the new terminal reservoir at Ragdale, at approximately the same elevation as Hallgates, but this time of 20 mg. and covering nearly 6 acres. The pipeline crosses the Derwent aqueduct, to which it is cross-connected and supplies both Leicester and Loughborough from the north. Supplies are taken from Ragdale to the Melton area by pumping. The rest of Phase 2 consists of another river intake alongside the first, the pumped storage reservoir at Foremark and a second treatment works adjoining the first at Melbourne.

This was not to be the end of the Hallgates story, however, and possibly a digression may be permitted at this stage.

At the time that the constituent members of the RDWB were amalgamating to leave only two water supply undertakings in Leicestershire, similar amalgamations were occurring throughout England and Wales. In consequence, the water industry became at once both more professional and more cohesive. It became common for newly formed authorities to find they were faced with a serious imbalance between the consumers' demand for water and the resources available to meet that demand. Further, many found that little or no planning had been done by their predecessors. The message that came from the industry at large was a forecast that the demand for water could be expected to double by the end of the century. This forecast derived solely from the amounts of water which the undertakings themselves put into supply. No one knew how much additional water was being abstracted directly by industry and agriculture. If valid, this forecast meant that the country would soon face a major problem.

The Government responded by passing legislation setting up the Water Resources Board in 1963. The Board was charged with the duty of ascertaining future needs for water and of preparing a strategy to meet them!

New powers were given to River Authorities which were reduced in number. They were to licence all abstractions and could move into the field of water resource development within their own catchment areas. They were to finance these activities by licence fees to be paid by abstractors. It was under this legislation that the Welland and Nene River Authority was to develop Rutland Water and the Trent River Authority to seek powers to build Carsington. The latter scheme was not to receive Government planning consent until 1978, following, in effect, three Public Inquiries. The final go-ahead did not come until 1979 after the first Thatcher Government had come to power. This was 8 years after the first Inquiry and five years after the River Authorities had ceased to exist! Such is the timescale today. Around 15 years has to be allowed between publication of proposals and the commissioning of a major project. Engineers
who plan such schemes, must therefore look 20 years or more
into the future to ensure that they have not become out-dated
by the time they are commissioned and hoping that there is
still some spare capacity available before yet further develop-
ments are needed.

Returning to the story, the re-organisation of the Water
Industry in 1974 meant that water supplies to Leicestershire,
Nottinghamshire and Derbyshire, as well as many other counties
ranging as far west as Montgomeryshire and as far south as
Gloucestershire came under one management. This created new
opportunities which are being fully exploited in the public
interest.

In the 1975-6 drought, first Derwent division (Derbyshire)
and then to a lesser degree Lower Trent (Nottinghamshire)
which is far less dependent on surface water, began to suffer
shortages. Soar Division, with additional supplies becoming
available from the Phase 2 Dove scheme, was able to give help,
and because of common access to the Derwent aqueduct, resources
were operated on a communal basis. Initially a fairly informal
arrangement, this modus operandi was continued after the
emergency.

Whilst Soar had a surplus of water to meet its needs, the
other two divisions were moving into a deficit pending the
Government's decision on the Carsington scheme. Work on that
project is now well advanced, although additional water is not
currently expected to be available before 1986.

The fact that Melbourne T.W. can be utilised on a sub-
regional basis serving the three East Midlands divisions: Soar,
Derwent and Lower Trent, is fortuitous. It rests on the
historical fact of the Derwent aqueduct and the accident of
geography by which the Hallgates reservoirs are able to gravitate
water backwards across the River Trent. This has been seized
upon, so that Hallgates reservoirs are now an essential element
in the Water Authority's long-term strategy for supplies to the
East Midlands sub-region. This is not all.

