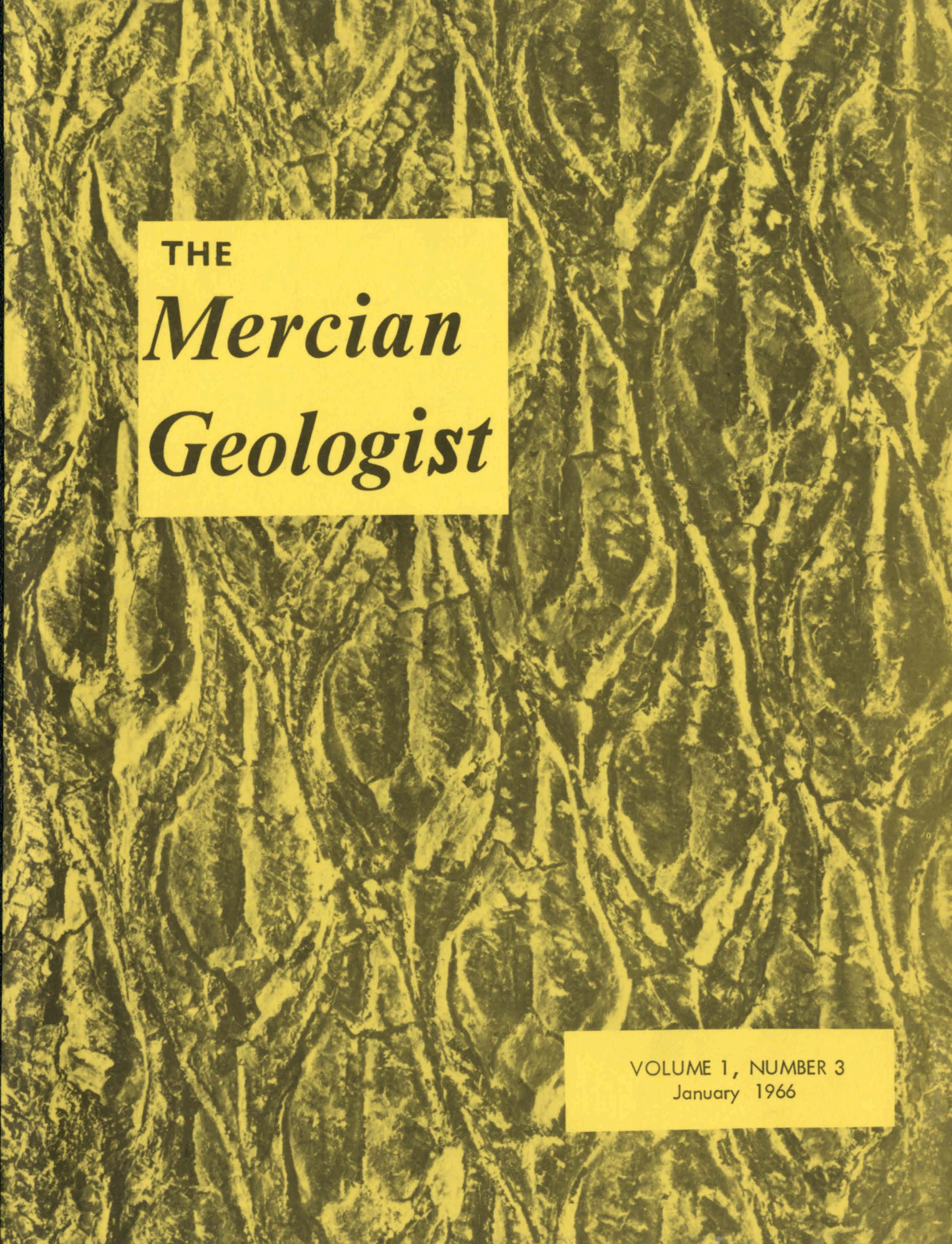

THE

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JOURNAL OF THE EAST MIDLANDS GEOLOGICAL SOCIETY

Volume One Number Three

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ERRATA

"Mercian Geologist" vol. 1 no. 2, 1965

p. 194 line 30:

For *Carbonicola* read *Anthracosia*

p. 194 line 34:

For *Gastrioceras* read *Gyrochorte*

CONTENTS

THE EAST MIDLANDS GEOLOGICAL SOCIETY

Council 1965

Address for correspondence: The Secretary,
East Midlands Geological Society,
443, Meadow Lane,
Nottingham

The Cover: Pattern of bark with leaf cushions, of the Coal Measures tree Lepidodendron. Specimen from the roof of the Kilburn Coal, Trowell Colliery, Nottingham. X3.

Photograph by J. Eyett

EDITORIAL

Since its inception early in 1964, the East Midlands Geological Society has grown steadily and surely: individual membership is now around 180 and there are, in addition, some 60 institutional members. Attendances at indoor meetings have ranged from 50 to over 100 and at excursions from 25 to over 80. The need for our society has therefore been emphatically demonstrated.

The area included within the Society's title and interest is a large one. Originally formed in Nottingham, the Society was never, from its inception, conceived of as a purely Nottinghamshire body. Indoor meetings have since been held, or are to be held shortly, in Loughborough, Newark, Matlock and Derby; it is hoped to hold future indoor meetings even farther afield - in Leicestershire, Lincolnshire and Northamptonshire. Nonetheless, it is impossible to maintain an equal intensity of activity in all these regions; thus the organisation of local groups within the Society is planned, in the hope that such groups will arrange activities supplementary to those of the main Society. In addition, local geological and natural history societies are to be offered affiliation with the E. M. G. S. - not with a view to absorbing such Societies, an idea quite contrary to the aims of our own Society, but with a view to the furtherance of interest in geology by means of joint activities and mutual publicity.

"The Mercian Geologist", as its official organ, plays an important part in the life of the East Midlands Geological Society, not only by chronicling its activities but also as a stimulus for research and the recording of geological information. As its title indicates, the coverage of this journal is visualised as the whole of the Midlands area; in the present issue, for the first time, we have the pleasure of including articles on West Midlands geology. Review articles on topics of general geological interest are also welcomed.

It was anticipated, when the journal was first planned, that initial difficulty would be encountered in securing sufficient copy. No such problem has in fact arisen; the readiness with which each issue has been filled has shown how great was the need for a journal of this kind. "The Mercian Geologist now has a world-wide readership, copies travelling to all Continents and most countries. It is especially pleasing that the authors of papers, in several instances, have been amateurs; we trust that this will continue to be the case in all future issues. The Editorial Board would like to emphasize its willingness to consider for publication articles from all sources, within or outside the Society, and to help and advise in the preparation of manuscripts to any degree that may be necessary. Articles should be addressed to The Editor; typescripts are preferable, albeit not essential, and format should follow, as closely as possible, that adopted in previous issues.

Production of "The Mercian Geologist" has necessarily involved assistance from many sides. I would like to thank all members of the Editorial Board for their considerable assistance; in particular Mr. Hanford, who functions as artist to the Society by redrawing or relettering text-figures where necessary, and Dr. Taylor, who has throughout been my righthand man and whose services to the journal have been too numerous even to list. The work of our panel of referees, necessarily anonymous, is gratefully acknowledged, as are the services in photography of Mr. John Eyett. Finally, the work of all our authors must be mentioned; without them, there could be no journal!! It has been an especial pleasure to include an article by Emeritus Professor Henry H. Swinnerton, the Society's first Honorary Member, whose work in the popularisation of geology and in research on Midlands geology will be well-known to all interested in the science.

In 1966, the British Association for the Advancement of Science will be meeting in Nottingham. The Society looks forward to playing as full as possible a part in the meetings. It is a pleasure to note that Dr. Taylor has been appointed Local Secretary for Section C (Geology) and has contributed the geological section for the "Handbook".

William A.S. Sarjeant

THE BASAL PERMIAN BEDS NORTH OF KIMBERLEY, NOTTINGHAMSHIRE

by

Leonard Hugh Waring

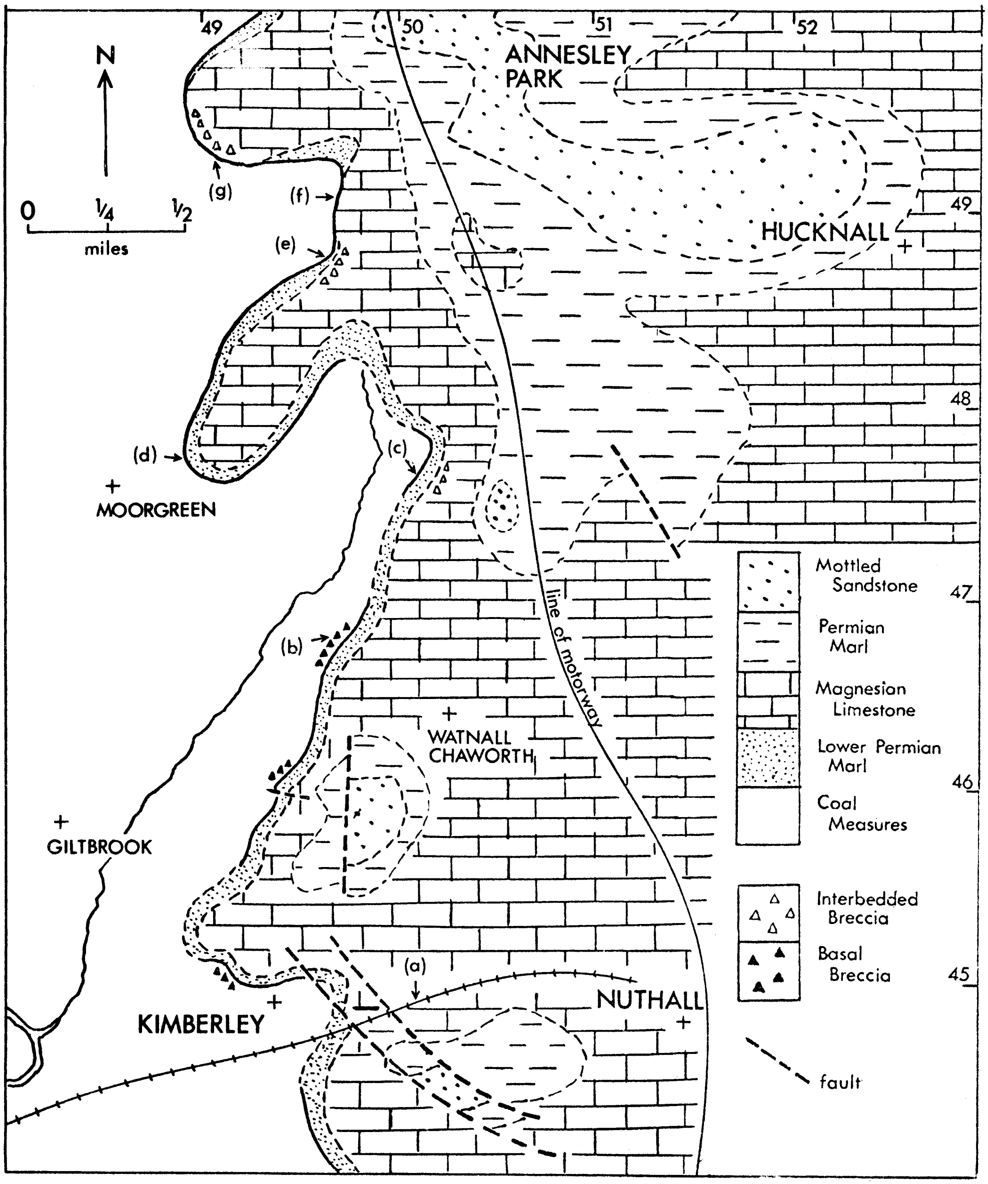
Summary

The Basal Breccia, Lower Permian Marl and the overlying Magnesian Limestone have been studied in detail for four miles north of Kimberley and immediately east of the Middle Coal Measures. It is concluded that two breccias are developed at different horizons and that the basal beds show facies changes. The Basal Breccia of Kimberley thins rapidly north. The Lower Permian Marl is generally of constant thickness. The second breccia interbedded with the lower beds of the limestone is interpreted as indicating that a nearby land mass was being continuously eroded during the Lower Zechstein. To the north a land mass is postulated, separating the area described from the Mansfield area to the north.

Introduction

The area investigated covers approximately eight square miles to the north-west of Nottingham. It is bounded in the north by Annesley Park and in the south by Kimberley and Nuthall (Text-fig. 1).

A well documented section for the basal Permian of South Nottinghamshire is still clearly to be seen in the railway cuttings at Kimberley (Wilson 1876, pp. 533-535 and Sherlock 1911, p. 83). The succession and a brief description of the rock types within the area described have been determined as follows:-



Text-Fig. 1 The geology of the area to the north of Kimberley
(a) to (g), localities mentioned in the text
(h), Motorway exposure, not shown on the map. Located 220 yards, directly north of the motorway line, off the northern edge of the map

	Thickness in feet
Magnesian Limestone	greater than
Cross-bedded, sandy, flaggy, dolomitic limestone.	25 feet
Lower Permian Marl	17
Also known as the 'Marl Slate' and "Dolomitic Siltstones" (Taylor 1965, p. 185). Calcareous, well-bedded, thinly laminated, micaceous mudstones and siltstones with many plant remains.	
Underlain by alternating thin bands of blue grey clay and medium to coarse grained sandstone. These bands are exposed in the railway cutting only, probably local.	0 to 1
Basal Breccia	2 to 5
Light grey coloured, weathering buff brown. Fragments largely Carboniferous siltstones, limestones, ironstones and sandstones, plus about 10% quartz vein pebbles, cemented in a sandy calcareous matrix. A few flat pebbles are arranged parallel to bed margins, others randomly orientated (Plate 11 - fig. 1).	

UNCONFORMITY

Middle Coal Measures

Similar exposures are now uncovered in the approach road cuttings to the M. 1. Motorway at Nuthall (SK 522440).

With reference to earlier work within the Permian succession of Nottinghamshire, a successful correlation was presented by Sherlock (1926 and 1928). He insisted that any such correlation should use the Rhaetic as a reference datum, although a previous correlation of the Permo-Trias of Nottinghamshire (Sherlock 1911, p. 76) was based on a Middle Permian Marl horizon (summarized by Taylor 1965, pp. 181-182). From the section in the railway cutting and other local exposures, it was shown that the Permian subdivisions of South Nottinghamshire represent a condensed sequence relative to beds further north which are their time equivalents.

Everywhere basal rocks of the Permian rest with an angular unconformity on the Coal Measures. Although the basal beds have been well described, their stratigraphical relationships and their sedimentary evolution have not been fully discussed. The Permian of South Nottinghamshire shows four principal rock types:-

1. Basal Breccia. Formed at a period between the Upper Carboniferous and the Permian Zechstein. Considered to be a terrestrial deposit laid down over a rocky desert peneplain by Wills (1956, p. 108); also described as a beach deposit (Lamplugh and Gibson 1910, p. 26).

2. Basal mudstones and siltstones. Lower members of the transgressive Zechstein deposits. Lithologically unlike higher Permian Marl horizons, the term 'Dolomitic Siltstones' being more appropriate. Described as deposits of desert lagoons (Gignoux 1950, p. 218).

3. Marine and shoreline sandy dolomites.

4. Shallow water mudstones, with siltstone and sandstone intercalations. As they alternate with marine limestones, they are of marine origin (Sherlock 1947, p.47). Probably formed as a regressive deposit of the Zechstein Sea.

It is generally accepted that at the beginning of the Permian, the Zechstein Sea advanced over folded and eroded older Palaeozoic strata in Eastern England. The direction of the transgression was towards the south west or west, the sea advancing over desert areas (Wills 1956, p. 106). Before the marine transgression, continental low lying regions were the main areas of deposition, and these may have been filled by coarse sands and breccias derived from surrounding higher slopes (Sherlock 1947, pp. 45-47). It was an irregular shoreline with bays and peninsulas, producing the lithological variations in the basal Permian beds of South Nottinghamshire.

Local Details

General Statement. Throughout Nottinghamshire the Basal Breccia and Lower Permian Marl are irregular in thickness and lithology, the Permian as a whole thickening northwards. The dolomites also show a change in lithology (Edwards 1951, p. 99). Directly north of Kimberley the amount of silica in the basal beds increases in quantity, and the rock also becomes coarse grained. The increase in grain size, and the presence of pebbly detrital material in the dolomite, suggest that a Zechstein shoreline was close. Finally, in the extreme north of the region the Lower Permian Marl is overlapped by the limestone, and therefore the remaining Lower Zechstein deposits are thin.

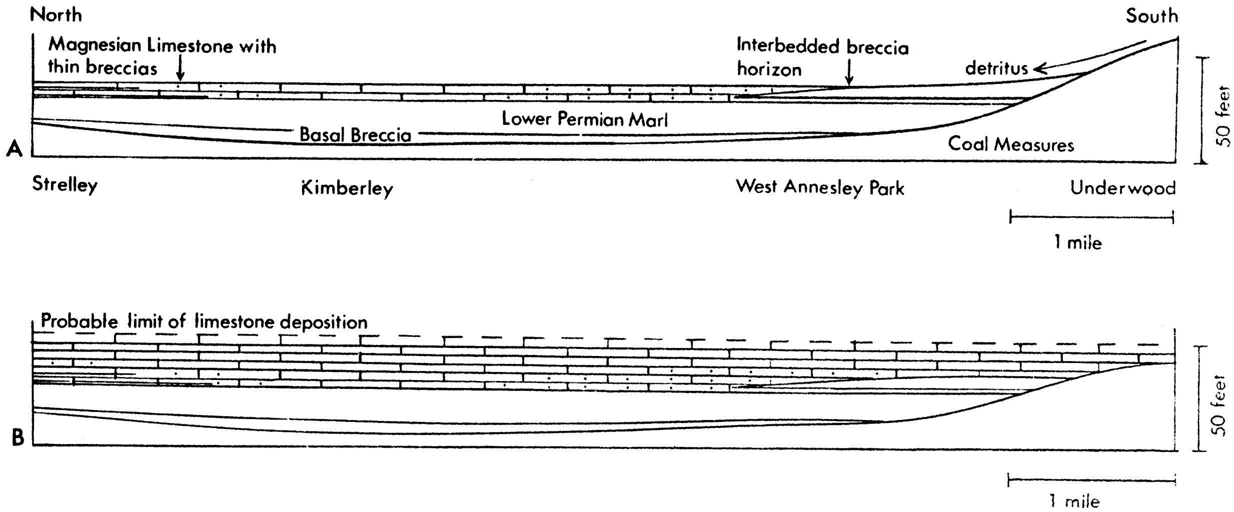
In addition to standard mapping techniques, borehole data, from the M. 1. motorway contractors and the Coal Board, were used to determine the thickness of the Lower Zechstein beds. Difficulties in mapping the base of the Permian were partially overcome by using a hand auger and by digging trial pits.

Exposure Details. Localities mentioned below are shown on fig. 1 by letters in parenthesis. All grid co-ordinates in 100 KM grid square SK.

(a) Kimberley Railway Cuttings (501449). These exposures are regarded as the type section for the base of the Permian in South Nottinghamshire (Gibson and Lamplugh 1908, p. 129; Sherlock 1911, p. 81; Taylor 1965, p. 182). The maximum known thickness for the basal beds in this area is here exposed.

(b) Sledder Wood, spring (499468). Fifteen feet of Lower Permian Marl are clearly visible but the underlying breccia horizon is difficult to detect, a maximum of 9 inches only having been observed. In hand specimen, the texture and colour of this breccia is very similar to that of Kimberley. It possesses elongate fragments with their long axes approximately parallel to the bedding and its cement is mainly dolomite. Red stained clays of the Coal Measures were collected from auger holes below this breccia.

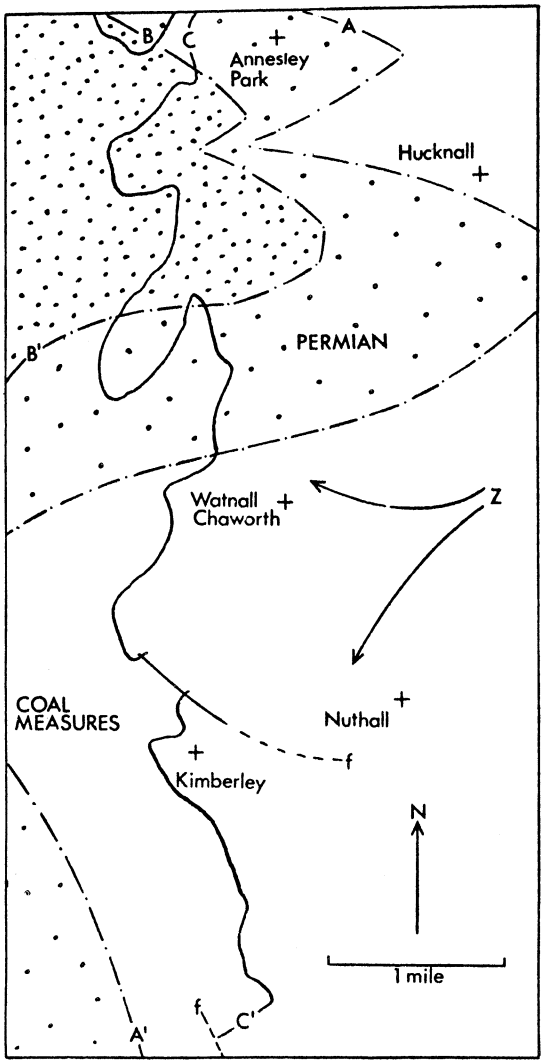
(c) Crowhill Farm, spring (502478). About 12 feet of Lower Permian Marl is exposed, but no Basal Breccia underlying the Marl was discovered in situ. Dolomitic breccia and coarse Magnesian Limestone fragments were observed in the field east of, and at least 10 feet vertically above, the spring. They had been brought to the surface by deep ploughing, the actual depth to the solid limestone being everywhere less than 12 inches. A tract of these limestone fragments in the soil extends about 25 feet east into the field. It is concluded that a second breccia horizon exists within the Magnesian Limestone. The fragments within this dolomitic breccia are on average less than 1 inch in diameter and are similar to those of the Basal Breccia; they lie parallel to the bedded surface of the flaggy Magnesian Limestone.



Text-Fig. 2 Reconstructed stages of deposition

A – situation during the deposition of the interbedded breccia horizon

B – situation at the close of deposition of the Magnesian Limestone



Text-Fig. 3. Palaeogeographical reconstruction

A - A', limit of high topographical regions during Pre-Permian deposition

B - B', limit of high topographical regions during the deposition of the basal beds

C - C', present outcrop of Coal Measures - Permian junction

Z probable direction of Zechstein advance

f fault

(d) Quarry near Shortwood cottages (489477). At least 10 feet of Lower Permian Marl is well exposed, passing conformably into the overlying limestone. The texture of the limestone is granular but not brecciated. Since the base of the quarry is filled with debris to a depth greater than 9 feet, neither the unconformity nor the Basal Breccia is exposed. In adjacent fields, clays of the Coal Measures were revealed, but the Basal Breccia was not located. Within the Lower Permian Marl, cross-bedded siltstone horizons appear; they contain rolled mudstone pellets. Hard calcareous bands, characteristic of the Kimberley and Nuthall Lower Permian Marl, are present as two thin layers only. At the base of the top layer, casts of the marine lamellibranchs Schizodus sp. and Bakevellia sp. occur. The remainder of the rock is composed of a thin bedded sandy mudstone with more quartz and mica than in the Lower Marl at the Kimberley section. Carbonaceous layers up to 1½ inches thick are common to the top few feet.

(e) Quarry, near Beauvale Priory (497488). Eight feet of flaggy sandy limestone are exposed. In the area surrounding the quarry, the base of the limestone was proved to lie about 10 feet below the present floor. Among the debris in the quarry a few calcareous siltstone fragments from the Lower Marl were seen, but their relation to the exposed rock was not discovered. Within the Magnesian Limestone, thin layers of breccia are interbedded with sandy dolomite to a maximum thickness of 3½ feet. Cross-bedded units are common.

(f) Auger holes near Abbey Wood (496490). After sampling noncalcareous clays from depths of 4 to 6 feet, no Lower Permian Marl was found. Clays of the Coal Measures occur directly below the Magnesian Limestone. The absence of the Lower Permian Marl indicates that it has been overlapped by the lower beds of the limestone, although it is possible that downward slip of the limestone from the upper levels of the scarp may have covered any Lower Marl outcrops or alternatively a fault may be present in the area, although no field evidence of such a structure is known.

(g) Old Quarry, Abbey Wood (492494). This exposure is largely overgrown but approximately 8 to 10 feet of Magnesian Limestone can still be seen in the quarry (Plate 12) and to the east, at intervals, for nearly 40 yards. The limestone is a cross-bedded sandy dolomite with flaggy beds, rarely exceeding 1½ feet in thickness.

Beds of breccia occur within the limestone, with fragments similar in lithology to those of the Basal Breccia of Kimberley and Nuthall. Individual fragments, which may be up to 6 inches in length, are much larger than any seen elsewhere (Plate 11-fig. 2). Although the majority of the fragments are composed of hard calcareous siltstones closely resembling the beds of the Lower Permian Marl, soft angular mudstones and sandstones occur. The maximum thickness of one of these beds, five feet above the quarry floor, is 1½ feet. It is well cemented and shows distinct cross-bedding. The angular fragments are orientated parallel to the inclined cross-bedding, with their long axes coincident with the dip of the inclined units. The breccia fragments not in the cross-bedded unit also show preferred orientation. They are mostly tabular and lie parallel to bedding planes. Other, thinner, more deeply weathered beds contain quartz pebbles and are poorly cemented and sandy. A breccia horizon three feet above the floor of the quarry is variable in thickness from 0 to 1¼ feet. At the base of the exposure, the sandy limestone disappears beneath the undergrowth and debris from the rock face. From its topographical position, the sandy limestone should lie either unconformably on the Coal Measures or conformably over the Lower Permian Marl. A trial pit, 5 feet deep, at the base of the exposure revealed similar Magnesian Limestone to that in the quarry but no interbedded breccia or Lower Marl.

Below the quarry, the scarp face slopes very steeply downwards for 25 feet. The clays at the base of the scarp are probably of Coal Measures age since they contain many ironstone nodules. At the junction between the Magnesian Limestone and the underlying clays, the level was calculated to lie from 6 to 8 feet below the base of the limestone exposed by the trial pit at the base of the quarry. Further investigations by trial pits and auger holes to find the basal Permian beds were unsuccessful; overlap of the Lower Permian Marl by the Magnesian Limestone is assumed.

(h) M. I. Motorway, temporary exposure. Park Springs (498504). Drainage excavations for a stream crossing the motorway revealed horizontal Permian beds unconformably overlying nearly vertical Coal Measures silty mudstones. Neither the Basal Breccia nor the interbedded breccia are present, but the lower beds of the Magnesian Limestone are coarse and sandy and contain some small Coal Measures fragments and pebbles. The Lower Permian Marl is present but its thickness is reduced to approximately 8 feet. It is lithologically similar to the siltstones and mudstones of the underlying Coal Measures with the addition of carbonate. Less than 100 yards away to the south, the Lower Mottled Sandstone has also been exposed. At present, the relationship with the underlying Permian is not seen, but it is possible to estimate the total thickness of the Permian deposits lying below the Lower Mottled Sandstone to be less than 40 feet. This thickness is less than that three miles to the south at Kimberley.

Conclusions

Environments of deposition

The Basal Breccia is possibly a terrestrial deposit, its thickness variations being due to deposition in hollows between higher ground. Restricted movement and erosion of the matrix is indicated by soft and angular fragments of Coal Measures age occurring within the breccia. The alignment of some fragments may suggest transport by water for only a short distance. Lamplugh and Gibson (1910, p. 26) and Smith (1913, p. 216) suggest that this is a shoreline deposit. They attribute the imperfect rounding of the material to the absence of strong wave action.

The Lower Permian Marl formation was probably deposited under brackish water conditions which became increasingly saline as the Zechstein Sea advanced. The proximity of land is indicated by the presence of much silica, the thick carbonaceous layers, and the increase in cross-bedding in the Dolomitic Siltstones to the north of the area. The finer, calcareous and dolomitic siltstone bands possibly represent deposits formed at a greater distance from the shore.

The existence of an interbedded breccia in the lower beds of the Magnesian Limestone shows that such breccias were able to form in marine environments, as opposed to the continental or shoreline environment which gave rise to the lower Basal Breccia. The increasing quantities of coarse detrital material in the dolomite northwards from Kimberley probably indicates that a former shoreline is being approached (Text-fig. 2). Thin layers of breccia within the Magnesian Limestone have been noted elsewhere in South Nottinghamshire (Taylor 1965, p. 187). The size of the fragments within the interbedded breccia of Annesley Park further suggests that there was a land mass immediately to the west of the Zechstein Sea during the time when the lower beds of the Magnesian Limestone were being deposited. It is possible that the breccia was formed as a scree deposit and was subsequently swept into the Magnesian Limestone sea. This intra-Permian breccia horizon may be similar in origin to the Harworth and Calverton breccias of the Middle Permian Marl and Lower Mottled Sandstone described by Wills (1955, pp. 108-109).

General Palaeogeography

The Permian of South Nottinghamshire represents a shoreline facies of the Zechstein Sea. The sediments were probably deposited in brackish or lagoonal shallow water, the conditions becoming fully marine as the sea transgressed. The nature and approximate location of the continental shoreline can be determined by close investigation of the basal deposits. It is suggested here that the local palaeogeography may have been either:-

Plate 11

fig. 1. Basal Breccia. Kimberley Railway Cuttings (a). Most of the fragments are randomly orientated, with an even size distribution; some are soft and angular. A few tabular siltstone fragments show bedding characters. (Photo: J. Eyett)

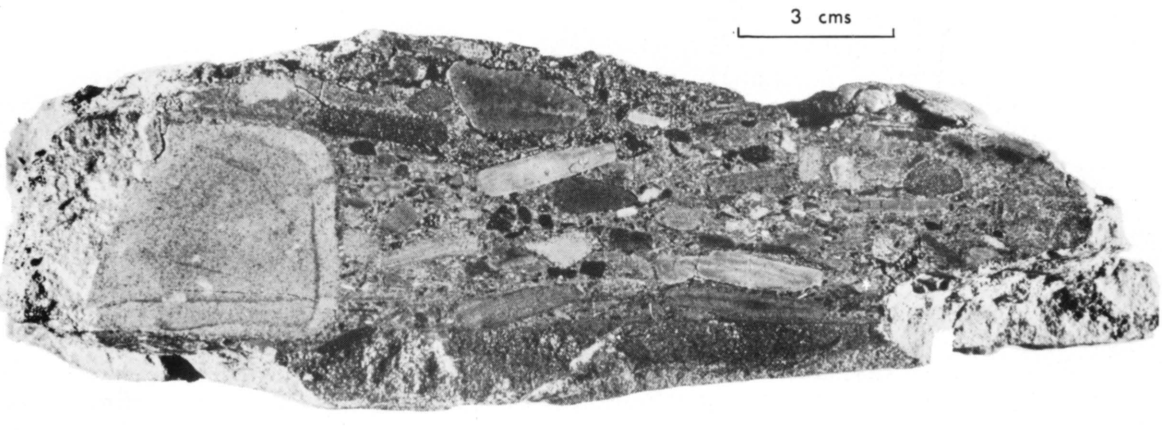


fig. 2. Interbedded breccia. Old Quarry, Abbey Wood (g). Tabular fragments are aligned parallel to bed margins. Soft coarse sandstone and black mudstone fragments occur with larger fine grained sandstone and siltstone fragments. The matrix consists of small quartz pebbles and sand grains cemented by dolomite. (Photo: J. Eyett)

(1) A flat lying desert, containing shallow hollows or basins, filled with either breccias or freshwater lakes. Plant fragments in the Lower Permian Marl suggest that there was a vegetation fringe along the shoreline. Over the whole of this region a progressive advance of the European Zechstein Sea occurred.

or (2) An upland desert region in which Palaeozoic rocks were being actively eroded. Later erosion of the retreating shoreline caused the sea to spill into previously shallow, possibly freshwater basins. The final advance of the Zechstein Sea covered the remaining lowland areas.

Wills (1955, pp. 103 - 105) suggests that the basal Permian deposits of the north of England support the idea that the adjacent land was a flat lying desert plain. In South Nottinghamshire, it is argued that the evidence supports the idea that the surrounding desert was moderately elevated rather than flat lying (Text-fig. 3). The Charnwood area,and possibly a Central England land mass on the site of the present Pennines,were being actively eroded.

Local Palaeogeography

George (1963, p. 50) has written, concerning the Permo-Trias, "Variations in the succession must therefore be read as revealing the interplay of several factors, of which the occurrence of 'barriers' is only one." These barriers which obstructed the advance of the Zechstein Sea are here interpreted as either a group of islands or a peninsula. The interbedded breccias at the base of the Magnesian Limestone may indicate the presence of a former barrier of moderately high relief, having a maximum height of approximately 2000 to 3000 feet. This is suggested by the fact that many of the fragments within these breccias are large, angular and friable, showing very little evidence of long transport. The many calcareous siltstone fragments in the breccia may have resulted from the destruction of an earlier lower marl by a later transgression of the sea. Since the basal beds of the Permian directly north of Kimberley suggest a deposition closer to land than is indicated by similar deposits to the south, then the existence of a barrier of islands or an extension of a land mass eastwards may have briefly halted the progress of the Zechstein transgression in South Nottinghamshire.

Finally, it is possible that the land masses to the west and south-west of the area discussed were tectonically active and being eroded, throughout the deposition of the basal beds and the lower part of the Magnesian Limestone.

Acknowledgements

I would like to thank Dr. P.L. Hancock for his constructive criticism and advice in the preparation of this manuscript.
I am also grateful to Mr. R.E. Elliott and Mr. M. Lock for their kind reading of the text, and to Mr. R.E. Waring for his assistance in the field.
Thanks are due to the National Coal Board and Sir Owen Williams and Partners for access to borehole data and site investigation reports.

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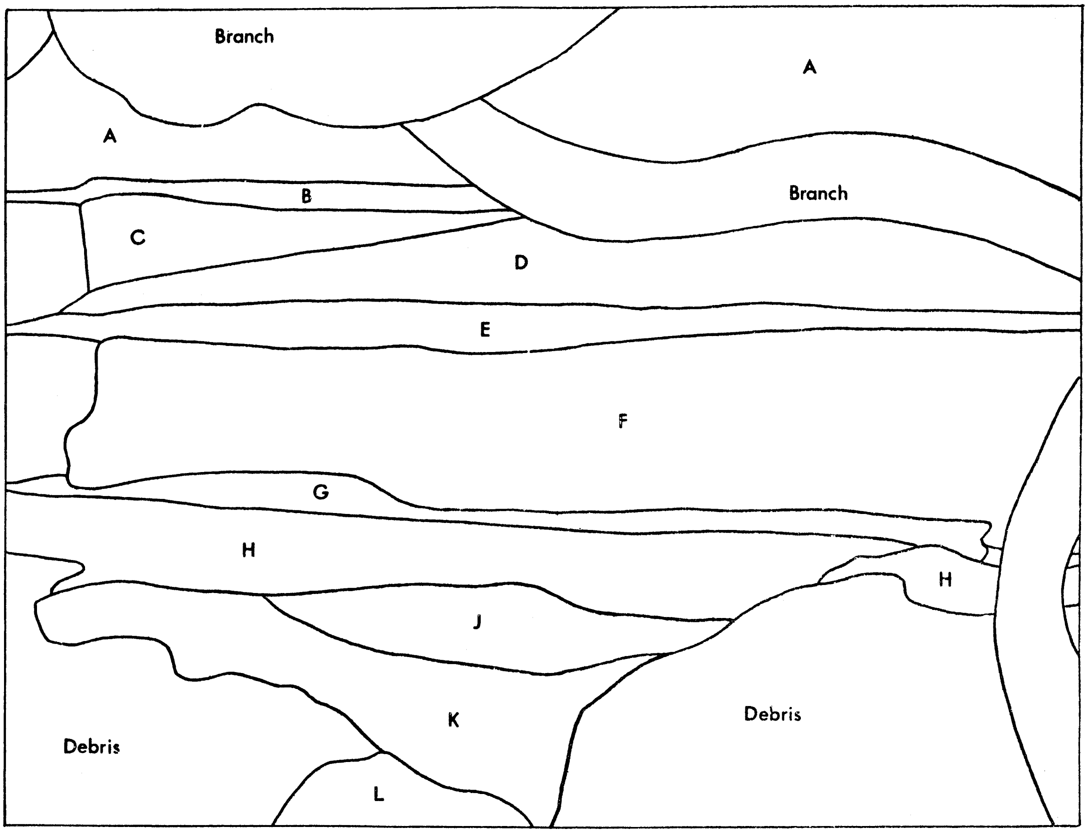
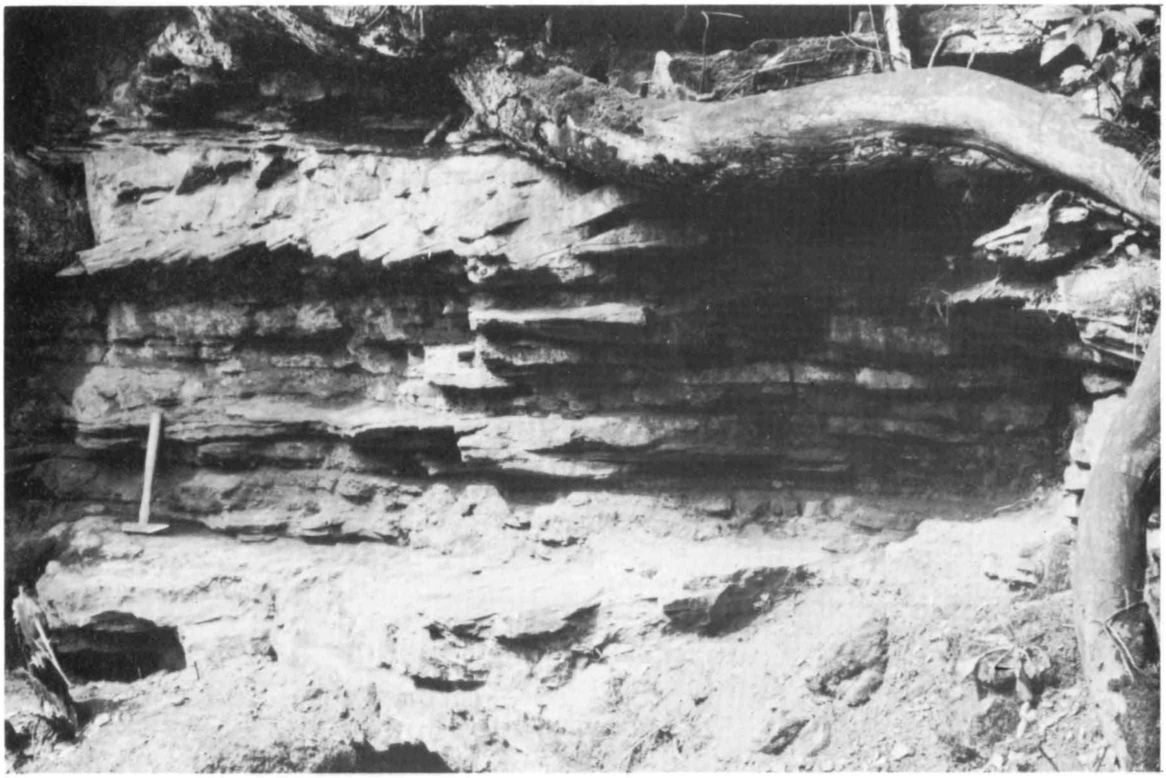


A Flaggy and fractured limestone, $4\frac{1}{2}$ feet below the top of the exposure
B Thinly bedded and brecciated dolomite
C Hard and calcareous limestone. Cross-bedded, massive and dolomitic
D Thinly cross-bedded limestone, sandy with pebbles
E Very coarse breccia. Sandy with large pebbles
F Thin flaggy, sandy dolomitis limestone
G Coarse sandy limestone, gritlike and strongly weathered
H Thick coarse breccia with pebbles
J Thinly cross-bedded limestone. Dolomitic
K Hard and calcareous limestone. Massive and dolomitic, with 2 inches of fine breccia at the base
L Trial pit, 5 feet deep. Hard, massive dolomite, becoming flaggy at the base.



Interbedded breccia exposure. Old quarry, Abbey Wood (g)
(Photo: L.H. Waring)

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Manuscript received 20th October, 1965

JAMES SHIPMAN (1848-1901), PIONEER NOTTINGHAMSHIRE GEOLOGIST

by

Robert William Morrell

Summary

This short essay seeks to place on record something of the character and work of a man who was once described as "the authority" on the geology of the Nottingham district. Included is a bibliography of Shipman's published work.

The geological knowledge available to today's students is the product of the dedicated labour of many individuals. Some have become famous in the annals of geological history whereas others, by far the majority, have quietly slipped into obscurity, only to emerge from time to time as impersonal names quoted in the text or references of published papers. With the passage of time and the loss of valuable records, it becomes increasingly difficult to give substance to such shadowy names and consequently much that is of interest to the student of the growth of geology is lost.

The purpose of this paper is to give, albeit all too briefly owing to scarcity of material, some details of the career and work of one of Nottingham's greatest amateur geologists, James George Shipman. His name is now almost forgotten and when it does come up, it is only as a passing reference in geological papers, Posnansky in 1960 and Taylor in 1965 being two who quote him. However, at the time of his death his name was almost a household word in certain circles - those interested in archaeology and geology. For the former, his short work on the Nottingham Town Wall is still the only standard work on the subject; the geological data included in the book makes it of great interest to geologists as well as those interested in local history. To Shipman must go the credit for the formation of Nottingham's first geological society, an organisation which grew out of a Saturday afternoon rambling group and characteristically took the name of Nottingham Geological Rambling Club at its foundation in 1889. Unfortunately for the geologists, the Club appears to have been quickly swamped by botanists and soon changed its name. (It still exists as the Nottingham and Nottinghamshire Field Club, but now exhibits no interest in the subject that gave it birth.) In view of the breadth of his work, it is easy to understand why the writer of a letter published in the "Nottingham Daily Express" for November 23rd, 1901 (Mr. E. Richards) should claim that Nottingham would long cherish his memory. The writer has been proved wrong; Shipman was soon forgotten.

James Shipman (he appears to have dropped his middle name at an early date) was born of working class parents in 1848, in a Nottingham very different from that of today. I have been unable to trace anything about his parents or childhood; as Shipman had the reputation of being rather retiring, it seems that we will probably never discover much about his background. He had two elder brothers living at the time of his death; their first names tally with those in an entry in the 1851 census reports for Nottingham. At an early age he entered the printing industry, but left later to join the staff of one of the Nottingham papers. This was to be his life's work and he eventually rose to the position of Sub-Editor of the "Nottingham Daily Express."

As a journalist, Shipman worked in a department bringing little contact with the general public (though he was to come to the fore when commissioned by his paper to settle a local dispute of a geological character). His relations with his colleagues seem to have been very good and it is on record that he gave of his very limited spare time to aid in their welfare; this seems reflected in his election as President of the East Midlands branch of the Journalists Institute in 1898 and as a Fellow of the National body a year later.

Outside his profession, Shipman had two dominating interests, his church and his geological work. Shipman was a Congregationalist and his religious life centred round the Colwick Street Mission, founded in 1874 and now defunct. His theology appears to have been liberal and unlike many non-conformists he does not appear to have been a Sabbatarian, though he was a Sunday School teacher. It was out of a rambling group associated with the Mission that the geological society mentioned earlier was formed.

Shipman's interest in geology appears to have commenced actively with his attending a class at the Nottingham Mechanics Institute in 1868 conducted by Edward Wilson, F.G.S. The tutor was himself a Nottinghamshire man, having been born in Mansfield in 1849; he was the son of Dr. T. Wilson of that town and at the early age of fifteen won a prize at Nottingham Grammar School for an essay on "The Coal Fields of Derbyshire." Elected a Life Fellow of the Geological Society of London in 1872 and recipient of the balance of the Murchison Fund in 1888, he was for fourteen years government lecturer at geological and biological classes in the Mechanics Institute and University College, Nottingham. Wilson left Nottingham for Bristol in 1883, where he became Curator of the local museum; he died in Bristol at the early age of 49 on May 21st, 1898. Shipman must have been a good student, for his studies led to a period of close co-operation with Wilson. In 1877 the "Geological Magazine" published Shipman's first paper, entitled "The Conglomerate at the Base of the Lower Keuper." In 1879, the outcome of the collaboration between Shipman and Wilson was made public by the publication in the "Geological Magazine" on their joint paper "On the occurrence of the Keuper Basement Beds in the Neighbourhood of Nottingham." Both papers illustrate Shipman's primary interest in stratigraphy rather than palaeontology, perhaps understandable in view of the not very fossiliferous strata outcropping at Nottingham.

Throughout his life Shipman remained an amateur, though at one stage he was a part-time lecturer in geology at University College, Nottingham which seems to suggest that he was considering taking up the subject professionally. In 1870 he received the Queen's Medal in Geology from the Science and Art Department, South Kensington, and in 1885 he was elected a Fellow of the Geological Society.

The importance of getting out and about to examine formations for himself was a lesson Shipman learned early; one may be an armchair philosopher but never an armchair geologist. He made frequent visits to interesting localities,constantly recording observations in detail; he utilised an auger a great deal to supplement outcrop information. The importance of keeping records of all temporary exposures is an aspect of Shipman's work that was of paramount importance and it was a lesson that he impressed on others. W.T. Aveline paid a glowing tribute to Shipman in the Preface to the Geological Survey Memoir on the Nottingham area (2nd Edition 1880); it is well that it be reproduced here, not only as an indication of Shipman's painstaking and regular work but also for the emphasis it gives to the importance of keeping records of temporary exposures:-

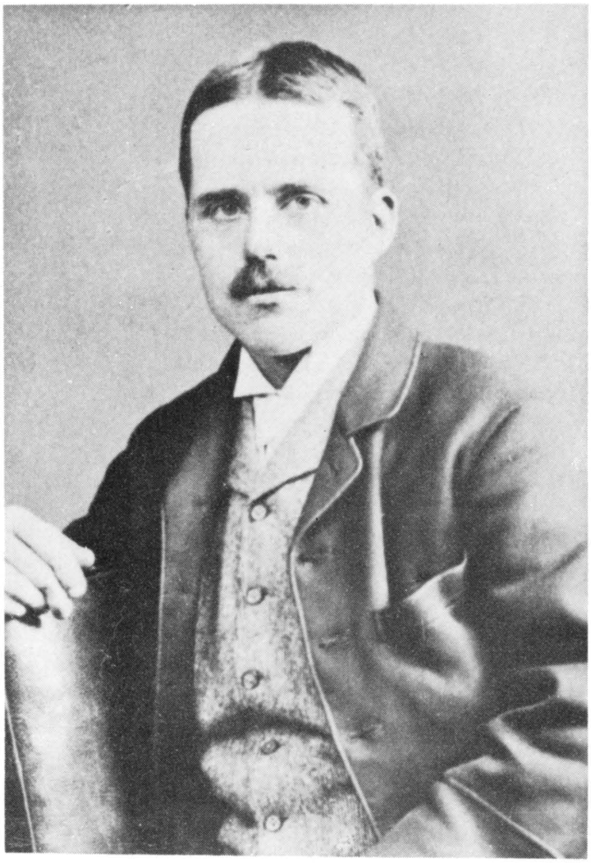

Fig. 1.

James Shipman (1848 - 1901). The only known photograph, taken during his early 30's.
(Photo in the possession of the Geological Society of London, reproduced by courtesy)

Fig. 2.

Edward Wilson (1848 - 1898), pioneer teacher of geology at the Mechanics Institute and subsequently at University College, Nottingham.
(Photo in the possession of the Dept. of Geology, University of Nottingham, reproduced by courtesy).