Despite the recession which was developing throughout the
1970s, demand for water continued to grow in the East Midlands,
particularly in Hinckley (in Soar Division) and in Nuneaton
(in Avon Division). Both Divisions had made provision in their
capital spending programmes for the laying of pipelines into
these two towns to bring in additional supplies. In the wake
of the drought, a new idea developed, namely the possibility and
the desirability of linking the water supply systems of the East
and West Midlands, always providing of course, that the costs
were acceptable. An intensive study began which took two years
to complete. This took account of the needs and future plans
of the Divisions for Hinckley and Nuneaton, for additional
terminal reservoir storage which was also needed and increasingly
so and of other factors which had a bearing on the study. The conclusion that was reached was both far-sighted and gratifying, for not only did it justify the effort which had been put into the exercise, it was further justification, if it were ever needed, of the guiding philosophy behind the 1974 re-organisation. That conclusion, which was adopted by the Water Authority, was that the funds required by the two Divisions' reinforcement schemes and the funds required to increase terminal storage to suitable levels should be pooled and the original plans scrapped in favour of a new project. This would involve the laying of a large diameter trunk main between Hallgates reservoirs and the terminal storage at Oldbury (between Nuneaton and Atherstone) which serves Nuneaton and N.E. Warwickshire.

A further main would be laid between Oldbury reservoirs and those at Meriden which serve Coventry and the surrounding area. Additional storage reservoirs will still be needed at the various sites, but given the inter-linking trunk mains, they can be much reduced in size.

The new mains will be more costly than the re-inforcements planned originally, but the excess will be matched by the savings to be made on building the reservoirs. Overall, the cost of the adopted major scheme will be the same as that of the several smaller projects which it replaces. Whilst the scheme does not save money, it does provide something for nothing, as will be appreciated from Fig.1.

Coventry's water supply comes from the River Severn. It is abstracted and treated near Upton-on-Severn, north of Tewkesbury before being pumped across country through an aqueduct consisting always of two, sometimes three pipelines, to Meriden. Nuneaton's water supply is provided from Tame Division (Birmingham and West Midlands) and originates from the Elan Valley Impounding Reservoirs in mid-Wales. It is delivered into the Oldbury reservoirs. Leicester's Hallgates reservoirs are supplied from the Derwent Valley reservoirs near Sheffield and by abstraction from the River Dove near Burton-on-Trent. What the Severn Trent Water Authority and its 8,500,000 consumers get for nothing are the missing links in this vast regional water grid. It is something which could only be achieved under the aegis of a single Authority and then only by the fortuitous accident of timing arising from the coincident needs of two neighbouring divisions.

Hallgates has thus been elevated to the level of strategic centre, a lynch-pin in a Regional water grid. It is a far cry from that seemingly uncertain initial decision of 1894!

Much of the new pipeline system has been laid. Surveys have been conducted to choose the best site for additional terminal storage at Hallgates. These included the sinking of the boreholes
Fig. 1. The Severn Trent Water Authority area showing primary supply mains including the new West to East Midlands link to form a regional water grid. Treatment works (T.W.) and Service Reservoirs (S.R.) are also shown.
shown on the Map and the accompanying sections in Boynton's Fig. 2A and 2B with the intention of choosing a site which, as before, would incur the minimum excavation in rock. At the time of writing it seems unlikely that the reservoirs will be built in this area because of the costs of the landscaping required by the Bradgate Park Trustees who own the land. Current plans are therefore based on another site some distance away.

Is this the end of the Hallgates story? Maybe, maybe not. Other developments are still possible.

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GEOLOGICAL INTERPRETATION OF RECORDS AND PHOTOGRAPHS
OF HALLGATES RESERVOIRS

H. E. Boynton, Ph.D.

During the study of records and photographs made available by the Severn Trent Water Authority a considerable amount of geological information, as yet unpublished, has been discovered.

These include records of borehole logs, main and reservoir excavations and photographs taken during excavations of two of the reservoirs and their connecting mains in the Hallgates area of Charnwood Forest. Information collected for alternative sites for two new reservoirs in the same area has also yielded new geological facts.

Reservoirs No. 1 and 2 built in 1895 and 1911 (the first in this area) do not appear to have been recorded in any way and there are no logs or photographs known. It would appear, though, that their position is such that were sited in an embayment in the Charnian rocks, as crags of banded tuffs to a thickness of about 7 metres are seen immediately behind the reservoir. It is probable, however, that the Charnian rocks were cut through at the northern end of the excavations to allow a road to be built linking the reservoirs with the Filter Station on Roecliffe Road.