"There has also been another source of fresh information, which has tended to modify the geological work on the east side of Nottingham. When this part was first surveyed, it was chiefly covered with fields and small gardens, guarded by high fences and locked gates, while a few roads and brickyards afforded the only sections from which to make out the geological structure of this area, which has since been transformed into a busy town. It was from the exposures of the strata made while digging the foundations of the houses, constructing the deep sewers, forming the new streets, and cutting down the roads, that a more accurate knowledge of the geology of that area was acquired. But the information thus opened out would have been entirely lost had it not been for a gentleman of Nottingham, Mr. James Shipman, who, for upwards of 10 years, spent most of his leisure hours in watching the excavations, and carefully noting every change of the strata exposed, marking the directions of the Faults and the amount of their throw, the thickness and dip of the beds &c., &c.......Mr. Shipman kindly allowed me to make use of the results of his long and diligent labours, and I only regret that the small scale of the 1-inch map will not allow of full justice being done to his work."

Shipman's results, referred to by Aveline, are found in a series of lectures given before the Nottingham Naturalists' Society and later published in their "Transactions" and "The Midland Naturalist"; had the "Geology of Nottinghamshire", on which Shipman was reputed to be working at the time of his death, ever been published, it would have been a major source of information on the geology of the area. Shipman's practice of visiting exposures led him to embark on his only major archaeological work, "Notes on the Old Town Wall of Nottingham." (1899). Shipman records his reluctance to undertake work of an archaeological nature as he was unqualified to do it; however, as no one else seemed bothered about the exposure which brought the remains of the wall to light, he undertook to record the details. James Shipman's published works illustrate the various phases of his work. His earliest published work was on the Keuper and Triassic rocks; he then turned to the rich alluvial deposits of the Trent Valley and from this to specific localities around Nottingham, this latter phase of his work commencing with a paper on the "Geology of the Parish of Lenton" (1884) and going on to cover "The Geology of Stapleford and Sandiacre" (1891). The only published paper in which the geology of Nottingham proper is covered was published in 1889 in the "Transactions of the Nottingham Naturalists' Society." The last period of Shipman's life was spent, in the main, on studies of the coal deposits in the county and it is about these that he writes in his last few strictly geological papers. His interest in the coal measures is reflected in his building up of what the "Nottingham Daily Guardian" referred to as "one of most valuable and representative collections of coal sections known to exist"; it seems that this was the collection which Sir J.J.H. Teall advised Shipman's brother, after the death of the geologist, to present to University College, Nottingham.

The scarcity of manuscript material and photographs and the almost total lack of personal data make it difficult to visualise Shipman. His home, in the now not very salubrious Robin Hood Chase area of Nottingham, was typical of the Victorian lower middle class type; No. 8 Manning Grove was the last of three moves of house. According to all reports on Shipman's character, he was of a retiring disposition,to "the point of timidity" asserted his friend, the Nottingham antiquarian Alfred Stapleton. This is repeated by J.W. Carr in his obituary of Shipman, published in the "Quarterly Journal of the Geological Society of London" for May, 1902: "Owing to his extremely shy and retiring disposition, he was not so well-known outside his own locality as his great abilities and wide knowledge merited, for few men with equally restricted opportunities have done so much for local geology." The same article also stressed his "....extreme thoroughness and conscientiousness" as being "the keynote of all his work." This latter point is also brought out by Stapleton who stated that Shipman's maxim was "Take your time. Don't hurry, make the very best you possibly can of the thing before publishing." It might be that in this Shipman went just a little too far, for Stapleton also records that for some years prior to his death Shipman had been working on some fossil footprints found at Mansfield in a formation not previously known for evidence of life. It is doubtful whether this was ever published.

Shipman does not appear to have enjoyed robust health and perhaps it is this factor that accounts for the reports of him being rather shy; however, as we have seen that he ran a geological society, was active as a church worker, and spent hours visiting exposures, one tends to think the reports not completely accurate - indeed it would be difficult to lead a geological field excursion and remain shy and retiring.

The only personal description of him known to survive suggests that his personality was more serious than shy. J. A. Hammerton who joined the "Nottingham Daily Express" as Editor about a fortnight before the General Election of 1895 and held the post for two years, includes the following evocative, if somewhat acid, word picture of him in his memoirs, "Books and Myself" (p. 112).

> "Shipman, the senior sub-editor, had either walked straight out of a Dickens novel or was ready to walk into one; indeed, I felt that he would have been more real in a Dickens story than he was in life. Very diminutive in stature, with a habit of walking so that while both his feet pointed to the right and seemed determined to carry him from the straight path, he still showed himself master of his soul by directing his course ahead. A devoted Sunday-school teacher, he took life with fearful seriousness; his work likewise. I suspect that he had been found in the sub-editors' room, sitting at the same desk, many years before, like some of the items of the office furniture, and although I have no information on the point, I suppose he left it only for the eternal home to which for so many years he had been directing the thoughts of his Sunday-school children. He was an amateur geologist, and had even written a dreary book on "The Rambles of a Geologist", a copy of which he presented to me, suitably inscribed. One of the original reflections in its pages recorded how he had observed that, after peering into the secrets of nature by chipping rocks with his hammer on a summer's day, he lay down to rest on the greensward, still wearing his straw hat (the 'boater' of our younger days) and he perceived that when lying on his back his hat was apt to come in contact with the ground, and so to tilt itself off his head. He was quite an efficient sub-editor of the dull old sort, albeit capable of such original reflections. He came once to an evening gathering at my home, carrying a bulky roll of music with him. My wife and I were horrified, but felt we could do no less than ask him to favour the company with a song, which he most willingly did, to his own great satisfaction, but only to remind us of the Glasgow comedian's ancient joke about the singer whom you could not hear behind a tramway ticket. Measured on a wall of the reporters' room was a record of the heights of many members of the staff, past and present. Shipman's was the lowest ...."

Shipman does not appear to have been engaged in any major controversy; not for him the thoughts that troubled his Scots counterpart Hugh Miller (Shipman and Miller seem to share much in common). The only recorded instance of his taking up a controversial matter relates to the use of Darley Dale stone in the construction of the Nottingham Guild Hall. A dispute had blown up as to whether the stone being used by the contractors was as specified, some individuals appearing to think that the stone used was not of the correct quality. Shipman was commissioned by his paper to investigate and he did so in his usual way, by visiting the various quarries in the Darley Dale area and seeing for himself the various types of rock being quarried. His findings were published first by his paper and later in pamphlet form; summarised, they are that the stone was "not the original Darley Dale Stone, but was of very good quality and would weather well", a conclusion borne out by the present state of the Guildhall.

James Shipman led an active life and at times one is left wondering as to how he fitted everything in. His habit of recording data at temporary exposures was put to good use and incorporated in the Survey maps of the area. An example of the information obtained from exposures being contrary to what the geological maps indicated is to be found in his paper on the "Geology of the Parish of Lenton", first published as part of Godfrey's "History of the Parish and Priory of Lenton" and later as a separate work. The Survey map represented the Coal Measures as rising to the surface over a large area on the north side of Wollaton Park, which is west of Nottingham. Shipman noted, however, that when excavations were being made for a new gas-holder, where the map showed Coal Measures Lower Mottled Sandstone was revealed. In drawing attention to the error, he seeks to explain how it could have been due to surface observation and points out that the Lower Mottled Sandstone extends over the area in question in a thin sheet through which at one or two points "the Coal Measures actually do peep out."

Shipman's important contributions to the knowledge of the geology of Nottingham area provided firm foundations for the future. Not unnaturally, fuller knowledge has necessitated modifications in detail of his conclusions, but his pioneer studies and his recording of information from sections no longer available will ensure consultation of his papers for many years to come. His death on Thursday, November 21st 1901, was quite unexpected and an inquest was called for; the Coroner's Report gave the cause of death as "apoplexy" due to the bursting of a small blood vessel on the surface of the brain. Shipman was buried in the family grave in the dissenters plot at Nottingham General Cemetery on November 26th. A few days before his funeral, a letter had appeared in the "Nottingham Daily Express" from the then Director of the Geological Survey, Jethro Teall, in which letter he expressed his grief and referred to Shipman as "the" authority on the geology of the district. It was, the Director noted, a source of regret not only to himself but also to his colleagues that Shipman "has gone from us without receiving from the Geological Society a special mark of the esteem in which his labours are held. His work would undoubtedly have been specially recognised by the Society had he lived but a short time longer."

Acknowledgements

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THE GEOLOGY OF THE M. 1. MOTORWAY IN NORTH LEICESTERSHIRE AND SOUTH NOTTINGHAMSHIRE

by

Frank M. Taylor

Summary

The construction of the M. 1. Motorway has provided numerous temporary excavations in Permo-Triassic rocks in areas where the detailed stratigraphy was little known. The rocks of the Keuper Series were exposed south of the River Trent, from the Waterstones Formation at Kegworth to the overlap of the Charnian Rocks by high formations of the Keuper Marl, south of Shepshed. North of the River Trent, the passage of low formations of the Keuper Marl down through the Waterstones and Keuper Basement Beds to the Pebble Beds was displayed in an almost continuous section. After crossing Coal Measures the Motorway continued on Upper Permian Rocks, exposing a new facies of the Lower Magnesian Limestone near Strelley, and at Nuthall, an almost complete sequence of Permian rocks with their unconformity on Middle Coal Measures.

Introduction

During 1963, 1964 and the first half of 1965, the construction of the M. 1. Motorway through North Leicestershire and South Nottinghamshire has provided a unique geological traverse of this area, in the form of the numerous cuttings and drainage trenches excavated during the early stages of road construction. These excavations are on a scale approached previously only when the railways were built in the late 19th and early 20th centuries. Work in the area began in 1961, when the major bridges for the Sandiacre - Stapleford By-Pass were constructed; this excludes the bridge over the motorway at the three-level interchange at Sandiacre, begun in 1963.

The geology of the area through which this section of the motorway passes was described by Fox-Strangways (1900 and 1905) and by Gibson et al. (1913). Detailed accounts on the geology of the ancient rocks of Charnwood Forest have been published by Watts (1947); a paper by Bosworth (n.d.) describes in detail the Keuper Marl / Pre-Cambrian unconformity. Adjacent areas to the Motorway have been described by Taylor (1964, 1965), and mention was made of the geology of the M.1. route in a general article on the motorway by Osborne (1960).

This article records the details noted from regular visits to the sections of the M.1., from the northernmost Pre-Cambrian exposure, close to the Charnwood Granite Company quarries (SK 491173), to the junction of the M.1. with the A.610 trunk road at Nuthall (SK 516445), a distance of 19 miles. The road crosses the River Trent at Sawley (SK 466309) and the River Erewash at Stanton Gate (SK 382484). The details of the route are illustrated in Text-fig. 1.

The East Midlands Geological Society visited the excavations on June 6th, 1965; this article includes, substantially, the record of that meeting, but additional exposures are mentioned which were either available before that date or which were cut after it.

Rocks encountered during the excavations included glacial boulder clays and gravels, recent river gravels and alluvium, Triassic and Upper Permian Rocks, Lower and Middle Coal Measures, and the Pre-Cambrian Rocks of Charnwood Forest. Only superficial comment is here made on the Pre-Cambrian Rocks, as a more detailed study of them is in progress at Leicester University. The Coal Measures were largely excavated prior to motorway construction by opencast coal mining; little undisturbed ground remains, but one or two exposures of interest were uncovered and are described. The greater part of the article is concerned with the Permo-Triassic exposures.

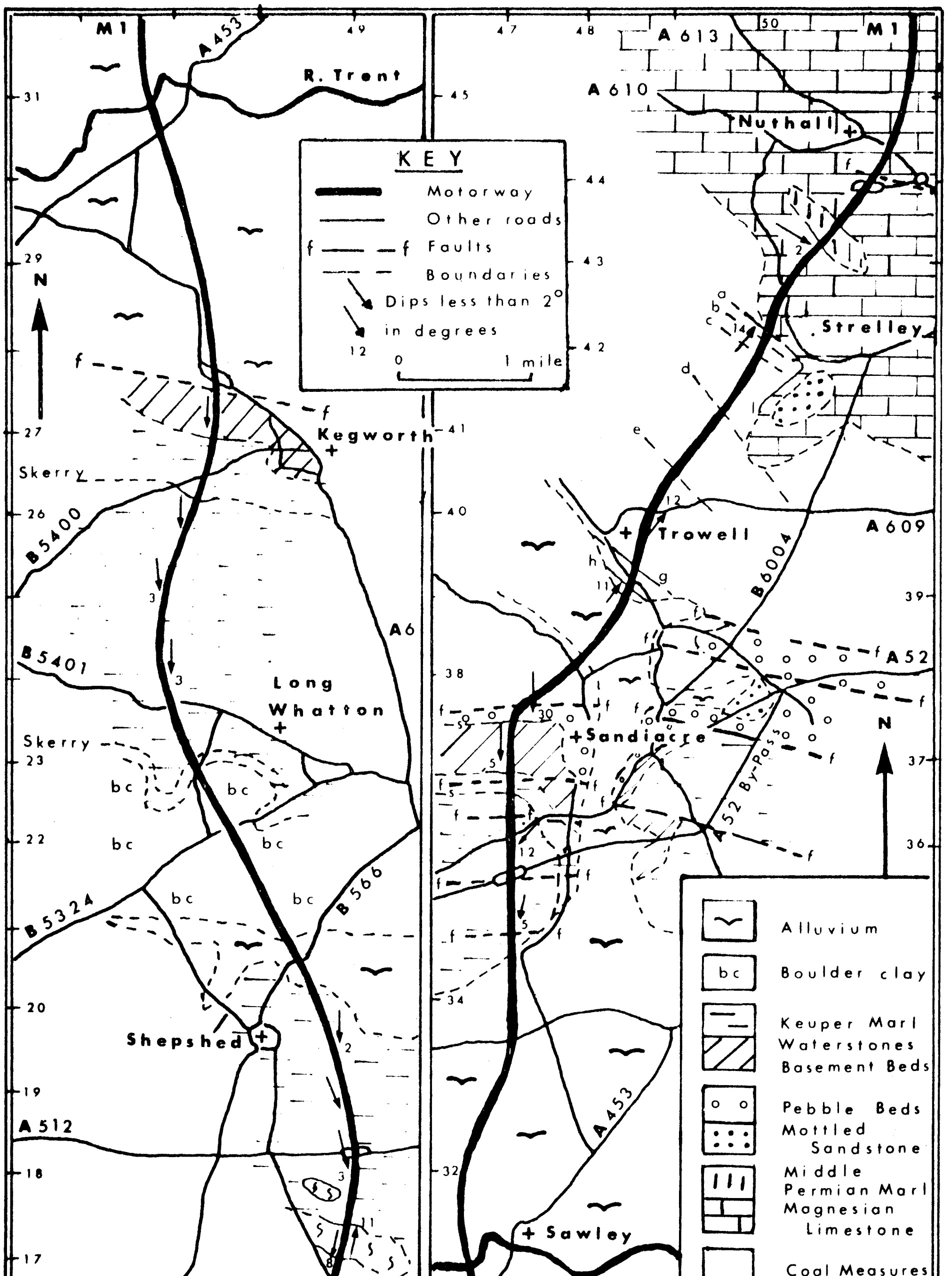
Detailed geology of the Motorway

The Motorway south of the River Trent

Of the three main cuttings in Charnwood Forest, the one just south of the junction of the motorway with the A.512 (SK 491173) was chosen as the starting point for the examination of the Triassic deposits, which extend continuously northwards to the River Trent. The Pre-Cambrian rocks were seen to be mainly syenites, similar to those of the adjacent Charnwood Granite Company quarries (SK 487180); in addition there were altered bedded deposits (hornfels) showing a steep northerly dip and the contact of the hornfels with the syenite. Overlying these rocks are basal Triassic deposits exposed on both the north and south sides of the cutting and showing breccias in contact with the upper surface of the Pre-Cambrian rocks. As is usual with the Triassic breccias of this area, its fragments were largely composed of local rocks, in this case of syenite and hornfels derived from the adjacent rock outcrops, the remains of local scree deposits. Here indeed, the classic unconformity of the Charnwood Forest region, described so meticulously by Bosworth(n.d.), was well displayed in a new excavation. The footings for the bridges over the B.5330 (SK 489166) and under the A. 512 (SK 491183) were dug mainly in red and green fine-grained siltstones and mudstones, and failed to reach the Pre-Cambrian rocks. Nothing was found which would indicate the horizon of the Keuper Marl which overlapped onto the older rocks at these localities.

North of the A. 512, the red and green siltstones were exposed in shallow excavations, with dips of two or three degrees to the south-south-east. After crossing a small steep valley east of Shepshed, finer grained rocks, dark red and green mudstones with thin skerry beds (grey-green dolomitic siltstones), were exposed at the summit of the next ridge (SK 488198).

A major lithological change occurred to the north of the B.588, where the motorway passes through Piper and Oakley Woods (SK 480215), cutting deeply into boulder clays. The realignment



Text-Fig. 1. The Geology of the M.1. Motorway in North Leicestershire and South Nottinghamshire.

a = Top Hard Coal; b = Dunsil Coal; c = 1st Waterloo Coal; d = Clay Cross Marine Band; e = Deep Hard Coal; g g = Black Shale Coal; h = Ashgate and Mickley Coals; s = Skerry in Keuper Marl.

of B. 5324 and local access roads provided extensive excavations in this material, to a depth of 20 feet. The boulder clay contained numerous erratics, including chalk and flint; Gryphaea sp., belemnites, brachiopods and oolitic limestones (Jurassic); blocks of Triassic marls and skerries; Coal Measures sandstones and coal; dolomitised limestones, cherts and cherty limestones with corals from the Carboniferous Limestone. All these fragments were embedded in a fine grained blue clay which weathers brown. Records of chalky boulder clay are not very common west of the River Soar; similar deposits are known well to the north at Risley (Swinnerton 1948, p. 77) and to the south at Coton Park and Cole Orton (Fox-Strangways 1900, p. 39, and 1905, p. 39). The deposit excavated on the motorway thus increases the known distribution of chalky boulder clay; the chalky material must be derived from the east. The inclusion of Carboniferous fragments therefore illustrates the complex nature of the deposit, for this material seems to have come from the north. There was no obvious division between clay containing only Mesozoic fragments from that containing essentially Carboniferous fragments.

The Keuper Marls return again north of the B. 5324, at the bridge taking the motorway under the unclassified road to Long Whatton (SK. 473228). The top of the cutting here is in sandy drift deposits, with numerous pebbles. Near the bottom of the cutting a thick series of skerry beds were uncovered, individual layers attaining thicknesses of 12 inches. These skerries are grey-green siltstones and sandstones often containing dolomite, gypsum and calcite. The thicker beds were very porous and contained voids in the rock up to $\frac{1}{4}$ inch diameter. Other beds contained gypsum nodules of about the same size; presumably leaching has removed the gypsum in some cases to create these voids. The skerries outcrop in the road leading to Long Whatton and have been seen in drainage trenches for new housing estates to the south of the village (SK. 477236); the skerries can therefore be grouped as the Long Whatton Skerry. In its general lithology this compares closely with the Cotgrave Skerry described by Elliott (1961, p. 220). Older beds, mainly red marls with thin green beds and dolomitic seams, outcrop to the next bridge (over the B. 5401).

To the north only shallow cuttings in red marls occurred until the larger excavation between Highfield and Mole Hill Farms was reached (SK. 472259). In this cutting another series of skerry beds were exposed. This is a thicker sequence than at Long Whatton and again many of the sandstones were porous. No gypsum nodules were located in this locality, but there were examples of salt pseudomorphs and ripple marks. The skerries outcrop to the south of Kegworth and can be referred to as the Kegworth Skerry. In a general way the lithology of the skerry is similar to the Plains Skerry described by Elliott (1961, p. 218) but not all the structures normally associated with the Plains Skerry in the Nottingham area were found on the motorway site.

Lower beds in the sequence were examined in the motorway cutting northwards to the B. 5400. At the bridge, (SK. 474265) the appearance of laminated siltstones and mudstones suggest the lowest beds of the Keuper Marl and north of the bridge the junction of the Keuper Marl with the underlying Waterstones is crossed. The top beds of the Waterstones are red shales and micaceous siltstones, and thin sandstones. The lower, thicker sandstones which are typical of the group were presumably not reached by the excavations in this cutting.

Further north the motorway is built on the embankment which will take it across the Trent flood-plain, which commences at the Lockington interchange junction (SK. 475276). Shallow boreholes indicate that the greater part of the flood-plain overlies Keuper Marl, which means that a fault north of Kegworth re-introduces this series of beds. Nothing is known of the horizons of the Keuper Marl which are present, as the bore-hole programme was concerned mainly with determining the depth of the gravel deposits. It is known, however, that Keuper Marl with the Tutbury Gypsum outcrops at Radcliffe-upon-Soar, to the east of the motorway, and also at Chellaston to the west, so that the Keuper Marl here (immediately north of the Kegworth fault) and mid-way between the localities may also be at about the same stratigraphical level.

Beyond the Kegworth fault are the lowest horizons of the Keuper Marl and to the south again the sequence of Keuper Marls is ascended up to the skerry at Long Whatton. From there to the Hathern - Shepshed road, the horizons overlain by the boulder clay can only be surmised; presumable younger horizons. No records of the Tutbury Gypsum are known from this area or from the area south of the Hathern - Shepshed road, but the Keuper Marl here may well be of this age.

The motorway north of the River Trent

The motorway crosses the River Trent in a broad curve at Sawley, the first cutting being excavated at Wilsthorpe Lodge (SK. 471351). The Keuper Marls were exposed in the cliff below the Lodge and consisted mainly of red siltstones and mudstones with occasional laminated beds. A feature of this section was the faulting which affected the rocks. In the 100 yards long cutting there were four small faults, but without the assistance of marker beds it is difficult to estimate their throws. The marl dips at 3 or 4 degrees to the south, so that older beds are encountered to the north. At the A. 52 By-Pass bridge (SK. 471356), the mudstones were affected by small scale puckering, minor folding and further dislocations. Continuing northwards, the dip of the beds increases to a maximum just south of the old A. 52 bridge (SK. 472361). The amount of dip here was 12 degrees to the south-west.

The structure described indicates movements in beds which are famous for their low dips and absence of faulting. Unfortunately the absence of marker horizons makes it difficult to estimate the combined effect of the structures. The absence of skerry beds in this section suggests that the overall effect is to cause repetition of the sequence.

The first series of skerry beds occurs at road level, at the base of the cutting just north of the bridge carrying the old A. 52. The rise of these beds to the top of the cutting is accelerated by a number of small faults. Having attained the ground surface level, the skerries form the surface to a small east - west valley, utilised by the Stanton road (SK. 472369). The only sedimentary structures found in these beds were miniature ripple marks. Minor faulting occurred throughout this section and as the next beds seen north of the Stanton road are close to the Waterstones, it is possible that a small fault, downthrown to the south by about 20 feet occurs to the south side of the valley.

Below the skerry beds, large nodules of hard marl contained veins of fibrous gypsum. This was the only occurrence of gypsum of this type in the motorway section.

Mention can now be made of the stratigraphical position of the Keuper Marl north of the River Trent. The lowest beds are at the Stanton road bridge and the youngest at Wilsthorpe Lodge, with a series of skerry beds dividing the sequence into two parts. This skerry outcrops to the west of the Erewash valley, where it created water problems during the construction of the A. 52 By-Pass road. The skerry would seem to have a similar stratigraphical position to that exposed in the Chilwell Brickworks (Taylor, 1964 p. 26) and to that exposed to the south of Kegworth, although the marls below the Sandiacre Skerry may be a little thinner.

The abutments for the Stanton road bridge were excavated in laminated marls and siltstones. At road level the siltstones are micaceous and a little to the north there appear the first yellow, fine grained micaceous sandstones. This is the Keuper Marl/Waterstones junction. The main mass of Waterstones, about 35 feet thick, appear as the road begins to turn to the east and were well exposed in the cutting, eventually reaching the ground surface level on the west side of the motorway overlooking the Golf Course (SK. 478382). Diligent search failed to locate fossils but some of the thicker beds contained well-formed calcite and gypsum crystals in small voids within the sandstone. No conglomerate occurs at the base of the Waterstones.