Reservoir No. 3, built in 1936 and situated just outside Bradgate Park and south of Nos. 1 & 2 was well recorded by a number of black and white photographs which are now in the Leicester Museums County Record Office in New Walk. Photographs of the east side of the excavation (Plate No. 1) show rock outcropping, but it is very hard to discern from the photographs, if it is of Charnian tuffs, Keuper Marl or superficial deposits. From the surrounding rock outcrops it could possibly be the first of these three.

Reservoir No. 4, completed in 1964, just inside Bradgate Park and known as Sliding Stones Reservoir (from the nearby wood and well known outcrop of the Sliding Stones Slump Breccia (Moseley, 1979) ) was recorded in much greater detail (Sizer, 1962; Evans, 1964). They both described the geology of the excavations of the reservoir itself and the adjoining tunnel at the northeast corner which carries the 60 inch main along by the wall of Bradgate Park (Plate Nos.7,9,10 & 11)and the main carrying the 54 inch down through Hallgate Hill Wood to the Filter Station (Cover picture).

Sizer recorded a Triassic wadi of marls and buff-coloured sandstones resting on fine-grained greenish Charnian volcanic tuffs. This can be very well seen in Plate No. 4,a photograph
taken by James Tyldesley. The Sliding Stones Slump Breccia was recorded in the southwest corner of the reservoir excavation, but this is not readily discernible on the photograph. The Triassic and drift deposits appear to be faulted in the middle of the west face.

Specimens collected by Sizer from the excavation and tunnel are in Leicester Museum. Among them is a piece of Triassic breccia containing Charnian fragments from the entrance of the tunnel where it was seen resting on the Charnian tuffs.

Access to Water Authority land in the Hallgates area enabled some geological mapping to be undertaken also. It was possible to trace, by examining material from animal burrows and soil augering, a band of very fine-grained, brownish-orange sandy clay along the northern fringe of the Charnian outcrops, from the access road south of the Filter Station eastwards through Hallgates Hill Wood to the line of the 54 inch main. This is thought to be Pleistocene in age.

During excavations for the car park and retaining wall in front of the Filter Station, made in 1959, Mr. Newton remembered encountering sandstone at a depth of about 1 metre below the present tarmac. Excavations for pipework connections around 1958 at the Cropston end of the Filter Station proved a thickness of at least 7 metres of Keuper Marl (now known as Mercia Mudstones). There was also evidence of Keuper Marl being present in a number of shallow boreholes sunk at the northern edge of the Settlement tanks (information from David Wheeler, a geologist with the Water Authority.

During the siting of No. 4 reservoir in Bradgate Park, several shallow pits were dug to find the depth to the Charnian. The logs of four of these are shown in Fig. 1. They recorded Drift, "Keuper Marl", Charnian boulders and Charnian tuffs.

By far the most important new data, however, is derived from 21 borehole logs taken in a survey by Edgar Morton and Partners of Macclesfield for siting two new reservoirs Nos. 5 & 6, adjacent to No. 4. These boreholes were put down on the west side of No. 4 in Bradgate Park and in the adjoining field to the north extending to the Warren Hills. The rocks found in these boreholes were subdivided into seven different types and labelled A to G on the sections. These divisions are as follows:

A. Superficial deposits comprising topsoil over sandy, silty marly clay with angular fragments of Charnian rock.

B. Firm very silty intact marl with no obvious fabric.
C. Fine to medium-grained brown sand, or very weakly cemented sandstone - possibly a wind-blown deposit.

D. Hard redbrown or greygreen jointed marl, very sandy in places. Thin siltstones (skerries) or marly sandstone layers are present.

E. As D with bands of breccia, gravel or conglomerate comprising angular Charnian fragments.

F. As E but with very little marly clay. Weathered/shattered Charnian rock.

G. Sound unweathered Charnian rock.

A represents Pleistocene drift deposits, B to E the Mercia Mudstones of the Trias and F to G greenish fine to medium-grained dust tuffs of the Maplewell Group of the Charnian succession. Many of the joints and fissures seen in this succession have been mineralised by calcite, dolomite and gypsum and the Charnian tuffs have also been mineralized by quartz, manganese, calcite and kaolinite.