The lowest beds of the Waterstones overlies a thick (3 feet) bed of coarse yellow friable sandstone. Lower beds consist of thin dark red marls and similar sandstones alternating for about 15 feet. These appear to be the local representatives of the Keuper Basement Beds. The road now trends to the north-east and the lowest Triassic beds seen on its line are the Pebble Beds, which can be seen exposed at The Cloud (SK. 477377) on the east side of the motorway. The first layer of large pebbles was taken to be the junction of the Keuper Basement Beds with the Pebble Beds. The Pebble Beds at The Cloud have abnormally high dips, 35 degrees to the south; only the upper beds are exposed, forming a cliff-like feature overlooking the Erewash Golf Course and the Erewash Valley. The dip of the beds and a feature indicate the location of a large east-west fault which separates the Pebble Beds from Upper Carboniferous strata, to the north. The fault was not exposed by the road works, as an embankment commences at about the point where the fault would have been expected.

The motorway now turns towards Stanton Gate (SK. 480381) and the River Erewash. An old quarry, situated on the Erewash Golf Course (SK. 472378), probably marks the outcrop of the Crawshaw Sandstone and bore-holes have located the principal marker horizons of the Lower Coal Measures in the Golf Course area, including the Alton Marine Band and the Kilburn Coal.

The motorway north of the River Erewash

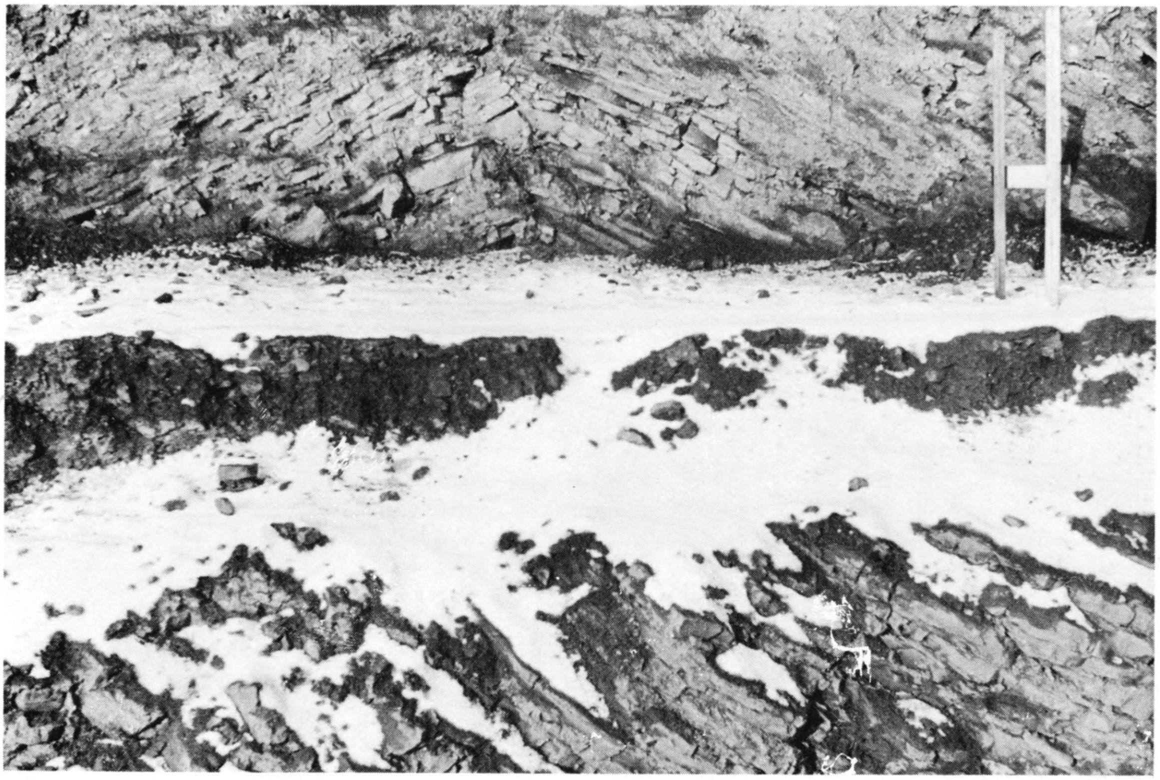
The River Erewash flood plain is much less extensive than that of the River Trent. Even so, it obscures outcrops for almost a mile. The next series of cuttings are at Trowell (SK. 487393) where the motorway has been driven below the B. 6003 and the adjoining railway line. The cutting exposed two thick coal seams, separated by only 10 feet of mudstones. Both these coals were of good quality; they were encountered along the length of the motorway as far north as the road bridge. Above the coals were a thick series of mudstones which graded up into sandstones. These rocks form the feature to the east of the motorway, overlooking the Erewash Valley. The excavations under the road show that a small fault occurs downthrowing to the north, and a third thick coal outcrops just beyond the railway bridge. This coal, about 5 feet 6 inches, is of very poor quality and is almost certainly the Black Shale Coal. The other coals are lower in the sequence and will probably be the Ashgate Coal with the Mickley Coal below.

The motorway now climbs to ground surface level and crosses over the A. 609 (SK. 489400). In the road cutting of the A. 609 are outcrops of the next important sandstone horizon, the Tupton Rock. The coals associated with this sandstone are below road level. The motorway now enters extensive open-cast coal sites, with much of the ground, forming the route of the motorway, 'backfilled' after the coal has been removed. The Clay Cross Marine Band was seen at the south-east end of Shortwood (SK. 495410; Motorway Services site) (personal communication from Mr. J.A. Smart of the Geological Survey) and the Catstone Hill opencast sites have excavated the Ell Coals, Waterloo Coals, Dunsil Coal and the Top Hard Coals (an ascending sequence).

Throughout this much excavated ground only small isolated areas of rock remain 'in situ' One of these was protected by a bridle path (SK. 453423) near Strelley and when the motorway went through this area, the Top Hard Coal was exposed for a distance of about 75 yards, dipping at 10 degrees to the north east. It was about 5 feet thick, with an excellent seat earth below. At a later stage in excavation, two lower coal seams were uncovered just to the north of the bridle path, the original opencast site having removed only the Top Hard Coal. These two lower seams, 3 feet 6 inches and 2 feet 9 inches respectively, would probably be the Dunsil Coal and the 1st or Upper Waterloo Coal: they are good bituminous coals. The excavation of these two seams and the 'backfilling' of the site took place so quickly that detailed measurements could not be made by the author.

The Permian Unconformity

Because of previous opencast activity and the rising base of the road over 'backfilled'



A small symmetrical fold in Lower Magnesian Limestone at the eastern end of the subway under the A.610 roundabout, eastern end of the Nuthall By-pass. (March 1965)

ground, the exact position of the Permian unconformity along the motorway could not be located accurately. Only the beds above the base of the Lower Magnesian Limestone were seen. These consisted mainly of thin, red dolomitic siltstones and sandstones; the dolomite occurs in the rock, as shown in thin sections, as a cement and as individual crystals but the bulk of the rock is of silica. Thin seams of dolomite, with large crystals, were readily distinguished by the buff colour of the rock.

The base of the Permian rocks was exposed in the adjoining Catstone Hill opencast site and has been described by Taylor (1965, p. 185). Further excavation in this area have revealed the very thin (one foot) development of Middle Permian Marl at the top of the Lower Magnesian Limestone, which at Catstone Hill is a sandy dolomite with numerous seams of breccia. Also close to the motorway is the old Strelley quarry (SK. 456423) which is composed of beds of sandy dolomite and occasional seams of breccia. The sequence here (and at Catstone Hill) is only 10 to 15 feet thick. It was therefore rather surprising to find on the motorway site the very hard dolomitic sandstones, which thickened gradually to the north making a third facies variation within a relatively short area.

The highest rocks exposed on this section of the motorway occurred in the cutting north of the bridle path bridge (SK. 435427). The top of the dolomitic sandstones is overlain by about 10 feet (to the top of the cutting) of dark red and green marls. Thin seams of coarse crystalline dolomite and thin dolomitic siltstones occur irregularly.

The road now begins a gradual descent to the A. 610 at Nuthall; the next series of excavations were noted at the interchange island and along the eastern section of the Nuthall By-Pass, at present the link road between the A. 610 and the motorway.

The eastern section of the Nuthall By-Pass

The excavations along the Nuthall By-Pass exposed a nearly complete Permian sequence typical of the area. It compares very closely with the Kimberley sequence (Gibson et al., 1913; Taylor, 1965, pp. 183-4). Rocks exposed were:

Lower Magnesian Limestone		15 feet
Dolomitic Siltstones		15 feet
Basal Breccia	up to	2 feet
- unconformity -		
Middle Coal Measures		

The breccia was exposed at the eastern end of the dual carriage way, as it approaches the A. 610 junction (SK. 520439). It is lithologically identical to that seen at Kimberley. Eastwards, the easterly dip and minor faulting takes the breccia underneath the A. 610 roundabout. Westwards there is a larger fault, the Cinderhill Fault, downthrown to the west, which brings the Lower Magnesian Limestone down to the floor of the cutting again. In the vicinity of this fault, particularly on the south side of the cutting, excellent exposures of the Permian/Middle Coal Measures unconformity were seen; the coloured Coal Measures mudstones and siltstones were exposed for a maximum depth of 15 feet.

Above the breccia, the well-bedded grey dolomitic siltstones contain abundant mica and plant remains. Presumably the grey colour will eventually change to buff tones by oxidation of the iron oxides, as at Kimberley.

The top of the sequence is made up of the Lower Magnesian Limestone, a coarse - medium grained dolomite, typical of much of the area of Southern Nottinghamshire, e.g. at Bulwell and Linby.

Because of the faulting and local variations of dip, this rock occurs at the A. 610 traffic island and along the whole length of the cutting west of the large fault, to the interchange junction where it was examined in the footings for the bridges. In this area the dolomite contains more quartz than further east.

A final point of interest concerns the Lower Magnesian Limestone at the A. 610 island. The rocks are involved in a number of small but intense folds with wavelengths of only about 25 yards, dips in the limbs of the folds being over 30 degrees (Plate 14).

It would appear, then, that the Lower Magnesian Limestone and Dolomitic Siltstones of the Kimberley - Nuthall area change southwards into the dolomitic sandstones exposed in the Strelley section of the motorway.

Conclusions

The excavations along this nineteen mile stretch of the M. 1. motorway illustrate the geology of the area in much the same way as a geological section illustrates the geology of a map. On this occasion the excavations have added considerable detail to the outline geological maps which existed previously.

The absence of Keuper Marls, with commercial quantities of gypsum, west of the Soar Valley suggests that the overlap of the Trias deposits on the Pre-Cambrian rocks of Charnwood Forest occurs at stratigraphical level just below the Tutbury Gypsum, although only further investigation can confirm this, since the beds may occur beneath the chalky boulder clay deposit or below the weathered marl zone south of the Shepshed - Hathern road.

North of the River Trent, additional details have been made available on the stratigraphy and structure of the Keuper Marl. The Keuper Basement Beds are now known as far west as Sandiacre, differing from those of the Nottingham area mainly in the thicker and coarser friable sandstone beds.

In the area underlain by Coal Measures, opencast excavation and prospecting has been mainly responsible for the detailed knowledge now available for this area, but the discovery of three coal seams at Trowell can be attributed to motorway construction.

At Strelley, the motorway exposed yet another facies of the Lower Magnesian Limestone and confirms the wide lateral extent of the Middle Permian Marls.

Finally at Nuthall, excavations provided briefly, a sequence of Permian strata comparable to that at Kimberley but complicated by the presence of faults and minor folds both of which are associated with the Cinderhill Fault, a structure affecting the underlying Coal Measures to a much greater extent.

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GEOLOGY AND THE BRITISH ASSOCIATION

by

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Summary

The Geology Section of the British Association for the Advancement of Science is at a critical stage in its development. The content and style of the annual meeting programmes require re-appraisal, so as to attract younger academics and research workers, without losing sight of the unique function of the Association in presenting comprehensible science to an educated lay public.

Introduction

In the late summer of 1966 the British Association for the Advancement of Science meets for the third time in Nottingham, the earlier occasions being in 1893 and 1937. The President of the Association for its 128th Annual Meeting is Sir Joseph Hutchinson, an eminent agriculturalist, but in the past this great honour has been bestowed on several distinguished geologists, including William Buckland (1832), Adam Sedgwick (1833), Archibald Geikie (1892), T. G. Bonney (1910), W. W. Watts (1935) and Sir Raymond Priestley (1956).

In the words of David Brewster prior to the first meeting at York in 1831, "The principal object of the Society .....(is) to make the cultivators of science acquainted with each other....and to bring the objects of science more before the public eye, and to take measures for advancing its interests and accelerating its progress". Although these principles have not been strictly adhered to, it says much for the organising forces within the Association that attendances at the annual summer meetings in recent years have been maintained at the 3,000-5,000 mark. This compares very favourably with the attendance of 2,000 at Nottingham in 1937. It is a remarkable post-war achievement and constant rebuff to a large proportion of the university world, which regards the Association as being somewhat redundant in these days of ultra-specialist groups and societies. Opinions of this calibre are easy to diagnose and basically reflect a lack of interest in the well-being and public image of science and scientists. The public have no right to be made privy to any new and exciting information regarding scientific progress, or so the argument seems to go. It is hardly surprising, therefore, that the image and professional status of certain subjects, more especially geology, continue at a low level in Britain, much lower in fact than in the earliest days of the Association.

Fortunately, the incomprehensible attitude of many people towards public relations is compensated for by the unstinting efforts of the officers of the Association, who invariably arrange a varied intellectual menu at each annual meeting. Not only do the officers of the 15 Sections try to appeal to specialist interests, but they also attempt to create programmes of interest to specialists and educated laymen of other disciplines. For instance, it would not be extraordinary for an Education Section audience to be composed predominantly of non-Education specialists. In fact, one of the fascinations of the annual meeting is the opportunity it offers to hear and meet people of other persuasions. This is accomplished in part in the lecture theatre, in part on a wide range of specialised and general excursions, and in part at numerous evening social functions.

The Geology Section

At the first British Association meeting the Geology Section (Section C) was combined with Geography and included among its committee members Buckland, Hutton, Murchison, Sedgwick and William Smith. In 1839 the Section name was altered to Geology and Physical Geography and in 1851 Geography became independent as Section E. Initially Mineralogy was a separate Section but it merged with Chemistry (Section B) in 1834.

It is interesting to look back on some of the great controversial issues of 1831. Lyell, for instance, was pouring scorn on the "extraordinary notion .....(of) Von Buch, who imagines that the whole of the land along the northern and western shores of the Baltic is slowly and insensibly rising!". This was hardly as forceful as Sedgwick on Lyell, however, who declared that "warped by his hypothesis (uniformitarianism) ..... in the language of an advocate, he sometimes forgets the character of an historian". Simultaneously, Taylor was rejecting the formation of vein ore-deposits by igneous injection and advocating a sublimation origin. The fixity and special creation of species was a widely held concept and there was considerable argument about the igneous origin of granite. Some petrologists even had the temerity to suggest that granites had a metamorphic origin!

The Geology Section is, or should be, a microcosm of the British Association as a whole in presenting new information to the public. The lethargy of certain academics is a serious handicap and makes the task more difficult than it should be but, by and large, the primary objective is achieved. In practice two complementary approaches are adopted at each annual meeting. First there are the morning sessions, given over to lectures on recent or near-recent research; and second there are field excursions, afternoon on weekdays and whole-day Saturday and Sunday, designed to demonstrate as far as possible new findings in the vicinity of the meeting centre. At Nottingham in 1966 a relatively wide range of field excursions is possible without excessive coach travel, whereas at Cambridge in 1965 this was not feasible because of the lack of variety and lack of suitable exposures in the immediate neighbourhood.

The ultimate responsibility for arranging topics and speakers at each meeting rests squarely on the shoulders of the Recorder of the Section, a position currently held by Professor F. Hodson. He in turn receives suggestions and advice from the Sectional Committee which is composed of two Secretaries and an annually elected series of senior and junior members drawn mainly from academic, civil service and commercial backgrounds. All ex-Presidents are ex-officio members.

The Recorder's role, though somewhat analagous to that of a General Secretary of a learned society, should be more than that of carrying out the wishes of successive Committees. Because the Committee membership is ephemeral, it devolves on him to initiate constructive policies designed to maintain and improve the well-being of the Section. Under certain circumstances, such as rapidly declining attendance at Sectional proceedings, he must be prepared to move away from traditional approaches in the presentation of subject matter to the public and other scientists. In this respect and for other obvious reasons, it is desirable that the Recordership of a Section should be in the hands of a person senior in status, though not necessarily in years.

Current Problems of the Geology Section

Perhaps the greatest problem currently facing the Recorder and Committee is the declining interest in the Sectional Activities by younger people of pre-graduate and immediate post-graduate vintage. Less than 10 years ago, 20 to 30 people of this age group could be anticipated at the annual meeting, but nowadays if the number exceeds single figures it is unusual. The fault to a certain degree rests with the counter attraction afforded by the blossoming of specialist groups, which naturally siphon off many who might otherwise have attended; but it is also partly financial. Pursuing the former aspect a little further, the impression gained is that many post-graduate students were once satisfied to call themselves geologists and less prone to take a blinkered view of the subject as a whole. In contrast, most, these days would prefer to be called sedimentologists and such-like and to maintain ever-narrowing interests in ever-deepening ruts.

The fact that research students quickly adhere to specialist groups, each holding short meetings in the year, brings us to the second point, that lack of finance may give the British Association meeting a low priority. There is no doubt that the costs of attendance to the non-subsidized people, whether they be undergraduates, post-graduates or otherwise engaged, are becoming prohibitive. The Cambridge costs were of the order of £2 - £3 per day. To warrant this personal expenditure at any time would require a very attractive programme indeed to be laid on, not just by one Section but by many. In these days of value for money, the British Association meetings are not always considered the best buy.

The problems of non-attendance are considerable and complex, with no facile solution immediately obvious. Most Universities, Colleges and Local Education Authorities are willing to subsidize young people to a limited extent, but the subsidies are often consequent on an invitation to read a paper before a given Section. In addition, some University and College students receive bursary or special maintenance awards, but these are numerically restricted and, in practice, intellectually restricted. Perhaps if there were to be some marked increase in the number and variety of awards to people below 30 years in age, these being dependent solely on the wish of the applicant to attend, it might lead to improved attendance.

The wish to attend British Association annual summer meetings, financial considerations apart, may never mature into actuality if the programme put on by a Section or Sections is unattractive, The responsibility for this depends on the Sectional Committees, aided by Local Secretaries who arrange field excursions. As far as morning lectures go, experience shows that very specialized sessions are rarely successful. At Manchester a few years ago, the attendance at an ultra-specialised session reached an all time low of less than 5 members. In some ways it might be justifiably said that sessions of this type get the audience they deserve. Recent advances in certain by-ways of a subject are bound to be high-powered, but is the British Association meeting the right place for their airing? It is difficult to see how they can possibly appeal to the educated layman, undergraduates, school teachers or specialists in other fields.

There is also the point that the more specialised a topic is, the less likely is it that the lecturer will be able, or even prepared, to simplify so that it becomes generally comprehensible. Even brilliant expositors, admittedly rare birds, occasionally fall into the trap of incomprehensibility. However, it is doubtful if brilliant speaking as such concerns many people. All they require, or should require, is that the subject matter of a 20 to 30 minute address should be presented competently, that it should be spoken with clarity and that the facts and hypotheses should be presented logically. It is remarkable how a whole morning session can be clouded by lack of primary competence on the part of one or two speakers.

Geology is a subject in which illustration by lantern slides is feasible and indeed desirable. Unfortunately, not all speakers seem to be aware of the failings of their slides in quality, comprehensibility or aptness. There is a regrettable tendency, occasionally a function of inexperience, to illustrate a lecture with too many slides so that insufficient time is given to absorb the content of each one. More reprehensible, however, is the overloading of illustrations with excessive data.

The selection of speakers for the annual meeting is the responsibility of the Section Committee in theory but again, in practice, rests on the shoulders of the Recorder who works in the context of topics suggested at the preceding annual meeting. If he is very fortunate, the broad framework of themes and speakers is established by early November of the year preceeding the meeting. Theoretically it is at this stage that some positive attempt should be made to attract at least a certain number of speakers of known expository proficiency. However, more often than not the lecture programme is not completely established before January, or even later, and the availability of desirable speakers becomes much more unlikely. In particular, the more active younger research workers, who are an important reservoir of speaking talent, have probably completed arrangements for field work by this late date. As more of this age group are engaged in work abroad than a decade or so ago, the time is approaching when Section planning should involve looking ahead not just to the immediate forthcoming meeting but to the meeting one year ahead.

It has to be realised, of course, that some invited speakers may be deterred from lecturing by the possibility of non-publication of their paper in the "Advancement of Science". The journal is now published monthly, as compared with a bi-monthly production a year or so ago, and this theoretically enhances the chance of a paper being published. However, as is usually the case, the quality and interest of the paper is all important and a positive recommendation has to be made to the editorial board of the journal by the Section C Committee. Summary papers (as discussed in the following paragraphs) would be particularly appropriate for publication.

Summary Lectures

Perhaps the most important lecture given during all Sectional transactions is the Presidential Address, to be given this year by Professor L.R. Moore, in which the usual approach is to summarize recent findings in the particular field of interest of the current President. (In 1937 the Presidential Address of Professor L.J. Wills was on "The Pleistocene History of the West Midlands".) These addresses are invariably well attended, not only because of the eminence of the President but also because of the summary nature of the paper being presented. In the latter context it is worth mentioning that, prior to 1965, it was customary for the local geology to be described in the opening session of the annual meeting and this summary also was usually well attended.

Is it presumptuous to suggest that summary-type papers are more attractive than ultra-specialized papers and likely to draw larger audiences? Surely the answer is no. Neither can it be assumed that more lectures of this kind would drive away, rather than encourage, younger academics, research students and undergraduates. Rudolf Richter discussing "Problems of sedimentation and the advantages of a Marine Geological Laboratory" at the 1937 Nottingham meeting must have closely approached the style of lecture envisaged here. If someone could be prevailed upon to summarize recent work on sole structures and turbidites, goniatite palaeoecology, or acid-basic intrusives relationships, then there would be a certain degree of attraction for the partially fledged professionals where now there is virtually none. If one, preferably two, summary addresses (excluding the Presidential) could be arranged each year, and time allotted so that each lasted 45 minutes followed by a 15 minute discussion, then several current criticisms might be eliminated. 45 minutes should allow a competent speaker adequate time to cover his subject and avoid excessive compression; the 15 minutes discussion period would not only widen the scope of the lecture, but should also prove interesting to the lay members of the audience who, television apart, rarely have the opportunity of hearing and seeing scientists in active debate. As far as prospective speakers are concerned, there ought to be no lack, providing they can be invited in adequate time. In the planning of these lectures it has to be recognized that the ability to summarize recent work in a particular field is not necessarily the prerogative of senior members of the profession.

Committees

Before concluding this general review of geology and Section C, reference should be made to two associated committees. One, composed of very senior members of the British geological scene, controls a research fund and periodically allots sums of money for work in any of the fields of geology. This used to be called the Critical Sections Committee and in 1937 was under the Chairmanship of Professor W. T. Gordon. The present Chairman is Professor L. R. Moore. The other, composed of university, museum and schools representatives, deals with matters concerning the teaching of geology in schools and usually confers during the annual meeting. The present Chairman is Professor T. N. George; in 1937 the Chairman was Professor W. W. Watts and the Secretary, Professor A. E. Trueman. Despite a slight under-representation of school teachers, the "Schools Committee" could be a very significant positive force in the current expansion of geology in schools. The time is rapidly approaching when this committee should not merely be a collator of information but also a disseminator of positive practical guidance to teachers and potential teachers on all aspects of the subject. To some extent Professor T. N. George has already given a lead in producing recently a comprehensive account and discussion on teaching methodology and course content in the Association Journal "The Advancement of Science" But consideration now needs to be given to items, such as handbooks and pamphlets on all aspects of geology teaching, including suitable field work. Anyone with knowledge of the rising tide of schools geology must be aware of the public relations problem that field work is, and will increasingly be, creating.

It is, perhaps, a commentary on the increase in specialist societies and groups that the number of committees linked to Section C has diminished. Now there are two, whereas at the time of the last visit to Nottingham there were eight in being, including one investigating the reptile-bearing oolite of Stow-on-the-Wold (Sir A. Smith Woodward as Chairman), another reporting on erosion of the Norfolk coast (Professor P. G. H. Boswell as Chairman), and another dealing with petrographic classification (W. Campbell-Smith as Chairman).

Conclusions

It is fitting to end this purely personal view of the problems of the presentation of geology in the British Association with some paraphrased words of a recent President of Section C. He was told more than 40 years ago that the Association was a dying useless thing; however, time had shown that the comment was not only ill-considered but also a grossly inaccurate prognostication of the future. The Association and its numerous Sections have continued to be living organisms since 1831 and will certainly continue to outlive their pungent critics. However, while destructive criticism can be safely ignored, it is necessary that Sectional Committees and Officers should be willing to hear and consider constructive criticism and ideas, so as to ensure virility of the Sections in their unique function.

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THE OCCURRENCE OF AN INSECT WING AND BRANCHIOPODS (EUESTHERIA) IN THE LOWER KEUPER MARL AT STYAL, CHESHIRE

by

David Barnard Thompson

Summary

These fossils occur in dolomitic, illitic, silty shales deposited in the upper parts of thin, generally fining-upwards cyclothems. The occurrence of the broken wing in tranquil flow evaporitic sediments is consonant with its transportation and settling from floodwaters which have entered a shallow lake or lagoon. There is some evidence that the branchiopods may have lived in the basin and undergone little transportation.

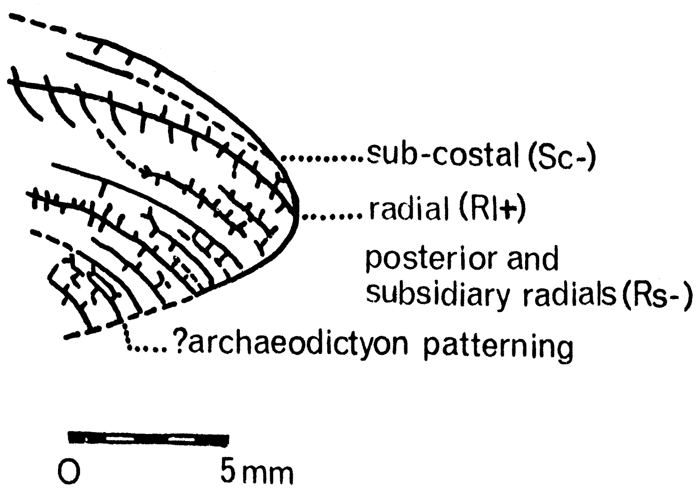
Introduction

A part of an insect wing was found by two members of a North Manchester Grammar School field excursion party (T. L. Jones and J. R. Chatten). The wing lies in the upper part of a thin sub-cycle of sedimentation 11.5 cm. thick. The branchiopods were found by G. W. Martin in the upper part of the next sub-cycle which is generally taken as the base of a larger cycle of sedimentation, probably some 12 metres thick, and known as the Giant's Castle Skerry belt.

These strata outcrop at Giant's Castle Rocks, immediately to the north west of the suspension bridge on the north side of the River Bollin, Styal, North Cheshire, (grid reference SJ 82778348). The section has not been described previously, though a very general account of the Lower Keuper Marl of this area is to be found in Taylor et al. (1963, p.72 - 77).

The specimens are now housed in the Manchester University Museum.

A greatly abbreviated description of the strata is presented here. It is intended to describe and interpret the sediments of these and other similar cycles in the future. Details of the flow regimes mentioned can be found in Elliott(1965 in press).



Text-Fig. 1. The insect wing, showing structure.

The upper sub-cycle, 36 cm. thick, has at its base 24 cm. of ripple-statified green dolomitic sandstones and dolostones, which in one place occupy an erosion channel. The strata are repeatedly affected by penecontemperaneous deformation structures which include open slumping, ball and pillow structures, load and flame casting, crinkle marks, a sand volcano, and salt pseudomorphs. These strata gradually pass upwards into light green silty dolomitic, illitic, micaceous shales which are repeatedly interbedded with dark green, highly illitic, laminated claystones. These upper strata contain salt pseudomorphs and crinkle marks. The Euestherias lie in the upper part of a bed of light green, very finely laminated, micaceous silty shale, some 6 mm. thick, which bears large halite pseudomorphs (1.75 cm. across) on its base, and crinkle marks in the laminae which contain the fossils.

The lower cycle, averaging 11.5 cm., has similar dolomitic sandstones up to 8 cm. thick at its base, but contains both flat laminations as well as cross-lamination, clay galls, an erosion channel, and an undersurface which bears groove casts, prod casts, and salt cube wrench-out marks. The inter-bedded laminated siltstones, silty shales and claystones which follow are similar to those described above, and bear similar structures, together with mudcracks. The insect wing was found in the less fissile, silty, micaceous shales at the base of these upper beds. Further small fragments of dark organic matter are found scattered in the laminated strata above.

The insect wing

(1) Mode of Preservation: Preservation is either by carbonisation or in original chitin, such that the major and minor veins stand out well on one or other of the two fragments.

(2) Description: The main specimen is 8 mm. x 9.5 mm., and represents the apical portion of an insect wing. The analysis of its veins is uncertain, but fig. 1 and plate 15 show the probable arrangement.

There is present a length of the sub-costal and main radial veins, and many subsidiary, posterior-radial branching veins, three of the eight sets of nerves typical of these primitive wings. There are many cross-veins, but no sign of archaeodictyon patterning, except possibly in the most posterior area of the subsidiary radials. Part of the skin of the intravenous areas is present, and bears tiny spinules which are readily seen under high magnification (plate 15). A counterpart of part of the block which bears the largest fragment is available, but its impression covers a smaller area, and reveals little that is not present in the main specimen. It is important in one respect, for it shows the Sc(-) for almost the whole of its length (fig. 1) and it is clear that it will not terminate against the R1 (+).

(3) Diagnosis: Photographs of the specimens were submitted to Dr. Laurentiaux, of the University of Paris, who noted that the absence of part of the anterior border and the vein pattern nearer to the body, did not allow accurate identification. He reports: "Etant donné l'allure plutot triadique et lache de l'archaeodictyon intercalaire et les trop rares traces nervuraires visibles, il pourrait s'agir d'une extrémité d'aile d'Euplecoptera (May-Fly), mais ce n'est qu une très vague presomption. Je ne vois en l'état de l'échantillon aucun autre indice de détermination au plus pourrait on penser à une extrémité également de Calvertiellidae, mais tout cela reste bien incertain".

These alternatives are classified as follows: (Piveteau 1953, p. 415 - 424, 426 - 430; Brues et al. 1954, p. 784 - 786, 802):-

1. Super-order EPHEMEROPTERA: Laurentiaux 1953. Primitive group; Carboniferous to present.
   Order Plecoptera: Packard 1886 (emend. Tillyard 1932)
   Permian to present.
   Sub-order Euplecoptera: Tillyard 1932. Permian to present.

2. Super-order PALAEODICTYOPTERA: Goldenburg 1854. Carboniferous to Permian.
Order Protohemiptera: Handlirsch 1908.
Family Calvertiellidae: Martynov 1932. (Range of family not given but one genus present in Permian of Kansas.)

Brues et al. (1954, p. 786) indicate that one vital feature of this latter family is that the Sc(-) should terminate on the R1(+). Preservation of the present specimen is sufficiently good to discern that this is not so, and for this reason the author believes that this alternative is unlikely. If it were so, it would extend the range of the super-order and the family into the Trias. In view of this, the first alternative is favoured as the most likely possibility.

The Branchiopods

The specimens of Euestheria comprise a group of 19 individual half carapaces. None are fragmentary: most are weakly preserved. The carapaces are of oval shape, but a considerable variation of shell shape exists, between one specimen which is elongate-oval and others which are sub-discoidal. The largest is 3 mm. x 2 mm., the smallest 1.75 x 1 mm. (see fig. 2). The hinge is not always clearly preserved, but where it is the ventral margins are both symmetric and asymmetric with respect to it and always evenly rounded. The umbo is displaced towards the anterior, with most of the variation of length and shape occurring posterior to it; in a few cases it is sub-central. Growth striae are generally faint, but a fairly wide spacing of 6 per mm. can be discerned on the best preserved type. Preservation is too poor to discern any trace of reticulum between the striae.

Despite the poor preservation, the specimens can be referred to Euestheria minuta (Alberti in von Zeiten) var. brodieana (Jones).

The specimens are found lying on top of, within, or slightly across, three laminations which occupy a vertical distance of 1.5 mm. In most cases the half carapaces lie flat, but some are sub-horizontal and affected by the crinkle marks which occur at the base and on the top; one lies across the bedding and tends towards the vertical. In one case the valves are so close to each other and in such a position as to suggest that they had been barely separated; this may be true in the case of the two largest specimens which lie only 2.5 mm. apart, one concave, the other convex upwards. Otherwise the shells are scattered, eleven concave upwards, eight convex upwards, the nearest 1 mm. apart, the furthest 1.2 cm, the average separation being 4.4 mm. Unfortunately the specimens were not orientated with respect to the locality, but they can be related to an arbitrary datum line and the upper and lower crinkle marks, which, with respect to the datum, lie at 010 and 080 degrees respectively. The frequency distribution for the direction of elongation of the shells is bimodal, and the maxima appear to be within 25 degrees of being perpendicular to either one or the other of the crinkle marks. Since the crinkle marks are held to be the result of frictional drag of the prevailing currents upon the hydroplastic sediment below, the length of the carapaces would appear to be orientated sub-parallel to the current.

Discussion

The abbreviated description of lithology, sedimentary structures and cyclical sedimentary organisation given previously is sufficient to demonstrate a general upward diminution of grain size, a fall in the flow regimes from high, through low, to tranquil, and an increase in aridity. Detailed interpretation will be attempted on another occasion, but it is enough to draw attention to the similarity of these descriptions to those of Smith (1910) and Elliott (1961) in the skerry belts of the Keuper Marl of Nottinghamshire. Smith believed these cycles to be due to influx of sediment and floodwater in the wet season followed by gradual dessication throughout a dry season. There is no reason to disagree with this view. A provisional interpretation of environment involves deposition near the margin of lakes, as suggested by Klein (1962) for his type II sedimentary structures in the Keuper Marl.

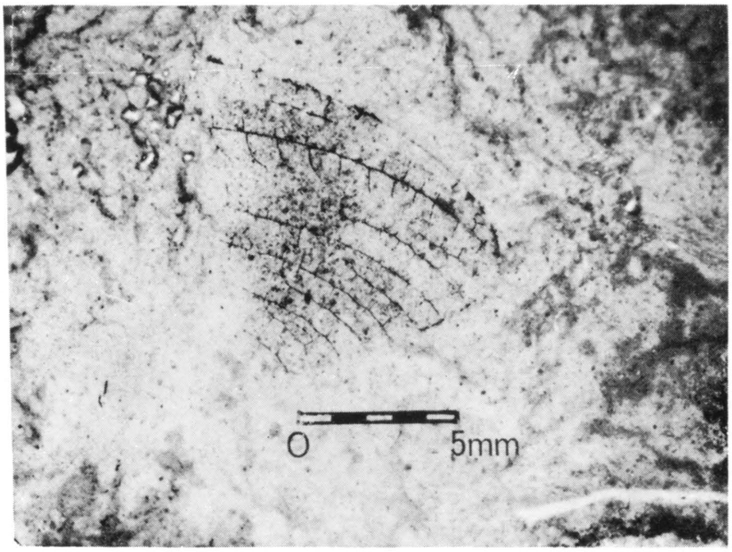
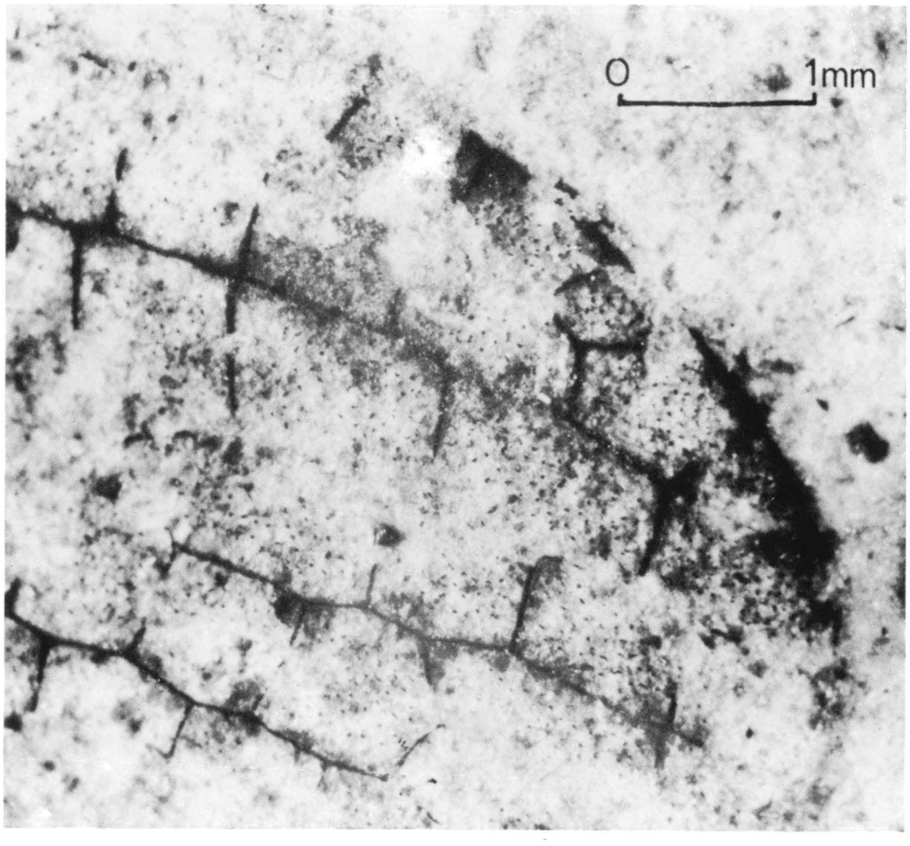


Fig. 1. x 4.75

Apical portion of insect wing at Giants Castle Rocks, Lower Keuper Marls, Styal, Cheshire. For analysis of venation see fig. 1.
The photographs of the wing were taken through a cover glass below which liquid paraffin was in contact with the specimen.

Plate 15
Fig. 2. x 2^4

Detail of the anterior extremity of the wing. Note that there is no sign of the Sc (-) terminating on the R1 (+).



This interpretation of events is not out of keeping with observations of the present day on the transport and settling of insect debris, for example in the neritic zones of the Mediterranean Sea. It is common for chitinous wings of insects to be transported by floodwaters, since they have a great surface area compared with their weight and volume and they easily float. Myriads of wings can be seen floating close inshore after being brought down from the mountainous regions of Lycia, (Wills, 1950, p. 94, quoting Forbes).

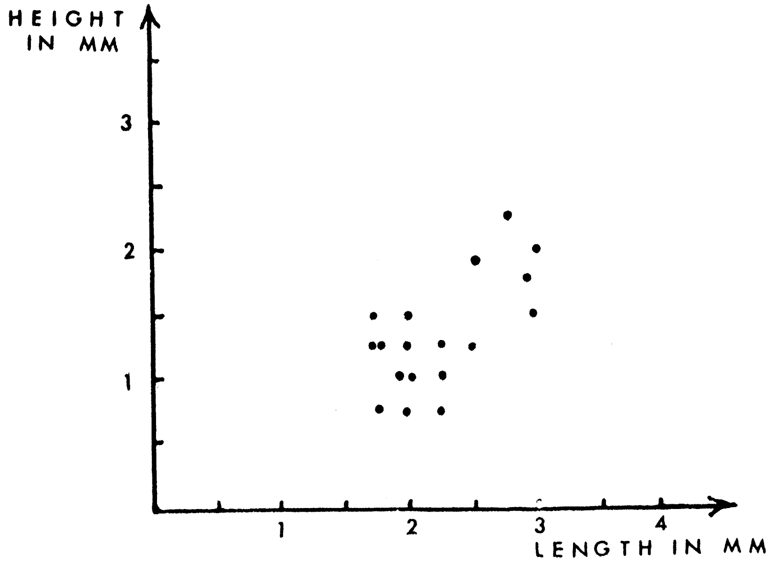
No insect wings have been described from the earlier Triassic of the British Isles, but Harrison (1876, p. 214) mentions the finding of an insect wing in the Tea Green Marl (Upper Keuper) of Nottinghamshire. Horwood (1916, p. 414) commented that the specimen perished in the hand, and that in fact, it was likely to be an Euestheria. Wills, following Richardson and Ramsey (see Wills 1950, p. 93 - 4), notes that the Rhaetic has many fossil insect wings in the Pseudomonotis Bed, and that these belong to types which have cool climate characteristics. They were interpreted as existing in marginal highland parts, for example upland Wales, from which they were presumably washed down by streams.

Kobayashi (1954, p. 54) believed that failing any other guide fossils, Euestheriae might be useful in correlating heterotopic facies in adjacent hydrographic provinces. He suggests that E. minuta was particularly characteristic of the Lettenkohle (lowest Keuper) in Germany and that E. minuta var. brodieana was indicative of the Rhaetic, where it was found prolifically (Lomas 1905, p. 166). Finds by Lomas (1901, p. 77) in the red Keuper Marls of Oxton, Wirral; by Brockbank (1891, p. 12 - 13, 31) and Warrington (1963, p. 318) in the Lower Keuper Sandstone of the Alderley area; north-east Cheshire; by Fowler and Robbie (1961, p. 103) at two marl horizons up to 1000 feet below the top of the Bunter sandstone facies in Northern Ireland, have extended its range considerably. Specimens of Euestheria are common in dolomitic rocks in Germany, often in the Keuper in association with species of the brachiopod Lingula and marine molluscs, and the lowest record of the present mutation seems to be the Lettenkohle (Jones, in Brockbank 1891, p. 31).

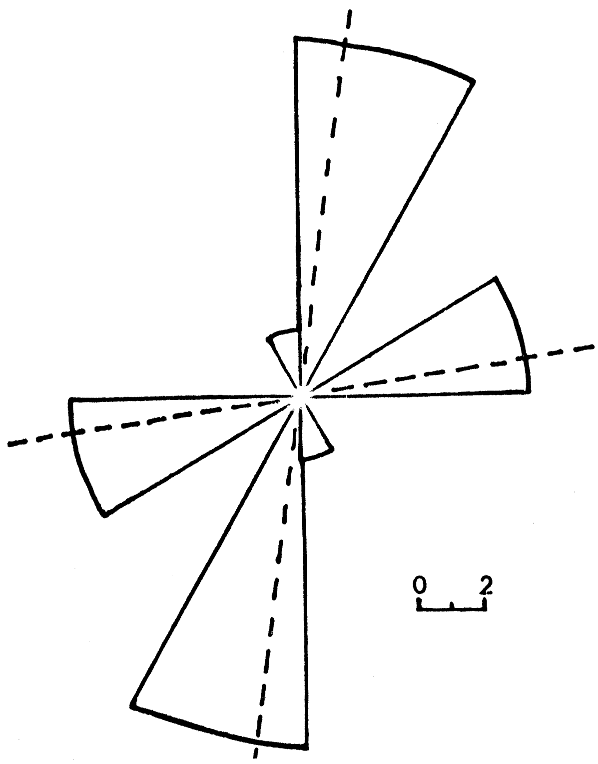
Lomas (1905,p. 166) showed that these animals have a wide distribution in fresh, stagnant or brackish waters, and in saltpans, but never in marine waters: that they endured great extremes of heat or cold, frequently occurring in regions of great dessication. Kobayashi (1954), in a worldwide review, added that dispersal is mostly achieved by transportation of the egg stage (ibid., p. 3) which is sufficiently durable to resist 3 - 5 years dessication. The light, dried, flexible carapaces were observed to be drifted widely by wind and water: small size, as in these specimens, is usually associated with cooler climates (ibid., p. 43) and inland habitats (ibid., p. 38): close development of growth lines with warm or hot environmental conditions (ibid., p. 42). Modern types are both nektonic and mud eaters. Kobayshi suggested that most, if not all, brackish water types are exotic (ibid., p. 50) though some workers infer brackish water habitats for certain Carboniferous types (see Weller in Ladd (ed.). 1957, p. 333). This was also the view of some German workers who found Triassic specimens of Euestheria with clear brackish water associates (see for example Buerlen, 1931).

In the present case, the two examples of barely disarticulated valves suggest that the animals were living a short time before they were interred; the preferred orientation of the valves and the scattered nature of the majority suggest that they were subject to the influence of currents, albeit weak and barely able to move sediment on the bottom; the pseudomorphs testify to considerable dessication. All these facts promote the view that the branchiopods may have lived locally, enjoyed fairly fresh water at first, had tolerated increasingly brackish conditions (which perhaps had stunted their growth) before succumbing to the high salinity of the evaporite phase. The corpses were, perhaps, carried a little distance before settling with the rest of the micaceous, illitic, suspended load which had probably travelled from much further afield.

The presence of fresh mica, abundant at times, is a characteristic which the Lower Keuper Marls of the north east Cheshire basin shares with the underlying Keuper Sandstone and Waterstone Formations. The author belives that this testifies to weathering in the source region of fresh rock, of a type which is alien



Text-Fig. 2 Relationship of length to height in eighteen Euestherias at Giants Castle Rocks, Styal, Cheshire.



Text-Fig. 3. The orientation of nineteen Euestherias with respect to crinkle marks. The datum line for north is arbitrary.

to upland Wales or the Midlands but could possibly be found in the now buried Mercian Ridge or even further south in Armorica. This view does not preclude the advent of local floodwaters from any local upland, but it does mean that the main waters came from very far afield. Hence the lakes and lagoons, which were mentioned previously, must have lain at the northern end of a more or less unified environmetal complex which extended from North Cheshire through the Midlands to the south or far south of England.

Conclusions

Branchiopods and an insect wing occur at the top of separate cycles of sedimentation.

It is concluded that the broken wing of the possible May-Fly was transported by floodwater and settled out under tranquil conditions on the bottom of a basin. Near the same place at a later time a number of Euestherias lived and were killed off, carried a short distance, and buried.

Acknowledgements

The insect photographs are by kind permission of Professor F.W. Shotton, and were taken by Mr. L. Vaughan. Help with x-ray work was given by D. Grundy and F. Forgeron, of Manchester University. The author wishes to thank Professor L.J. Wills; Mr. A. Brindle, entomologist, Manchester Museum; Dr. J.M. Ankatell for help and advice; and Mr. R.E. Elliott for a critical reading of part of the manuscript. To Dr. Laurentiaux we are all indebted, not only for his attempted identification of the insect wing, but also for the delicacy of his final comment: "....comme dit le proverb français 'la plus belle fille du monde ne peut donner que ce qu'elle a! ' ".

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SEPIOLITE FROM THE MALVERN HILLS

by

Ronald John Firman

Summary

A new discovery of sepiolite is described and the possibility of sepiolite being a common constituent in the Keuper Marl is discussed.

Introduction

Sepiolite is a comparatively rare hydrous magnesium alumino-silicate which has been recorded only three times from this country, namely from Kynance Cove, Cornwall (Caillere and Henin 1949); Mullion, Cornwall (Midgley, 1957); and from an unstated Midland locality in the Keuper Marl (Keeling, 1956). Hitherto the formation of sepiolite has been attributed either to alteration of magnesium rich rocks, such as serpentine, or to sedimentation in basic saline lakes (Millot, 1949). The Cornish sepiolites are examples of the alteration of serpentines and the Keuper Marl exemplifies the sedimentary mode of formation. The recent discovery of sepiolite in a tension vein in the Malvern Hills suggests that there may be a third method of formation of this mineral - by direct crystallation from a hydrothermal liquid.