Not all divisions were found in every borehole but there is a general downward succession and their properties form a gradual scale of increasing strength and stiffness.

Solid Charnian rocks were found in eleven of the 21 boreholes and they consisted of greyish-green fine-grained volcanic tuff with bands of coarser tuff in Borehole No. 13 and 15.

Structural measurements taken were as follows:

Cleavage 090°/ 75°N.
Jointing 180°/ vertical
Bedding 065°/ 50°SE (averages)

When the Charnian rocks were cored joints tended to open up and sometimes very thin veins of gypsum and quartz were found in them.

The Triassic succession of Mercia Mudstones consists of Type B red/brown silty marl, Type C fawn/brown silty fine-grained sand with rounded grains which indicate a wind-blown origin and Type D hard unweathered red/brown or greyish-green mark with skerries of marly sandstone and some joint surfaces stained black by manganese and Type E bands of breccia/conglomerate with angular fragments of Charnian tuffs. Thicknesses of E observed were up to 1 metre, but in the excavation the beds tended to be lenticular rather than continuous layers. Fig. 2 shows the two sections including 12 of these borehole logs. Section A-B lies parallel to the probable length
of the wadi and the logs here show either Superficial deposits (Type A) or Type A overlying Triassic mudstones (Type D). Borehole 4 passes into Type E at the base indicating the possible nearness of the Charnian rocks and Type E (Breccia with Charnian fragments) is also seen at the base of Borehole 1.

Section C-D taken across the wadi, from approximately NW to SE shows Charnian rocks near the surface in Borehole 15 (adjacent to Warren Hills Wood); at greater depth in Borehole 14 (south of 15) and at greater depth still in Borehole 13. In Borehole 10 the Charnian was not reached at 35 metres nor in Borehole 7 at 18 metres, but in Borehole 7 at 18 metres and in Boreholes 6 and 19 the Charnian tuffs were encountered at 5 and 3 metres respectively, indicating approaching proximity to the outcrops of the Charnian (Sliding Stones Slump Breccia). A small outcrop of this is seen just west of Borehole 6 and again in Sliding Stones Wood. Charnian tuffs were not encountered in Boreholes 9 and 11 at 9.5 and 17.5 metres, but were reached at 22 metres in Borehole 13. The present day valley sloping down to the Roecliffe Road may have been the site of a second Triassic wadi.

From this survey for the siting of Reservoirs Nos. 5 and 6 there is further evidence for the irregular palaeo-topography which appeared to have existed at the junction of the Precambrian and the Trias (Watts 1947) and this has been an important factor in siting the reservoirs in the Hallgates area.

Reservoirs Nos. 1 and 2, in spite of lack of records of the preliminary survey, were built in an embayment in the Charnian rocks, thus generally avoiding them except for the access road at the north end where the hard tuffs were cut through.

Reservoir No. 3 also has taken advantage of being excavated in the softer superficial and Triassic deposits, as far as can be judged from the photographs available. Its unusual curved shape may have resulted from the fact that it was sited on the softer rocks and avoided the Charnian particularly on the eastern side.

Reservoir No. 4, too, avoids much Charnian rock and was excavated mainly in the superficial Deposits and Trias, except in the southwest corner where fine-grained tuffs and the Sliding Stones Slump Breccia were revealed.

Plans for the siting of Reservoirs Nos. 5 & 6 have now switched to the Anstey area and it is probable that these two proposed reservoirs will not be built in the Hallgates area, because of the great expense which would have to be incurred in conserving the natural landscape in the vicinity of Bradgate Park.
REFERENCES


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Leicester

ACKNOWLEDGMENTS

Jim Carter, B.Sc. (Econ), IPFA, FBCS, Divisional Manager of Soar Division, granted us facilities and permission to obtain material and reproduce photographs, drawings and data for our papers. The views and opinions expressed therein are those of the respective authors solely. Many friends in Soar Division gave considerable assistance in locating information. In particular, James Tyldesley, B.Sc. (Hons.), C. Eng, FICE, FIWES, Divisional Engineer Soar Division and formerly Chief Engineer NWLWB, and earlier Deputy Engineer RDWB, provided the negative for Plate 4 as well as the geological report prepared by Edgar Morton & Partners relating to the Hallgates Reservoirs surveys. The Director of Leicestershire Museums, Art Galleries and Records permitted reproduction of photographs from those deposited by the former LWD and from records deposited by the former NWLWB prior to reorganisation in 1974.

Our grateful thanks are due to everyone for so much help, so willingly provided.

Alan "George" Newton
Helen Boynton.

73
REPORT OF THE COUNCIL FOR 1982-1983

The full programme of lectures was distinguished by the large audience of over 350 who attended Mrs Margaret Rule's talk on "The Raising of the Mary Rose", which required a change of venue from the Art Gallery to the Rattray Theatre at the University. It is also pleasant to record that Professor Ferguson arrived in Leicester in better weather than the previous season and obtained the audience he deserved. Mr. Baatz is to be thanked for preparing such a fine programme of lectures, and the help of our sponsors of individual lectures, the Leicester Mercury, Leicester City Council Recreation Department, and the University Bookshop is gratefully acknowledged.

The Society sadly remembers the late Ivan Tarrat, President of the 1980-81 session, who died just before the start of the 1982-83 session.

The incoming President, Mrs. R. R. Williams, is thanked for reporting the Society's meetings to the Leicester Mercury. Mr. Mann is thanked for his coffee making after each meeting, and the Museum staff are thanked for their customary courtesy.

D. G. Lewis
Hon. Secretary

The programme for the session 1982-83 was as follows:

4th October "Down to the Basement" Address by the President Dr. T. D. Ford.

18th October "The Language of Objects" - Mr. Stephen Bayley, Director of the Boilerhouse Project, Victoria and Albert Museum.

1 November "The Queen's Canalettos - J. G. Links, Author and Art Historian.

15 November The Leicester Mercury Lecture "Is there a future in Publishing?" - Mr. Geoffrey Strachan, Managing Director, Methuen London Ltd.


13 December "Healing Sanctuaries of Ancient Greece - Professor John Ferguson, B.D., B.A., F.I.A.L., President, Selby Oak Colleges, Birmingham.

17 January "The Mary Rose, a Tudor Time Capsule" - Mrs Margaret Rule, F.S.A., Archaeological Director, The Mary Rose Trust.

31 January "Man and Birds" - Dr. Jim Flegg, B.Sc., Ph.D., A.R.C.S. East Malling Research Station, Kent.
14 February  University Bookshop Lecture "Wind, an Alternative Source of Energy" - Dr. P. Musgrove B.Sc. (Eng.), Ph.D., Lecturer in Engineering, University of Reading.

28 February  "The Earliest Well-Preserved Fossils" - Professor H. B. Whittington, D.Sc., M.A., F.R.S., Woodwardian Professor of Geology, University of Cambridge.

14 March  "Lesser Known Australia" - Mrs. D. Bovey, Painter and Traveller.

9 May  Annual General Meeting followed by a Musical Entertainment by the Halcyon Singers.

ANNUAL REPORT OF THE GEOLOGY SECTION FOR 1982-3

President: Dr. R. J. King
Chairman: Dr. M. J. Le Bas
Secretary: Dr. D. J. Siveter
Treasurer: John Martin
Field Secretaries: David Martill and Diane Thurston
Committee Members: Alan Dawn
                   Michael Howe
                   Mrs. Knibb
                   Mrs. Marsden

A full programme of summer excursions was held, though the site clearance working party had to be delayed owing to the non-completion of a reserve.

Summer Excursions 1982:
May 29  Pindale and Dirtlow Rake, Castleton. Dr. T. D. Ford.
June 11  Bardon Hill Quarry. Dr. R. J. King.
September 11 Lower Lias Quarries at Long Itchington, Warwicks., Dr. R. G. Clements.