The Malvern Hills Material

Specimens were first found in dumps in the lowermost Wyche quarries (G.R. SO 771441) by Mr. J.M.A. Pontin and the writer in the summer of 1964. The material consisted of thin sheets, 1-2 mm thick, of a creamy white fibrous mineral, the fibres all being parallel to the wall rock and all orientated in one direction. Each fibre consists of bundles of microscopically thin components, which can be teased out of the bundles in a similar manner to asbestos fibres. Sheets consisting solely of the fibrous mineral can be bent almost double without breaking, like cardboard. Sheets containing calcite tend to be more brittle, but it is clear that fibres wrapping round the calcite have considerable strength. This asbestiform character was confirmed later when trying to grind the material in a pestle and mortar. Although intrinsically soft (hardness 2½ to 3) the fibres have a high tensile strength which makes powdering difficult. Some of the original material is deeper yellow than average and material collected this year from an in situ vein is browner and has a waxier lustre than any of the original material. It is not clear whether these colours are due to superficial staining or inherent changes in composition.

TABLE 1

X-ray powder diffraction data for sepiolites from Malvern and Mullion

Malvern		Mullion (Midgley, 1959)	
d (Å)	I	d (Å)	I
12.07	vvs	12.1	vvs
7.50	m	7.45	w
6.68	w	6.74	w
4.92	vvw	5.02	vw
4.50	vw	4.54	m
4.30	s	4.28	ms
3.75	s	3.74	m
3.50	vw	3.55	vw
3.35	s	3.35	m
3.19	m	3.17	m
2.97	m	3.03	vw
2.81	vvw	2.82	vw
2.685	vw	2.70	vw
2.615	vvw	---------	
2.55	ms	2.57	s
2.44	vvw	2.44	m
2.40	vvw	2.40	vw
2.25	mb	2.26	m
		2.13	vw
2.06	vvw	2.06	w
etc.		etc.	

Identification and Chemistry

Microscopic examination shows that the fibres have straight extinction, low birefringence, positive elongation and refractive indices about 1.522 - 1.528. This information is not sufficient to identify the mineral. That it is a member of the sepiolite group of minerals was confirmed by X-ray analysis. The X-ray powder patterns compare closely with sepiolite from Mullion (Midgley, 1957) (see Table 1) but research into the sepiolite group is not sufficiently advanced to allow the precise chemical composition to be deduced from the optical and X-ray data. Chemical analyses were therefore necessary, but, owing to the fibres being intimately intergrown with calcite, difficulty was experienced in obtaining a pure sample large enough for analysis. Treatment with dilute acetic acid successfully removed all the calcite but there is a risk that the sepiolite might also have been attacked, although X-ray photographs showed no sign of such a change. For this reason two analyses were undertaken, one of the sepiolite after acid treatment and one of the complete vein (i.e. calcite and sepiolite). This latter has been recalculated (Table II) on the assumption that all the calcium is contained in the calcite. The two analyses are so remarkably different, particularly in their Si/Al ratios, that there must be more than one form of sepiolite present and further investigations are now being undertaken.

Whether or not there are two or several forms of sepiolite present, they are markedly different from sepiolites previously described (see Table II and Text-fig. 1). According to the structure proposed by Braumer and Preisinger (1956) and favoured by Caillère and Hénin, the likely formula of a half unit cell of ideal sepiolite is $(Si_{12}) (Mg)_8 O_{30} (OH)_4 (OH_2)_4 8H_2O$. The dehydrated mineral should therefore have the formula $Si_{12} Mg_8 O_{32}$. Recalculation of analyses on the basis of 32 oxygens shows that the Si in the tetrahedral position may be partially replaced by trivalent elements such as Al and Fe^{3+}. Magnesium in the octahedral position may be replaced by Al, Fe^{3+}, Fe^{2+}, Ni or Mn^{2+} (Caillère and Hénin 1961). The Malvern sepiolites are distinguished from all other sepiolites by having a large amount of aluminium in tetrahedral co-ordination (Text-fig. 1). Although they contain less Al_2O_3 than the aluminous sepiolite from South Australia (Rogers, Quirk and Norrish 1956), twice as much is in tetrahedral co-ordination. The asbestiform nature of the Malvern material may well be related to its unusual chemical composition.

Mode of formation

Since the original material was collected from dumps, it was not possible to postulate the mode of formation except that, since it occurred in straight edged veins, it could be hydrothermal. Subsequent investigation led to the discovery of a vein in the wall of the quarry by Mr. A. J. Rundle. This approximately vertical vein has the character of a dilation fissure, its walls being lined with horizontal fibres of sepiolite. Calcite is sandwiched between the sepiolite. Although this certainly looks like a hydrothermal occurrence, it is possible that the sepiolite is replacing an earlier vein filling or that the sepiolite is replacing hornblende of the felspathised hornblendic country rock. The fibres have certainly not grown at right angles to the walls, as one might expect had the mineral been crystallising freely from the liquid, but this could be due to favourable crystallising surfaces, such as minute horizontal slickensides, which encouraged nucleation in this orientation. The variable composition might equally well be due either to successive members of a solid solution series crystallising or to differences in wall rock replacements. Further detailed work will be necessary to solve this problem.

Sepiolite in the Keuper Marl

Sepiolite should be of considerable interest to members of the East Midlands Geological Society not only because of its recent discovery in the Malverns, but because of its possible abundance in the Keuper Marl.

TABLE II

Analyses and structural formulae of sepiolites with tetrahedrally co-ordinated Aluminium

	(1) Malvern acid treated	(2) Malvern partial analysis recalculated	(3) Mullion	(4) Aluminous sepiolite	(5) Little Cottonwood, Utah	(6) Madagascar
$SiO2$	45.20	48.29	50.06	52.43	52.97	52.50
$TiO2$			0.16			
Al_2O_3	5.89	2.94	1.27	7.05	0.86	0.60
Fe_2O_3	0.35	2.29	3.49	2.24	0.70	2.90
FeO	0.11	0.55		2.40		0.70
MgO	21.39	22.20	22.24	15.80	22.50	21.31
CaO	0.70		0.04			0.47
Mn_2O_3			0.06		3.14	
Na_2O	0.81	0.15	0.08			
K_2O	0.01	0.11	0.10			
H_2O+	17.96	23.34	10.40	9.45	9.90	9.21
H_2O-	6.60		12.02	10.48	8.80	12.06
	99.01		99.92	99.71 incl. 0.58 NH_3	99.74 incl. 0.87 CuO	99.75

(1) Sepiolite Malvern (this paper). Acid treated.

$(Si_{10.71}Al_{1.29})\ (Al_{0.35}Fe^{3+}_{0.06}\ Fe^{2+}_{0.01}Mg_{7.61})\ O_{32}Ca_{0.18}Na_{0.37}$

(2) Sepiolite Malvern (this paper). Complete vein recalculated.

$(Si_{11.02}Al_{0.78}Fe^{3+}_{0.20})\ (Fe^{3+}_{0.20}Fe^{3+}_{0.11}Mg_{7.62})\ O_{32}K_{0.06}Na_{0.06}$

(3) Sepiolite, Mullion (Midgley 1957)

$(Si_{11.24}Al_{0.33}Fe^{3+}_{0.43})\ (Fe^{3+}_{0.18}Mg_{7.62})\ O_{32}Ca_{0.01}K_{0.02}Na_{0.06}$

(4) Aluminium sepiolite, Tintara, South Australia (Rogers, Quirk and Norrish, 1956)

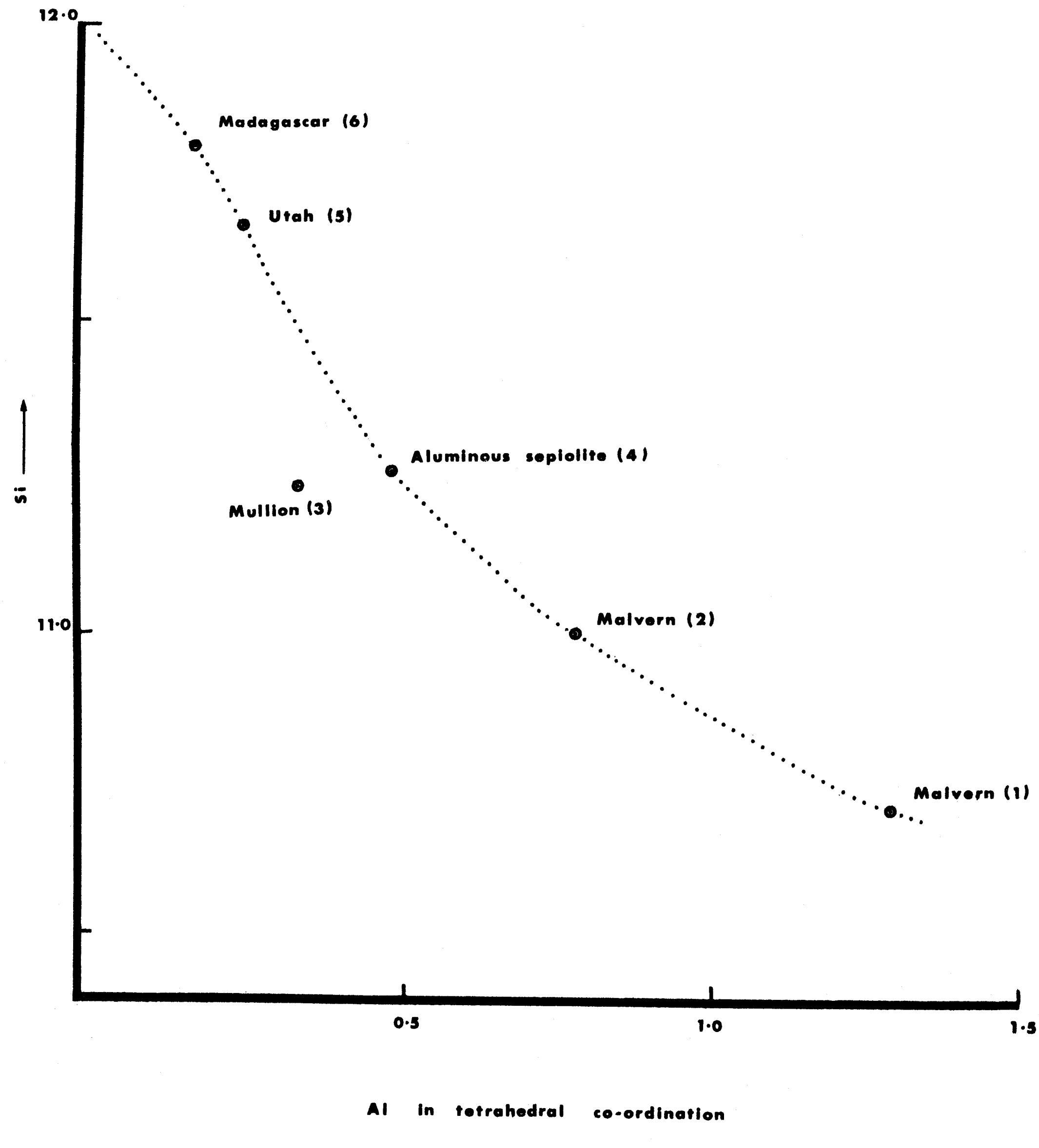
$(Si_{11.25}Al_{0.48})\ (Al_{1.37}Fe^{3+}_{0.37}Fe^{2+}_{0.44}Mg_{4.90})\ O_{32}Mg_{0.08}(NH_4)_{0.45}$

(5) Sepiolite, Little Cottonwood, Utah (Nagy and Bradley 1955)

$(Si_{11.67}Al_{0.24}Fe^{3+}_{0.09})\ (Fe^{3+}_{0.02}Mn_{0.53}Mg_{7.42})\ O_{32}Cu_{0.15}$

(6) Sepiolite, Ampandradava, Madagascar (Caillère 1936)

$(Si_{11.80}Al_{0.16}Fe^{3+}_{0.04})\ (Fe^{3+}_{0.47}Fe^{2+}_{0.13}Mg_{7.14})\ O_{32}Ca_{0.11}$



TEXT FIG. 1.

Sepiolite with Al in tetrahedral co-ordination

Dunham (1955) comments that the average of 39 analyses of Keuper Marl show that the ratio of MgO/CaO is greater than the 0.68 required for dolomite (CaMg $(CO_3)_2$). Since no magnesite ($MgCO_3$) is present, Dunham concludes that another magnesium rich mineral must occur.

The writer's work in the Chilwell Brick Pit, Notts. (G.R. SK 513355) suggests that a magnesium rich mineral other than dolomite is present there. As much as 36% of the marl may be soluble in HCl, the principal cations in the resulting solution being iron, magnesium and calcium. The MgO/CaO ratios in these solutions are up to eight times that required for dolomite. One sample from the middle beds of the quarry has an excess of 9% MgO over that required for dolomite. If sepiolite is present in this sample, then up to 40% of the rock could be sepiolite. That this is not impossible is shown by the fact that sepiolite is readily decomposed by acids, leaving gelatinous silica, and by the discovery (Keeling 1956) of sepiolite in Keuper Marl in a Midlands locality. Keeling's analyses suggested that up to 39% of a 30 feet bed of Keuper Marl at an unnamed locality might be sepiolite. Other possibilities include montmorillonite - chlorite complexes of the type described by Honeybourne (1951).

Whatever the reason for the excess magnesia in these rocks, it is clear that a thoroughgoing study of the mineralogy of the Keuper Marls would be worth while and that sepiolite is one of the minerals likely to commonly occur. Thus detailed studies of the well crystallised sepiolite from the Malvern Hills may throw light on the local Keuper Marl.

Acknowledgements

Thanks are due to Mr. D. J. Mather for the chemical analyses and to Messrs. J.M.A. Pontin and A. J. Rundle for assistance in the field.

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THE VALUE OF CORALLITE SIZE IN THE SPECIFIC DETERMINATION OF THE TABULATE CORALS FAVOSITES AND PALAEOFAVOSITES

by

Ian David Sutton

Summary

The variation of the morphological characters in the tabulate coral species Favosites gothlandicus Lamarck and Palaeofavosites asper (Twenhofel) from the British Silurian is discussed. In all cases, except that of corallite size, these morphological characters show such a high degree of variation, even within a single corallum, that they can be of little use in specific determination. A detailed examination of the average transverse axes of the adult corallites has demonstrated the possible value of this character in the discrimination of species of favositids. The method of measuring the transverse axes is described in detail.

The earliest comprehensive study of the favositid corals from the British Silurian deposits was that carried out by Edwards and Haime (1855). They considered that among the favositids from the Wenlock Limestone the following species were recognisable: Favosites gothlandica, F. forbesi, F. multipora, and F. aspera. Jones (1936) considered that F. gothlandicus, F. forbesi and F. multipora were in fact variations of the same species, and described them as 'formae' of F. gothlandicus.

During the present investigation of the Silurian tabulate corals, the author has studied the variation of the morphological characters of F. gothlandicus and P. asper in detail. The results of this study, described below, indicate that the division of F. gothlandicus into the three 'formae' of Jones cannot satisfactorily be accomplished, owing to the fact that even within a single corallum the complete variation of the morphological characters used by Jones to distinguish his three 'formae' may be recognised. A similar range of variations may also be seen in P. asper. The morphological terms used in the succeeding sections are explained in the accompanying plate (Plate 16).

Variations in F. gothlandicus from the Wenlock Limestone

The main morphological differences which Jones (1936) employed, in his definition of the three formae of F. gothlandicus, were the abundance of septal spines and the thickness of the corrallite walls.

Explanation of Plate 16

Fig. 1. x 6.

Transverse section of Favosites gothlandicus, showing the variation in the number of septal spines and in the thickness of the corallite walls in different parts of the section. At (A) the septal spines are few in number and the walls of the corallites relatively thin, while at (B) the septal spines are very abundant and the walls have increased considerably in thickness.

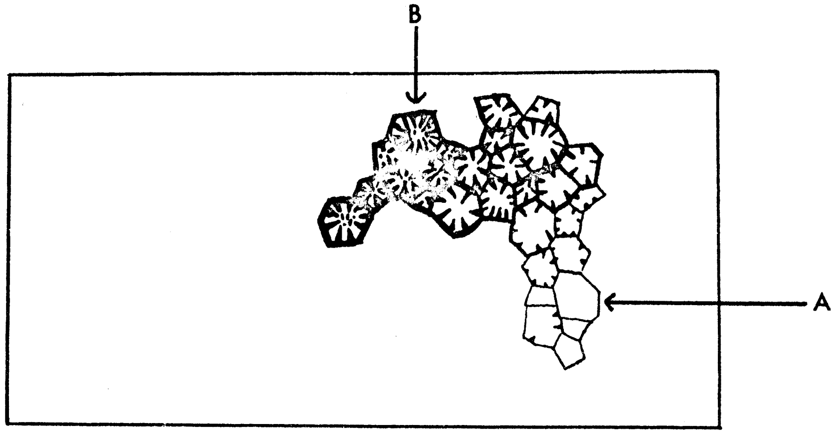
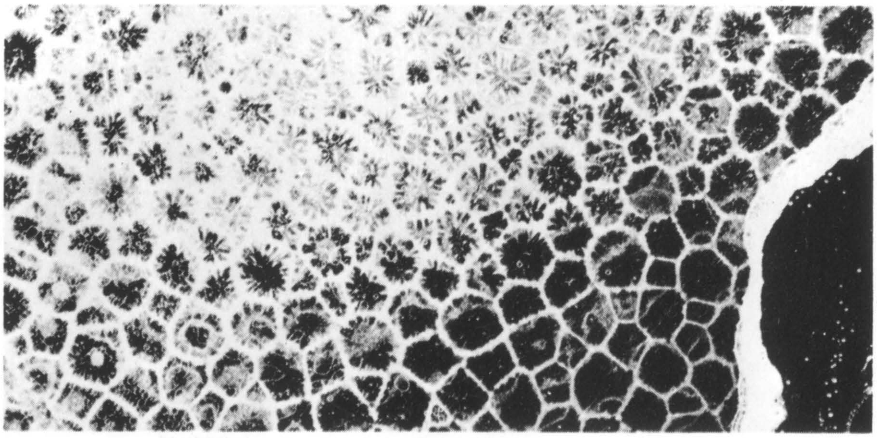
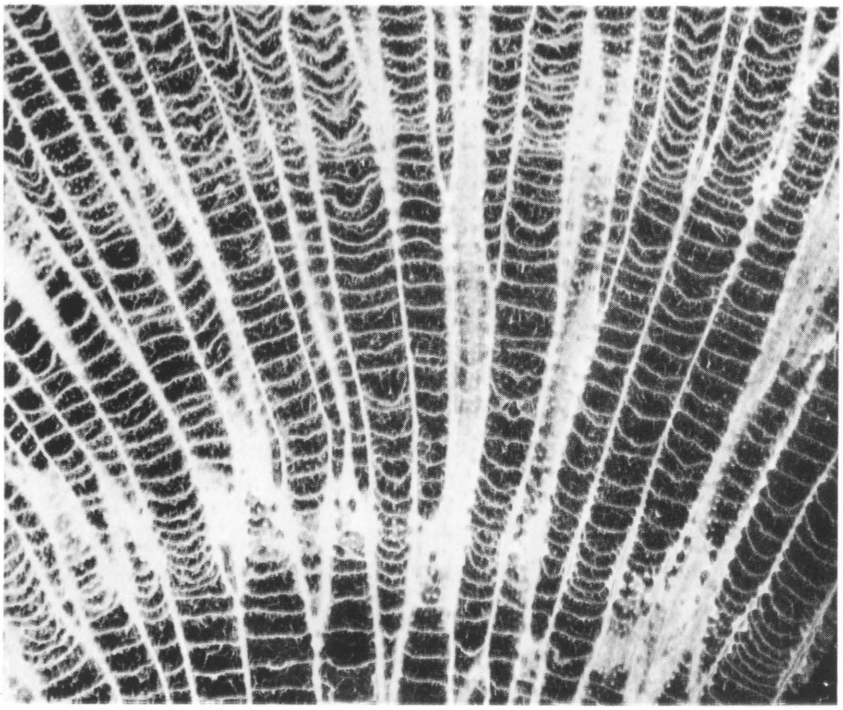


Fig. 2. x 6.

Longitudinal section of Favosites gothlandicus, showing the concentration of septal spines into distinct bands accompanied by an increase in the thickness of the corallite walls and a much closer spacing of the tabulae.





Jones described F. gothlandicus forma gothlandica as forms without, or with very few septal spines, and with thin walls; F. gothlandicus forma forbesi as forms with some septal spines and thicker walls, and F. gothlandicus forma multipora as forms with many septal spines and with relatively thick walls. Jones also described variations in corallite size, and in the spacings of the tabulae, between the different formae.

Septal spines have been noted by the author in all coralla of this species from the Wenlock Limestone. In nearly all specimens examined, longitudinal sections display bands of abundant septal spines, which are concentric with the upper surface of the corallum, separated from each other by areas where the septal structures are relatively sparse (Pl. 16-fig. 1).

In transverse sections, which inevitably cut through a number of growth levels of the colony, there is often a continuous variation from areas of very abundant septal spine development to areas of sparse development (Pl. 16-fig. 2).

Some coralla in this species are rather more abundant in septal spines than others, but this is insignificant compared with the variation found at different growth levels in a single corallum.

The variation in wall thickness of F. gothlandicus is dependant on the variation in the thickness of the peripheral stereozone of the walls. The amount of stereozonal thickening always shows a close relationship with the abundance of septal spines: where the septal spines are abundant, the walls may reach a thickness of up to 0.4 mm., but where there are few septal spines, the walls are rarely thicker than 0.1 mm.

The spacing of the tabulae in the Wenlock Limestone specimens of F. gothlandicus has a close relationship both with the abundance of septal spines and with wall thickness. In the areas where the septal spines are very abundant, the tabulae are very closely spaced, on the average separated from each other by about 0.35 mm., while in the areas of few septal spines and thin walls there is a much wider spacing, averaging about 0.8 mm.

The observations made in this study have led the author to the conclusion that the development of the septal spines, the thickness of the corallite walls and the spacing of the tabulae are all a result of the effect of environmental conditions. The alternations between areas with sparse septal spines, thin walls and relatively well separated tabulae, and areas of abundant septal spines, thick walls and closely spaced tabulae, suggest that the development of these characters may be related to seasonal variations in sea water conditions.

Jones (1936) considered that the inequality in the size of the corallites in F. gothlandicus was merely an effect of environment, and demonstrated that, where rapid gemmation occurred, the corallites would vary considerably in size.

In the present work an attempt has been made to deduce the variation one may find in the size of the adult corallites in different coralla of F. gothlandicus. The initial difficulties proved to be the selection of a reasonable method for measuring the transverse axes of the corallites, which are polygonal in shape, and the choice of corallites which would satisfactorily be regarded as adult.

As no standardised method for measuring the corallites of favositids has previously been used, it was considered that the most satisfactory procedure to give an indication of the transverse size of the corallites would be to find the average measurements of the longest and shortest transverse axes for each corallite. In each of the specimens of F. gothlandicus used in this study, it was decided that the one hundred largest corallites, in transverse sections which contained upwards of one thousand corallites, could certainly be considered as adult.

First of all, thirty-five specimens were selected from different horizons in the Wenlock Limestone of the Welsh Borderlands; the mean size of the transverse axes of the adult corallites, using the techniques as described above, was 1.56 mm., with a range of the means for all coralla of 1.22 mm. - 1.92 mm. (Table 1). These thirty-five specimens were then divided into three groups, based on the abundance of septal spines and wall thickness in the sections from which the corallites were measured (see Table 1). The results of this experiment showed that, in the coralla measured, there was no significant difference between the size of the transverse axes of those corallites with very abundant septal spines and thick walls, and those with very few septal spines and relatively thin walls (see Table 1).