Winter Programme:
September 29  Members' evening.
October 27  "Geology of the Himalayas" - Dr. B. F. Windley, Leicester University.
November 10 "The Midlands during Great Oolite (Middle Jurassic) times" - Dr. M. Bradshaw, Aston University.
November 24 "Basaltic Shield Volcanoes of the Western Indian Ocean" - Dr. J. Wadsworth, Manchester University.
November 27 Saturday School on Volcanoes at Vaughan College:
           Dr. D. S. Sutherland (Leicester University) - "Volcanic structure of the British Isles".
           Dr. R. Roach (Keele University) - "Ordovician Submarine volcanoes of Dyfed, Wales".
           Dr. R. S. Thorpe (Open University) - "Andesite Volcanism".

75
Dr. M. J. Le Bas (Leicester University) - "The Charnwood Volcano".  
Professor A. J. Meadows (Leicester University) - "Planetary Volcanism".  
Dr. A. A. Mills (Leicester University) - "Hazards and benefits of volcanic eruptions".  
December 8
"Conversazione" at the University.

1983
January 12
"Geology in Northern Greenland" - Dr. P. D. Lane, Keele University.

January 26
"The Stamford Dinosaur" - Mr. J. Martin, Leicester Museum.

February 9
"Non-ferrous mining in Leicestershire."  
Dr. R. J. King, Leicester University.

February 23
"Industrial Mineralogy - the Science of the Ordinary" - Professor A. C. Dunham, Hull University.

February 28  
MONDAY, 8 p.m.  JOINT MEETING WITH PARENT SOCIETY  
"The earliest well-preserved fossils"  
Professor H. B. Whittington, F.R.S., Cambridge University.

March 9
A.G.M. and Chairman's address by Dr. M. J. Le Bas

March 23
"Geophysical studies in the East African Rift" by Dr. M.A.Khan.

ANNUAL REPORT OF THE NATURAL HISTORY SECTION FOR 1982

President:  
I. M. Evans, M.A., F.M.A.
Chairman:  
H. C. Gabbitas
Vice-Chairman:  
H. J. Smith
Hon. Treasurer:  
Miss E. I. Clay
Hon. Secretary:  
Mrs. E. Loosmore
Hon. Asst. Secretary:  
Miss B. Davies, B.A.
Hon. Programme Secretary:  
Miss J. E. Dawson, M.A., A.M.A.
Editor:  
Mrs. D. Thompson, B.Sc.
Committee:  
Mrs. G. M. Ball, B.A.  
P. Clark  
Mrs. D. Koffman, M.D.  
P. Lucas  
J. H. Mathias, B.Sc., Ph.D.  
Mrs. J. Owen, B.A., Ph.D.  
K. Shilcock  
A. E. Squires  
co-opted - D.A.C. McNeil, B.Sc., Ph.D.

The Newsletter was published twice in 1982 - the Spring issue under the acting editorship of Harry Gabbitas and the Autumn one under our new editor, Doreen Thompson.

The high standard of our lectures continued during the year. One of the most interesting and certainly one which evoked most
questions was the (substitute) lecture on "Frogs" given by Dr. Robert Oldham of Leicester Polytechnic. This lecture resulted in some members of the Section taking part in a frog survey! An innovation in 1982 was the holding of some lectures in the Art Gallery of the Museum.

The Symposium organised by the Section and Leicester University at Vaughan College on March 20th had as its theme "The Natural History of Mountains and Moorlands". Speakers were Professor Winifred Tutin, Dr. S. Max Walters, Dr. Derek Yalden and Mr. Rob Williams and the Chairman was Mr. Ian Evans.

The Summer Programme included a day trip to Cheshire (which was led by members of the Cheshire Trust) and a day trip to Lincolnshire. A new and successful venture was a "Farming and Wildlife" meeting at Moss Farm, Great Dalby.

We all owe a great debt to Jan Dawson who organises both Winter and Summer programmes.

Paid up membership for the year was 178 (compared with 193 for 1981). Ordinary meetings were held at fortnightly intervals, and the average attendance for the second half of the 1981/82 winter session was 70, to hear the following speakers:

- 13th January  J. Martin - "Ringing Birds"
- 27th January  I. M. Evans - "Isles on the Edge of the Sea: an Introduction to the Hebrides"
- 1st February  Dr. D. Goode - "Nature Conservation in the 1980s - Success or Failure?" (Joint Meeting with Parent Body)
- 10th February  D. G. Rands - "Introduction to Grasshoppers and Crickets"
- 24th February  D. T. Grewcock - "The Year of the Red Deer"
- 10th March    Dr. Robert Oldham - "Amphibians"

The Annual General Meeting was held on 24th March 1982 after which slides were shown by a number of members.

The Section's Summer Programme of Outdoor Meetings was as follows:

- 17th April    D. T. Grewcock and Mrs. E. Hesselgreaves - Lawn Wood
- 1st May       H. J. Smith - Leire Cutting and Ullesthorpe Marsh
- 15th May      I. M. Evans - Cribbs Meadow and Wymondham Rough
- 20th May      N. Bennett - Belgrave Hall Gardens - evening meeting
- 29th May      Mrs. P. A. Evans - Skeffington Wood
12th June  Mrs. J. Buchanan and G. Sellars  The Clipston Woods
27th June  Members of the Cheshire Trust  Full-day excursion to Plumley, Whitton and Abbot's Moss, Cheshire.
10th July  A. Johnson and H. C. Gabbitas  Farming and Wildlife at Moscow Farm, Great Dalby
24th July  Lt. Col. D.H. Hall-Smith  Misterton - Moth trapping - evening meeting
7th August P. H. Gamble  Loughborough Big Meadow
21st August Dr. J. H. Mathias  Ashby Canal - Snaestone
5th September J. Wilkinson and T. Clifford  Full-day excursion to Scotton Common and Saltfleetby, Lincs
18th September A. E. Squires  A Walk through 14th century Leics.
2nd October M. D. Jones  Fossils of the Middle and Upper Lias - geological meeting
16th October C. N. G. Scotter  Great Merrible Wood - fungus foray

The average attendance at field meetings was 27. The Section would like to thank all leaders, landowners and other helpers who made the programme successful.

The indoor Winter Programme for 1982/83 began on 20th October with a Members' Exhibition Evening and other speakers were:

3rd November  Dr. J. A. Fowler - "Oil and the Shetland Environment"
17th November  G. R. Stansfield - "F.A. Sowter - would be approve?" - Tenth Sowter Memorial Lecture
1st December  Dr. R. Gornall - "The Development and Role of the Leicester University Botanic Garden"
15th December  M. P. Whitehead - "The Primates' Progress"

The average attendance for these meetings was 61.

The Section would like to thank the Museum for the facilities which it provides for all indoor meetings.

E. LOOSMORE  Hon. Secretary
B. DAVIES  Asst. Secretary
ANNUAL REPORT OF THE LEICESTERSHIRE FUNGI STUDY GROUP
1981/82 (affiliated 1981)

Chairman: Christopher Scotter
Secretary: Mrs P. Crowley
Treasurer: Mrs R. Hemsley
Records & Mr. R. Green
Herbarius Mr. A. Gouldwell
Committee: Mr. R. Dixon
Mr. S. Bradshaw
Mr. R. Iliffe
Mrs. C. Nisbet

The prime aim of the group is to collect records for, and
to publish a Mycological Flora for Leicestershire. Along the
route to this aim, however, lies a great deal of hard work, not
least the acquisition of the necessary identification skills
for such a difficult group of organisms taxonomically.

We have, however, made a promising start by computerising
nearly 1,000 records for 1981, establishing voucher specimens
in our herbarium and running a full programme of evening meetings
and field excursions for 1981 and 1982/3 after the field season
in Autumn the records are collated and computerised, and voucher
specimens sent to referees.

During 1982 we held ten monthly evening meetings and had
seven fungus foray days. Similar numbers were held in 1981.
We were fortunate in having several excellent outside speakers,
perhaps most notably Dr. Bruce Ing, an internationally recognised
expert on Myxomycetes (slime moulds).

We have published one newsletter and intend to publish
another in Summer 1983 detailing the group’s work and records
for 1982. The group has also purchased its own microscope with
generous financial help from Leicestershire Museums.

The membership hovers around 35 and the average attendance
for meetings is 17.

We would like to thank Leicestershire Museums for the use of
the excellent facilities at the New Walk Museum.