TABLE 1

Statistics of adult corallite size of coralla of Favosites gothlandicus from the Wenlock Limestone

Character	Mean of Means (mm)	Range of Means (mm)	Var. of Means (mm)	No.
Average transverse axes of the adult corallites from all coralla	1.56	1.22-1.99	0.0365	35
Average transverse axes of the adult corallites from coralla of Jones' forma gothlandica	1.58	1.25-1.99	0.0432	10
Average transverse axes of the adult corallites from coralla of Jones' forma forbesi	1.59	1.22-1.80	0.0247	13
Average transverse axes of the adult corallites from coralla of Jones' forma multipora	1.51	1.28-1.92	0.0469	12

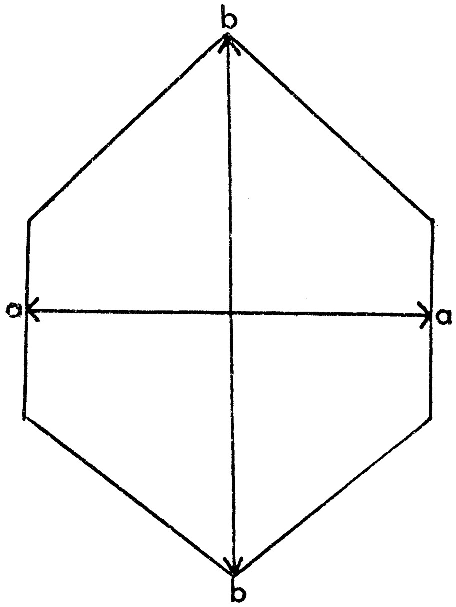
A further eleven specimens were collected from one horizon and locality of the Wenlock Limestone from Shropshire. These were measured in a similar fashion as those described above, and the ranges of the corallite size are very similar to those of the coralla measured from various localities in the Wenlock Limestone (Table 2).

TABLE 2

Statistics of adult corallite size of coralla of Favosites gothlandicus from one horizon

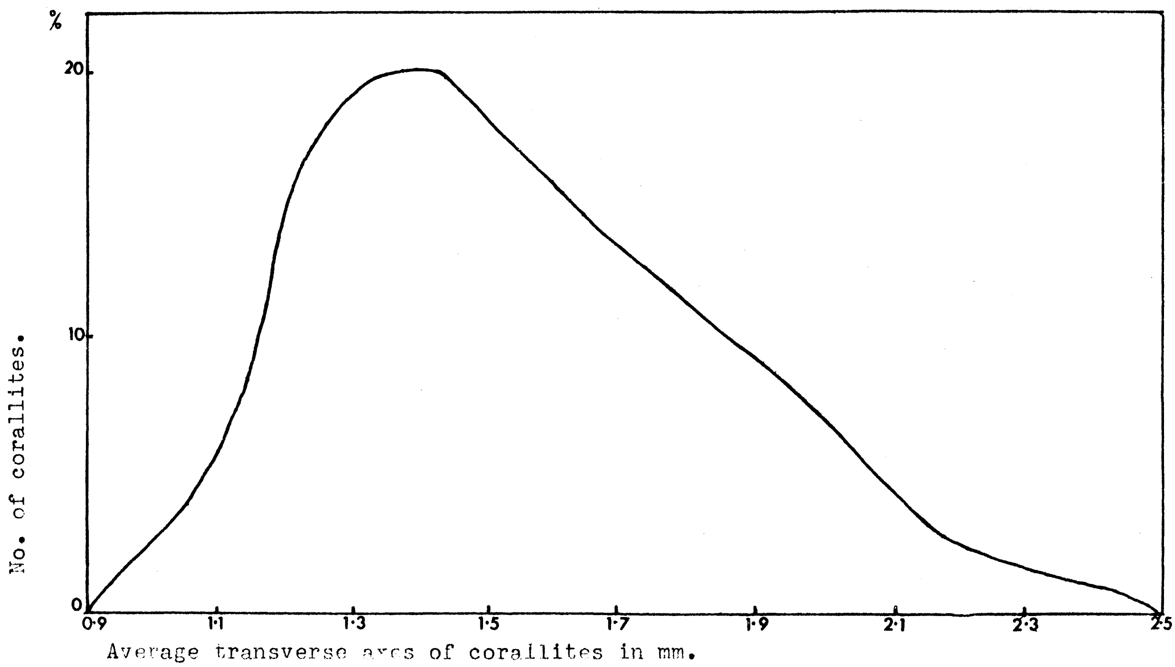
(Crinoidal Limestone, Coates Quarry, Wenlock Edge, Shropshire)

Character	Mean of Means (mm)	Range of Means (mm)	Var. of Means (mm)	No.
Average transverse axes of the adult corallites of all coralla	1.62	1.46-1.92	0.0231	11

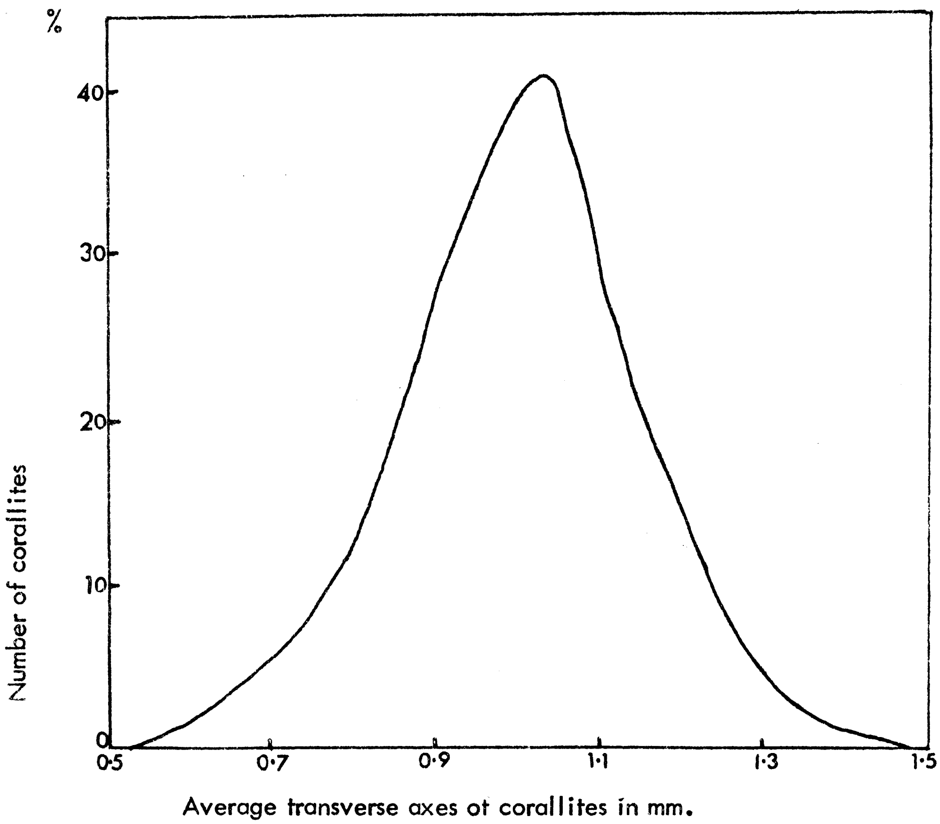


$\frac{a+b}{2}$ Average transverse axis

Text-Fig. 1. Diagram to show the system used for the measurements of the transverse axes of the corallites in the Favositidae.



Text-Fig. 2. Diagram to show the size ranges of all corallites measures of specimens of Favosites gothlandicus from the Wenlock Limestone.



Text-Fig. 3. Diagram to show the size ranges of all corallites measured of specimens of *Palaeofavosites asper* from the Wenlock and Aymestry Limestones.

The results of this study suggest that the varying environmental conditions which are indicated by the diverse lithologies in the Wenlock Limestone, have little effect on the adult transverse size of the corallites of F. gothlandicus; thus it appears that this character is one of the most stable morphological features of the genus, and may with detailed study prove valuable in taxonomic work on this species.

Variation in Palaeofavosites asper from the Wenlock and Aymestry Limestones

Twenty-three specimens of this species were used in this investigation. Fifteen of these were collected from varying localities and horizons in both the Wenlock and Aymestry Limestones, while eight were collected from a single horizon in the Wenlock Limestone.

The examination of this species has given almost identical results as those described for F. gothlandicus (Text-fig. 2). The septal spines show a variation from being very abundant to sparse in a single corallum; the areas of abundant spines are again developed in bands parallel with the upper surface of the coralla. As in F. gothlandicus, the wall thickness of the corallites shows a very close relationship with the abundance of septal spines, thicknesses of as much as 0.2 mm. being attained where septal spines are very abundant, whereas the average thickness is only about 0.06 mm. where septal spine development is lacking or very sparse. In the areas of abundant septal spines the tabulae have an average separation of about 0.35 mm., but elsewhere the separation averages 0.75 mm.

The comparison of the average transverse axes of the corallites of one corallum with those of another indicates a relatively restricted range for this character. The average transverse axes for all adult corallites measured are 0.9 mm., with a range from 0.80 mm. to 1.21 mm. (Table 3) in the average transverse axes of all coralla.

TABLE 3

Statistics of the adult corallite size of Palaeofavosites asper from (a) different localities in the Wenlock and Aymestry Limestones and from (b) one horizon in the Wenlock Limestone

Character	Mean of Means (mm)	Range of Means (mm)	Var. of Means (mm)	No.
(a) Average size of transverse axes of the adult corallites of all coralla examined	0.99	0.80-1.21	0.0095	15
(b) Average size of transverse axes of the adult corallites of coralla from a single horizon	0.99	0.91-1.09	0.0005	5

In Palaeofavosites asper the transverse size of the adult corallites is again shown to be the most stable morphological character and should be of great value in taxonomic studies of this genus. Specimens collected from the Aymestry Limestone show no significant difference in corallite size from those collected from the Wenlock Limestone . The variation in the development of septal spines, wall thickness and the spacing of the tabulae is so great even within one colony, that they can be of little use in taxonomic work at a specific level.

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THE LOWER KEUPER AND TRIASSIC FAULTING IN NORTH NOTTINGHAMSHIRE

Leader: R.E. Elliott

Sunday, 11th April 1965

A coach load of 40 members met in Nottingham and was conveyed to Kirton Brickworks (E.4693, N. 3680) in North Notts.

A succession from near the top of the Waterstones up to a level probably high in the Carlton Formation (Elliott, 1961) exposed on the quarry face was examined in detail. The party was fortunate in that excavations for an extension to the works had exposed more of the Waterstones than usual , and micaceous bedding planes with parting lineation were seen on blocks of sandstone. A few feet above the Waterstones a green and purple mudstone was noted, and near the top of the quarry five prominent green beds were pointed out. In addition at various horizons abundant ripple marks, few "miniature ripples", desiccation cracks and rare salt pseudomorphs were found. It was noted that thin fibrous gypsum layers occurred within a few feet of the surface in the highest part of the quarry, but for the most part the gypsum had been weathered out, as evidenced by numerous cavities in the silts and sands. The leader considered that the green and purple bed and strata up to and containing other thin purple mudstones, some 25 ft. higher in the succession, were equivalent to the Radcliffe Formation of South Notts. A brown siltstone skerry about fourteen inches thick, with load casts, occurring about 9 ft. above the highest purple layer, was thus near the base of the Carlton Formation. On this basis the Radcliffe Formation at Kirton was 40 ft. to 50 ft. thick.

On leaving Kirton Brickworks the route taken followed the foot of a marked topographic feature, with Keuper Green Beds to the left, and Waterstones to the right, as far as Kirton Church. An exposure of Waterstones (E.4692, N.3693) with parting lineation was pointed out in the cutting below the church, and having climbed the hill on to the Keuper Marl, an exposure of the green and purple bed was noted in a bank to the right of the road (E.4698, N.3694). The bus turned left towards Walesby and descended the same topographic feature, but the green and purple bed was noted in a cutting towards the bottom of the hill. Immediately after turning right for Milton, the bus was halted for a description of the relationship of topography to the four formations, namely Bunter Pebble Beds, Keuper Green Beds, Waterstones, and Keuper Marl, which were dislocated by a fault at that point (E.4690, N.3709) throwing Waterstones opposite basal Keuper Green Beds.

Continuing towards Milton, the location of the Waterstones outcrop, sometimes forming a low feature just above the alluvium, was noted; also the location of further exposures of the green and purple bed. A brief stop was made close to the Waterworks (E.4709, N.3725) at Milton to describe the mapping of a fault dislocating the nearby green and purple bed. At Markham Moor temporary exposures of the green and purple bed (E.4718, N.3736) and the green beds (E.4722, N.3736),previously seen near the top of the Kirton quarry,were pointed out in the low ground near the roundabout. The leader reminded the party that the green and purple bed was at the top of the scarp at Kirton, and had been seen at progressively lower points on the same topographic feature as the party travelled towards Markham Moor. Therefore this topographic feature was not controlled by the stratigraphy, and was probably topped by a plane of erosion.

After lunch at Markham Moor, the party proceeded to Retford via Gamston, in the vicinity of which outcrops of basal Keuper Green Beds and Waterstones were observed in passing. A low scarp and soil colour change, marking the boundary between the Keuper and the Bunter, were noted on the disused Gamston Aerodrome (E.4695, N.3765).

At Retford two exposures of a sandy facies mapped by the Geological Survey as basal Keuper Green Beds were examined in detail, one at Bolham Lane (E.4706, N.3823) and the second at the main road bridge over the Gainsborough railway (E.4709, N.3804). At the former locality the sands were mainly reddish brown in colour, and at the latter green. A possible lateral passage between Bunter and Keuper in the Retford district was briefly discussed.

Returning through Gamston, the party assembled by the roadside close to Haughton Park House Farm, east of Bothamsall (E.4686, N.3740), where a fault throwing red Waterstones against basal Keuper Green Beds was clearly visible in a ploughed field, in spite of a thin covering of pebbly drift. Journeying through Haughton Hamlet, a stop was next made at Haughton Decoy (E.4679, N.3718), where evidence for a larger fault throwing Keuper against Bunter was described.

The bus proceeded through New Ollerton and Wellow towards Eakring, and 2 ft. diameter borehole cores from water boreholes (E.4677, N.3648) were pointed out in passing. The leader stated that the cores commenced in the Keuper Marl and passed through Waterstones and Green Beds into Bunter Pebble Beds. At Stonish Hill, Eakring (E.4665, N.3622), an exposure of Waterstones was visited, from which the horny brachiopod *Lingula* had been recorded (Rose and Kent, 1955); several specimens were collected.

The journey back to Nottingham was broken between Bilsthorpe and Farnsfield at a point where the Bilsthorpe Fault outcrops. The party took a short walk eastwards along the line of the fault (E.4646, N.3592 to E.4637, N.3591), noting a Bunter Sandstone ridge on the left, overlooking low ground on the right composed of marls low down in the Waterstones and the basal Keuper Green Beds. Small temporary exposures of these formations were briefly examined. The leader mentioned that the fault had a throw of 228 ft. in the Coal Measures at Bilsthorpe Colliery, and probably about 70 ft. at the surface in the Triassic.

R.E.E.

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GEOLOGICAL TOUR OF THE SOUTHERN PEAK DISTRICT

Leader:- Dr. F.M. Taylor   Sunday May 2nd, 1965

Fifty members of the Society attended the Southern Peak District General Excursion, the second of a series of such excursions designed to illustrate the geology of the East Midlands. It was intended that the country to the north and west of Nottingham would be visited on this occasion, so that a comparison could be made of the geology to be found to the east and west of the Derbyshire limestone country.

The region is mainly composed of Carboniferous rocks, with overlying representatives of the Upper Permian and Lower Triassic Formations. The formations and horizons mentioned on the excursion and in this text are listed in the Table below.

TABLE 1

Sequence of formations and horizons

West	East	
Pebble Beds at Leek and Ashbourne	Pebble Beds) Mottled Sandstones)	Lower Triassic
(No Upper Permian)	Middle Permian Marls) Lower Magnesian Limestone) Dolomitic Siltstones) Basal Breccia)	Upper Permian
-unconformity-	-unconformity-	
Coal Measures of the Potteries Syncline and Goyt Trough, not seen on this excursion.	Top Hard Coal Group) Waterloo Coal Group) Ell Coals) Clay Cross Marine Band)	Middle Coal Measures
	Clay Cross Soft Coal) Deep Soft Coal Group) Deep Hard Coals) Tupton Coals and Rock) Black Shale Coal) Kilburn Coal and Rock) Wingfield Flags) Alton Coal and Marine Band)	Lower Coal Measures

West	East	
	Thin Coal	Lower Coal Measures
1st Grit (High Moor Grit)	Crawshaw Sandstone	
Pot Clay Marine Band	Gastrioceras subcrenatum Marine Band	
2nd Grit	Rough Rock	Namurian or Millstone Grit
3rd Grit (Roches Grit)	Belper or Chatsworth Grits	
4th Grit	Ashover Grits	
5th Grit	Kinderscout Grit	
Crowstones	Mam Tor Sandstones	
Churnet Shales	Edale Shales	
P zone limestones, shales	P zone limestones and shales	Avonian or Carboniferous Limestone
D_2 zone very thin	D_2 zone (thin at Wirksworth but thickening rapidly beyond Cromford)	
D_1 zone Waterhouses Limestone	D_1 zone with <u>Cyrtina septosa horizon</u>	
S zone very thin or absent	Older limestones, not exposed at the surface.	
C_2 zone. Weaver Beds		

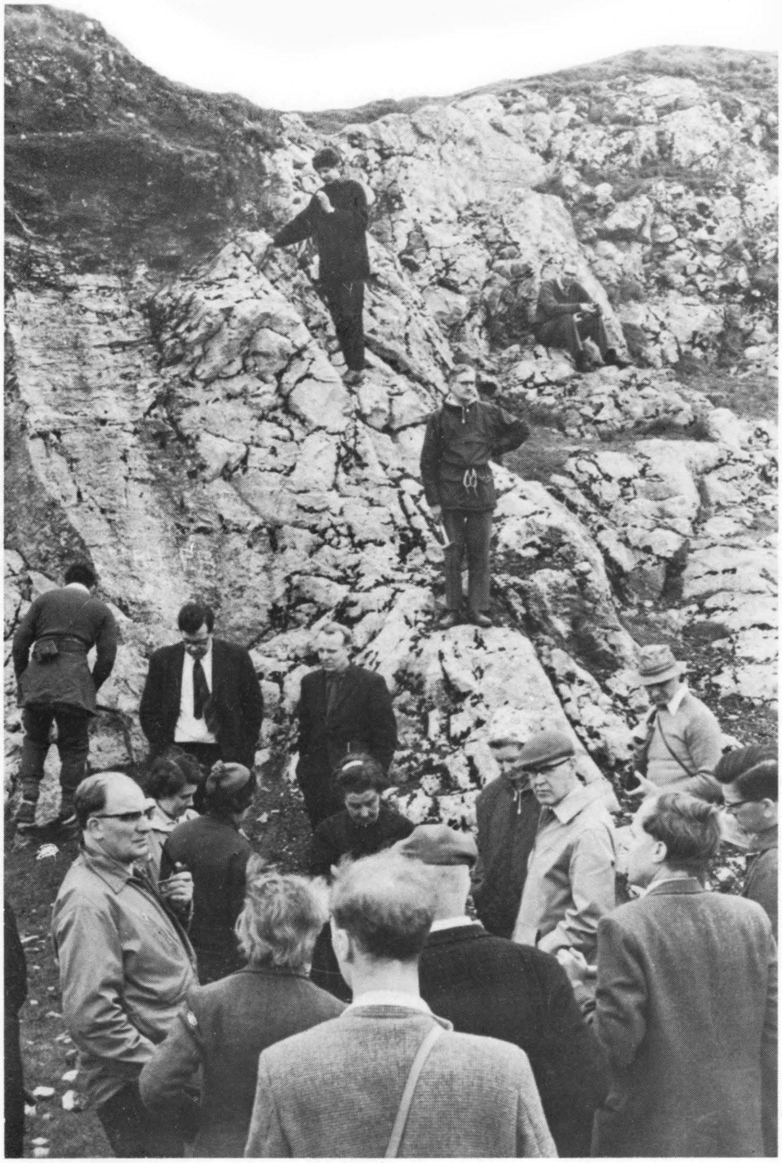
<u>Fold Axes affecting this area</u>

West	East
Goyt syncline	Erewash and Langley Mill anticline
High Moor Anticline (Macclesfield Forest)	Ripley and Alfreton Synclines.
The Minns Anticline	Crich, Ashover and Hardstoft anticlines
Bosley Synclines	Stanton - Chesterfield Synclines
Biddulph Syncline	Brimington anticline.
Astbury Anticline	
Lask Edge Anticline	
Rudyard Syncline	
Roaches Anticline	

The character of the excursion closely followed that set by the first of the series (Taylor 1964). The geology of the region was described from the coach, only selected quarries and view points being visited. The excursion was designed to introduce members of the Society to the area and to encourage members to visit the localities again, when details could be noted. No attempt was made at a comprehensive survey of the area.

The route is best followed with reference to O.S. maps One Inch to One Mile Nos. 110, 111, and 112, together with the corresponding Geological Survey maps, Nos. 125, 112, 110 and 123. The Chapel-en-le-Frith sheet (111) is about to be published and will make a useful additional guide.

The first part of the tour covered the Permo-Trias rocks west of Nottingham, exposed irregularly along the A.610 to Nuthall. At Canning Circus, Nottingham (SK 564401) exposures of Pebble Beds were seen at the road side, the remains of old road widening schemes. As the road descends



Members of the East Midlands Geological Society examining and discussing the elaterite (top left) and D_1 Limestones of Windy Knoll Quarry, near Castleton, Derbyshire. Council members in the picture are Mr. P.H. Speed (with pipe); Mr. R.J.A. Travis (shoulder strap); and at bottom right, Mr. E. Taylor, the Treasurer, and Dr. F.M. Taylor (with hammer). The President, Mr. P.C. Stevenson (in hat) is examining a specimen of elaterite.

(Photo: F.N. Hoskins)

to the River Leen, Mottled Sandstones are seen now only in temporary exposures, at Bobbers Mill (SK 550411). Westwards the route crossed Permian rocks, mainly the Lower Magnesian Limestone, although a number of faults cause local complications particularly in the Cinderhill area. The Magnesian Limestone was seen at the road cutting at Cinderhill Colliery (SK 532439) and at the sides of the road to Nuthall (SK 515455). Here the M.1. crosses the A.610 and the resultant numerous excavations have helped to fill in details of local geology.

From Nuthall the direct route (A.611) was taken to Alfreton. Initially the road continues to cross the Magnesian Limestone but descends on to the Middle Coal Measures beyond Watnall (SK.495465). The Magnesian Limestone escarpment continues northwards, the road northwestwards. (Waring 1965 p.202-fig. 1).

Coal mining activities were soon indicated by the presence of Moor Green Colliery (SK. 480479). The Top Hard Coal Seam at this colliery is 340 feet below the surface, indicating the presence of high Middle Coal Measures at outcrops in the Moor Green area. Beyond the Reservoir, the old Willey Lane Pit (SK. 479501) proved the same seam at 546 feet. These high horizons of Coal Measures are maintained to the Annesley Woodhouse (SK. 474527) cross roads, where the route turns westwards, across the strike of the beds which are dipping east. Changes of geological horizon are now rapid, as shown by the features of the sandstone beds. The Top Hard Rock and Coal are crossed at Selston. The old Selston Pit (SK. 458528) worked the Deep Hard Coal and Deep Soft Coal and lower seams, whilst the Hobsic opencast coal site (SK. 455535) worked the Waterloo Coals and Ell Coals, possibly also the Top Hard Coal, at the surface. The Deep Hard and Deep Soft Coals outcrop along the Erewash Valley. As the river is crossed, however, dips begin to change direction. Initially very low inclinations are recorded but dips to the west are encountered climbing the hill into Somercotes. The younger rocks are again encountered as the axis of the Alfreton Syncline is approached. Eventually the Top Hard Coal was again crossed as the coach entered Alfreton (SK. 413558). One of the many faults in this area, the Main Ridge Fault, was recently exposed in the basement of the Midland Bank, King Street. As the coach turned northwards along the A.61, the nose of the pitching Alfreton Syncline was followed, giving initially E - W outcrops and a descending sequence.