Christopher Scotter, B.Sc., M.Ed., M.I.Biol.
Chairman, L.F.S.G.
Leicester Literary and Philosophical Society
Membership 1982/83

<table>
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<th>Year of joining</th>
<th>Name</th>
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<tr>
<td>1969</td>
<td>Miss D.M. Adams</td>
<td>24 Midway Road, LE5 5TP</td>
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<td>Miss M.S. Albury</td>
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<td>1969</td>
<td>Dr. C.P. Alexander, MB, LRCP</td>
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<td>1981</td>
<td>Mrs S. Anderson</td>
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<td>Mrs. R. Armitage</td>
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<td>Dr. W.H. Brock</td>
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<td>Mrs. J.H. Brown</td>
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<td>Dr. K.F.C. Brown</td>
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<td>Miss J.E. Dawson, MA, AMA</td>
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<td>Mrs J. Drew-Edwards</td>
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1953  Miss E.M. Judge  13 North Avenue, LE2 1TL
1971  Mrs D.M. Keay  The Pines, Links Road, Kirby Muxloe
1982  Mrs E.M.L. Kemp  28 The Oval, Oadby, LE2 5JB
1974  Dr. M.A. Khan, Ph.D., 144 Evington Lane, LE5 6DG
  FGS, FRAS
1974  Dr. N.W. King, BSc,  White House Farm, 22 Main Street,
  MB, BS, DDARCS  Barkby, Leics.
1958  Rev. A.H. Kirkby, MA,  27 Westminster Road, LE2 2EH
       BD, Ph.D.
1962  H.G. Kneen, FBTI  52 Homeway Road, LE5 5RG
1982  Mrs J. Knopp  16 Delaware Road, LE5 6LG
1982  J.R. Lainé  46 Kimberley Road, LE2 1LF
1976  Miss F.M. Lamb  5 Farley Road, LE2 3LD
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       PhD, FGS
1981  P.F. van der Lemm  6 Guilford Road, LE2 3BD
1980  Dr. D.R.S. Leslie  9 Mosse Way, Oadby, LE2 4HL
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1982  R.C. Loosmore  1 Roundhill Road, LE5 5JR
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1981  B.A. Ludlam  27 Westleigh Road
1957  Mrs P.M. McLaughlan  38 Knighton Church Road, LE2 3JH
1969  J.K. McLaughlan, LLB  166 Evington Lane, LE5 6DG
1975  Mrs M.E. McLearie  39 Ashfield Road, LE2 1LA
1972  Dr. D.A.C. McNeil  175 Byron Street, Loughborough
1982  Mrs A.F. Mace  1a Fox Lane, Kirby Muxloe,
1977  S.T. Mann  12 Palmerston Boulevard, LE2 3YR
1975  Dr. H.G.K. Majut  24 Stanley Road, LE2 1RE
1959  Miss K.E. Marson  75 Pine Tree Avenue, LE5 1AL
1979  Mrs G. Marvin  14 Dalby Avenue, Bushby
1973  Mrs N.H.L. Matthews  3 Bude Drive, Glenfield, LE3 8BA
1933  Dr. M.L. Millard, MB,  2 Cranborne Gardens, Oadby, LE2 4EZ
       ChB.
1974  N.H. Miller  621 Saffron Lane, LE2 6UN
1977  Dr. A.A. Mills  34 Holmfield Avenue, LE2
1982  Dr. J.J. Modi  11 Rushford Drive, Willow Park
1974  J.A. Morley, FCMA  45 The Broadway, Oadby, LE2 2HF
1972  D.L. Morris, BSc,  63 Regent Road
       FRICS
1948  Miss I.N. Morton  90 Howard Road, LE2 1XH
1948  J.H.M. Morton  Belvoir Lodge, Medbourne, Market
       Harborough, LE16 8DS
1982  Mrs A. Mothersole  53 Grass Acres, Millfield Farm
1982  A. Musharraf  29 Gwendolen Road, LE5 5EL
1982  B.D.J. Musson  67 Bridge Road, LE5 3LB
1982  S. Newby  C/o Milligate School, Scott Street,
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