At the bottom of the hill, the view to the west includes the Crich Tower (SK. 542554) on the skyline, indicating the position of the Crich axis which brings the Carboniferous Limestone to the surface. The effect of this axis aligns outcrops once again northwest to south east; and east of the road the opencast coal site of the 2nd Ell Coal, now restored, (SK. 408570) can be detected. From Crich to the A. 61 dips are to the east and can be as high as 30°, the whole succession down to the limestone occupying only a very narrow outcrop.

The Deep Soft Coal is 116 ft. below the surface at Shirland Colliery (SK. 399580) and outcrops just to the west of the main road through the village. As the road turns to the west, a descending sequence is rapidly traversed until the outcrop of the Tupton Rock is encountered at Higham (SK. 390593). At this point the road turns north again and runs along the crest of the rock to Clay Cross. The influence of the Ashover anticline controls the outcrops, and the axis can be detected from a view point looking west across Amber Valley. The sandstone escarpments have steep dip slopes to the east except for the opposed escarpment of Cocking Tor, which forms the skyline to the north west, being identified by the Cocking Tor Quarry cranes. Immediately below the view point is the opencast site of the Tupton Coal; the winding gear for a small adit mine was seen to the north (SK. 390611). Turning to the east side of the road, a series of exposures in the Tupton Rock was examined.

The coach continued into Clay Cross (SK. 391634), where the Tupton Coal is recorded at 127 feet below the surface and the Black Shale Coal at 308 feet. At Old Tupton (SK. 390652), the Tupton Coal Group is indicated by the presence of blocks of Cockleshell Limestone in the dry stone walls. At New Tupton (SK. 390660), a large fault downthrows the sequence to the north, giving higher Lower Coal Measures. Outcrops of the Clay Cross Soft Coal, probably occurring as two distinct coals, the

Sitwell and Chavery Seams, are on the east side of the road, at the Avenue Colliery and Coking Plant (SK. 391679; Taylor and Howitt, 1965). These horizons are followed into Chesterfield.

Entering Chesterfield, the crooked spire of the church, a famous landmark situated on the Deep Hard Rock, is seen. For the first time, outcrops are affected by an east-west axis passing through Chesterfield, but since it pitches to the east, our route (A.619) to Baslow crossed the nose of the syncline and a descending sequence was followed. Thus the Tupton outcrops at the Ashgate Road (SK. 369709), the Ashgate and Black Shale Coals at Upper Moor (SK. 356706), and the Brampton Seam at Belmont (SK. 345705). Sandstones of the Wingfield Flags Group form the main features around Wadshelf (SK. 315708). Old workings in the Norton, Forty Yard and Alton Seams can be seen as the road descends to Stonelow Bridge (SK. 288716). The Crawshaw Sandstone forms an impressive feature just below this bridge and an old quarry occurs close to the road. Below the sandstone occurs the Gastrioceras subcrenatum Marine Band, the marker horizon for the base of the Coal Measures. The Chatsworth Grit forms the next major feature with the Reticuloceras superbilingue Marine Band occurring in Jumble Coppice (SK. 269721).

It would seem then, that Baslow (SK. 251723) is built on the last remnant of the Ashover Grit, for to the north a sandstone at a lower horizon, the Kinderscout Grit, increases in prominence. From Baslow the road, (A. 623),continues northwards to Calver Sough. The river follows a prominent gap between two sandstones, one of which, to the east of the road, trends north - south, whilst the other on the west strikes northeast-southwest. The first escarpment is formed by the Chatsworth Grit, with possibly the Kinderscout Grit at its base; the second is possibly the Kinderscout Grit but more likely a sandstone within the Edale Shales, occupying a position similar to the Mam Tor Sandstones noted below.

On Crossing the bridge at Calver (SK. 248745), the highest Carboniferous Limestone (Eyam Limestones) can be seen at the extreme eastern edge of Longstone Edge, which also trends northeast-southwest. The change of strike of the beds below the Chatsworth Grit can only be explained by an early Namurian structure, not affecting the later R - zone beds.

After touching the boundary of the Limestone and Edale Shales, the route diverges from this boundary, following the A. 622 to Grindleford, and the excellent escarpments of Froggatt Edge and Millstone Edge (Chatsworth Grit). Very fine views of the Gritstone country west of Sheffield can be obtained to the east of the road, whilst on the west side the Kinderscout Grit extends westwards to Hucklow Edge.

At Hathersage (SK. 232816), the coach turned on the A.625 towards Castleton. West of Bamford the valley opens out towards Hope (SK.171835) with the Mam Tor Sandstones forming Win Hill, Lose Hill, and the landslip-scarred mass of Mam Tor. To the south, Bradwell Dale marks the junction of the Carboniferous Limestone, (D_2 and P_2 zones) and the Namurian shales. (E. zone). The northern margin of the limestone is seen as the coach approaches Castleton (SK. 150830) and continues on to the Winnatts Pass (SK. 140828). The surfaces which can be seen extending down into the valley are dip slopes of the fringing reef limestones, with dips in places in excess of 30°. The reef limestones can be seen in Cave Dale (SK. 150827), Cow Low Nick (SK. 141823), the Winnats, and Treak Cliff (SK. 134832). Extending westwards into the main limestone area are well-bedded limestones, almost horizontal. As the coach passes along this northern fringe, older limestones of the D_1 subzone are seen.

On reaching the junction of the A. 625 with the Sparrowpit road (B. 6061), a stop was made to visit Windy Knoll Quarry (SK. 125830) (Plate 17). The elaterite, neptunian dykes and D_1 limestones were examined and Mr. R. J. A. Travis gave a summary of the cavern formations of the area, the entrance to Windy Knoll Cave being close to the quarry. The nature of the Mam Tor Sandstones could be seen on the scar of the landslip. The sandstone feature continues westwards as Rushup Edge.

The junction of the Reef Limestones and the main shelf limestones was followed along the

Sparrowpit Road. At Eldon Hill the Cyrtina septosa fossil bed, a marker horizon in the D_1 sub-zone, occurs close to the road (SK. 116818) and in the quarry (SK. 114816). At the entrance to Perry Dale, the junction of the limestone with the shales is on the north side of the road, and is marked by a swallow hole (SK. 099813) which takes the streams off the shales and down through the limestones. From Sparrowpit, the road (A. 623, 624) continues to the south following the western margin of the limestone to Buxton. Nothing much can be seen of the extensive outcrops of igneous rock which occur within the limestone to the north east of Buxton at Waterswallows. (Moseley 1965, p. 283).

The western margin of the limestone continues south of Buxton. In the vicinity of Burbage (SK. 043724), a north-south fault separates the limestones from high beds of the Namurian. From Axe Edge (SK. 039704) (A. 53) a good view of the western margin of the limestone can be obtained as far as Chrome Hill (SK. 070674) and Parkhouse Hill (SK. 080670), which are formed by steeply dipping, very fossiliferous reef limestones. A link road crosses to the Congleton Road (A. 54). At the road junction (SK. 021709) Lower Coal Measures in the centre of the Goyt Syncline occur. The main part of this syncline is to be found to the north, but the effect of the fold is felt far to the south. This structure is the first of a series of folds, some very tight indeed, proved in rocks extending down from the base of the Coal Measures to the base of the Namurian. Continuing along the Congleton Road, the features seen dip into the Goyt Syncline. These include the Reves Edge Rock (SK. 013698), underlain by a coal, and the less impressive Dane Bower Grit (SK. 005705) (Rough Rock). Further west these beds bend over to the west at Shutlingsloe and Hammerton Knoll (SJ. 976697 & SJ. 964674), forming the High Moor Anticline, a rather broad structure with low dips. Periodically, views can be obtained to the south east and to the impressive feature of the Roches (SK. 000640).

Travelling westwards towards Wincle Cross and the Leek - Ashbourne road, the outcrops seen assume a north - south strike. These include Cophurst Edge (SJ. 952691) (Roches Grit), with its much quarried crest, and the two sharp anticlinal ridges of Croker Hill (SJ. 933676) with radio mast, and to the south of the road, that of Bosley and Wincle Minns (SJ. 941665). All these latter features are composed of the crowstones, quartzites at the base of the Namurian. Now the road descends to Bosley Reservoirs (SJ. 920660), excavated in Boulder Clays at the eastern edge of the Cheshire Plain. Glimpses of this plain were obtained as the coach descended the hill, but the view is not as extensive as that obtained from parallel routes to the north.

At the cross roads (A. 54/A. 523) a quick look north to Whitemoor Hill Quarries (SJ. 915679) revealed the lowest of the Crowstones. Continuing westwards, towards Congleton the irregular nature of the drift-covered Cheshire Plain was appreciated, with its masses of boulder clay and sand deposits, the geology being further complicated by the terraces of the River Dane. Dominating this area to the south is a hill standing several hundred feet above the Congleton area, known as The Cloud (SJ. 903636); it forms the northern termination of the Biddulph Syncline. The Cloud is made up of a number of sandstones, the most prominent being the Roches Grit, with the High Moor Grit forming the skyline.

Because of the drift covered nature of the Cheshire Plain little could be seen, en route, of the junction of the Carboniferous and Triassic deposits. It can be seen at the North Rode Viaduct (SJ. 896657), where the two Systems are brought together by the Red Rock Fault.

From Congleton, the northern end of the Biddulph syncline was traversed by taking, first of all, the A. 527 road towards Biddulph; then the left turn at Mossley (SJ. 877619) for Rushton; and eventually the Macclesfield - Leek road. Along this route the structure of the syncline is superbly set out, the effect of the southerly pitching axis and the steep dips being displayed by the sandstone outcrops.

Descending towards Rudyard Lake, views of the next fold (anticline) to the east were seen, extending from Ashmore House (SJ. 914608) towards Lask Edge (SJ. 915571). Further east the Macclesfield - Leek road (A. 523) is seen flanked by Rudyard Lake to the west and a fine escarpment (? 4th Gritstone) dipping to the east. This road was joined at Ryecroft Gate (SJ. 939616) and the route followed towards

Leek; the road eventually turns to the east down the dip-slope of the gritstone. The view to the east is into the axis of yet another syncline. Dips beyond the axis are westerly and older rocks outcrop, but there are still further complications beyond the ridge of Gun Hill (SJ. 969615) before the Carboniferous Limestone is encountered in the Dove Valley (SK. 129604).

Our route however, turned south-east along the strike of the Carboniferous Beds, following an old valley now filled with Triassic Sandstones and Pebble Beds. At first these red pebble beds occur in irregular patches, but they thicken southwards and form two impressive cuttings on the road entering Leek, one on the north side of the River Churnet and the other as the road climbs up towards the church. A stop was made on this part of the road (SJ. 984564) to examine the Pebble Beds. The coarse, soft sandstones are dark red in colour and contain numerous pebbles of many different sizes, shapes and compositions. It was noticed with regret that the cutting was being lined with concrete blocks; a local Councillor saved the Town a consultant's fee by enquiring from the party its collective opinion regarding the weathering of the rock face and the possible effect on the factories perched immediately on the edge of the cutting.

Our encounter with the Trias was brief, for by leaving Leek on the Ashbourne Road (A. 523) we quickly passed back on to Namurian strata. Little is known about the details of this area, except that lower and lower horizons of the Namurian were crossed until the Carboniferous Limestone was seen south of the road at Cauldon Low (SK. 078488) and the boundary of the Namurian and Avonian crossed at Waterhouses (SK. 083502). Churnet Shales can be examined in the banks of the River Hamps and the highest limestones, P. Zone, in the road and old railway cuttings (SK. 085501) east of the bridge. A stop was made at Brownend Quarry (SK. 091502), to see the Waterhouses Limestone (D_1) and the Weaver Beds (C_2). The absence of the S zone and the steep dip (75°) of the beds evoked some considerable discussion. Continuing towards Ashbourne, the southwest edge of the limestone was seen at the Weaver Hills (SK. 095464) and as the road descends towards Mayfield the Trias/Carboniferous Limestone unconformity was crossed.

In order to keep to the southern margin of the limestone, the Kniveton-Carsington Road (B. 5035) was taken out of Ashbourne. Again the route crossed ground the geological details of which are little known. Nothing much can be seen of the Trias/carboniferous Limestone unconformity, but isolated rounded hills made up of dark limestones, presumably of P zone age, occur north of Ashbourne, suggesting that its nature is irregular. These beds can be examined in the stream sections in the neighbourhood of Kniveton (SK. 210503). Between this village and Carsington (SK. 252533), excellent views were obtained northwards to the dolomitised limestone north of Bradbourne and Brassington, i.e. the Rainster Rocks (SK. 215548). To the south, Namurian sandstones give gentle dip slopes to the north. From Hopton towards Wirksworth (SK. 288509), the road runs along and crosses the P. zone/D_1 limestone boundary and the southernmost mineral vein of Derbyshire, the Yokecliffe Rake.

The junction of the P. zone limestones and shales, and the D_1 limestones was examined close to the footbridge (SK. 288511) over the Cromford Road out of Wirksworth. Sufficient fossil evidence was found to indicate the age of the underlying limestones, the junction being particularly well displayed on the east side of the road, but the age of the overlying dark limestones had to be accepted since diagnostic fossils were not obtained from them.

The edge of the limestone was followed to the bridge (SK. 280521) marking the position of the High Peak Railway, where it was intended to stop to examine the character of the local P zone reef limestones, immediately underlying Namurian Shales. However, time was getting short and the coach was directed along the Whatstandwell road instead. This Road climbs to the foot of the Black Rocks (SK. 295525), (? Ashover Grit) and then traverses the very broad Alderwasley syncline. Views of the Crich Stand Limestone (SK. 342554) (D_2) quarry, with the Tower above, indicated the position of the Crich Anticline, this time seen from the west side, before the route joins the Derwent Valley. The river, running southwards, has cut through the Chatsworth or Belper Grits and flows along a strike section towards Ambergate, the beds assuming a more obvious easterly dip to the south as the affect of the Crich anticline and local faulting becomes less. This easterly dip is well seen along the road from Ambergate to Ripley, (A. 610).

After passing through the second railway bridge, the paired escarpment of the Belper Grits sweeps down to the road and the quarry to the south, Ridgeway Quarry (SK. 359512), exposes the highest gritstone of the area, which is probably the Crawshaw Sandstone at the base of the Coal Measures. A visit to this quarry would have located the underlying shales and sandstone (? Rough Rock), the question marks indicating that the all-important *Gastrioceras subcrenatum* marine band has not yet been found in the Ambergate area. The steep dip at the quarry further emphasises the structural complexity of the area, with its many faults.

The next rocks seen are those at the quarry of the Butterley and Blaby Brick Works (SK. 360517). This very fine quarry exposes Lower Coal Measures probably about the vicinity of the Upper Smalley Coal and below the Alton Marine Band. A coal, seen in the southern part of the quarry, is involved with a number of small faults. At the base of the quarry is a ganister and fireclay horizon, the shales and sandstone between being involved in a text-book example of a wash-out structure.

After passing under the canal bridge (SK. 360521), the country north to Crich was viewed, showing excellent north-south features. West of the canal is the dip slope of the Chatsworth Grit. Higher rocks seem to be faulted out for the next features are caused by the hard beds of the Wingfield Flags. On the south side of the road the General Refractories' Quarry (SK. 362520) used to expose the Alton Coal and Marine Bed, but now the fossils can only be obtained from the tips. Higher shales are still exposed, with a thin bed containing *Lingula* sp.

As the next road cutting was approached, the feature of the Kilburn Rock was seen to the north and the rock exposed in the cutting itself. The effect of the easterly dip was shown by the rapidity by which marker horizons are passed on the road to Ripley; the feature of the Tupton Rock and in succession the open case coal sites for the Tupton Coal (SK. 376514), Deep Hard (SK. 384513) and Deep Soft Coals, the latter occurring on the lower slopes of Hartshay Hill (SK. 390511), on both sides of the road. The Clay Cross Marine Band must now be crossed, though it has not been located, and also the lowest coals of the Middle Coal Measures, for Ripley is mainly built on the Sandstones above the Top Hard Coal Group.

As on the outward journey, the length of traverse of this group of Middle Coal Measures is increased by the effect of shallow folding (the Ripley syncline and its associated Langley Mill (SK.451471) anticline to the east). Eventually, at Kimberley (SK. 497448), the low escarpment of the Upper Permian Rocks was seen cutting across the road, marking the unconformity of the Permian and Carboniferous. The road is built on the dip slope of the Magnesian Limestone. This completed our circuit, the outward route being joined at Nuthall.

This long traverse over the Middle Coal Measures serves to emphasise one of the main differences between the areas to the east and west of the limestone. On the west side, the limbs of the north-south folds are much steeper and the crests of the more numerous folds, closer together, giving a tighter fold pattern. The limestone is only seen at one very small inlier (Astbury, SJ. 865595) to the south of Congleton. On the east side the folds are broader, becoming increasingly so to the east with axes trending northwest-southeast, so that similar horizons are maintained over wide areas. Larger limestone inliers occur at Ashover and Crich.

It was also noted that reef limestones, although most fully described in the literature from northern outcrops, occur pretty well right round the limestone outcrop and can be of all ages from C_2 zone to P zone.

The excursion arrived back in Nottingham with most members determined to revisit the region at a later date. In this respect, at least, the excursion seemed to have been successful.

F.M.T.

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THE STRATIGRAPHY AND STRUCTURE OF THE INFERIOR OOLITE ROCKS OF THE COTSWOLDS

Leader:- Dr. P. L. Hancock   Saturday and Sunday 3rd - 4th July, 1965

Twenty-one members and friends, including two members of the Geological Association of London, attended the first weekend field excursion of the Society. The main purpose of the trip was to examine the stratigraphy of the Inferior Oolite and in particular the nature of the Upper Bajocian unconformity. Some attention was also given to joints and superficial structures.

Twelve localities were visited, from Bourton-on-the-Water to just south of Stroud. Locality positions on a section showing the "folding" beneath the Upper Bajocian unconformity are shown on text-fig. 1, and the route followed on text-fig. 2.

The party left Shakespeare Street, Nottingham at 9.40 a.m., and travelled to Bourton-on-the-Water via Loughborough, the Motorway and Southam.

Locality A. Quarry near Coldpark Farm, Bourton-on-the-Water (SP 157197)

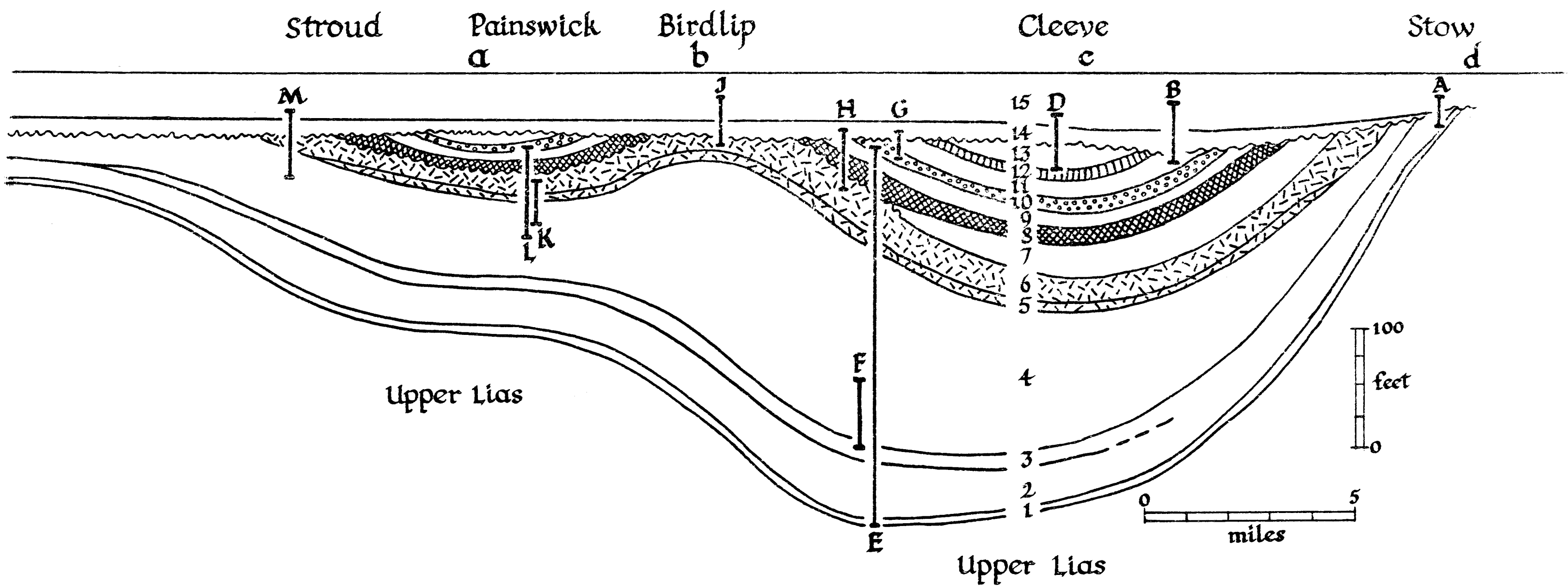
Since this locality lies nearly on the line of the Moreton anticline, the Upper Inferior Oolite rests on a low member of the Lower Inferior Oolite. In its present state the quarry shows only the "Yellow Stone", a local equivalent of the Pea Grit. At one time Clypeus Grit was exposed overlying the Yellow Stone (Richardson 1933, p. 31). The party found several specimens of the echinoderm *Clypeus ploti* loose on the floor of the quarry, although the Grit was not seen in situ. The Yellow Stone, which is a freestone, is unusual in two respects. Firstly, it is richly fossiliferous, and secondly, most of the 20 to 30 feet exposed is permeated by brown pipes; similar structures elsewhere, produced by the boring of annelids and bivalves, are restricted to the few inches immediately beneath the unconformity. The Upper Trigonia Grit is absent here, having been overlapped by the Clypeus Grit.

Locality B. First railway cutting west of Notgrove Station (SP 086199)

The following succession is now exposed:-

Upper Inferior Oolite	(Clypeus Grit	40' 6"
	(Upper Trigonia Grit	4' 6"
Middle Inferior Oolite	Notgrove Freestone	12' 8"

This locality is closer to the core of the Cleeve Hill syncline than the previous one; therefore the Upper Inferior Oolite rests on an upper member of the Middle Inferior Oolite. Further, the Upper Trigonia Grit, the usual basal member of the Upper Inferior Oolite, is present here. In one block of Upper Trigonia Grit, casts of both *Trigonia costata* and *T. duplicata* were found. The latter fossil is indicative of the Upper rather than Lower Trigonia Grit age of the formation. The ammonite *Parkinsonia* was also found in the Upper Trigonia Grit; ammonites are rare in the Cotswolds. The top few inches of bored Notgrove Freestone were located.



Text-Fig. 1. The relations between members of the Inferior Oolite in the Cotswolds

Folds:- (a) Painswick syncline (b) Birdlip anticline (c) Cleeve Hill syncline (d) Moreton anticline

Succession:- UPPER INFERIOR OOLITE (15) Clypeus Grit (14) Upper Trigonia Grit

(Upper Bajocian Unconformity)

MIDDLE INFERIOR OOLITE (13) Phillipsiana and Bourguetia Beds (12) Witchellia Grit (11) Notgrove Freestone (10) Gryphite Grit (9) Buckmani Grit (8) Lower Trigonia Grit

(Middle Bajocian Unconformity)

LOWER INFERIOR OOLITE (7) Tilestones, Snowshill Clay and Harford Sands (6) Upper Freestone (3) Pea Grit (2) Lower Limestone (1) Scissum Beds

Localities:- A to M

Based in part on Crown Copyright Geological Survey diagram (Plate XII, Kellaway and Welch 1961) by permission of the Controller of H. M. Stationery Office.

Locality C. Old Slate Quarry, Salperton Downs (SP 079213)

Although the rocks in this quarry belong to the Stonesfield Slate division of the Great Oolite and are thus outside the stratigraphical scope of the excursion, the locality was visited to see the joint pattern. Throughout the Cotswolds four major joint sets are developed. They are usually orientated normal to bedding surfaces (the kathetal condition, cf. Hancock 1964); two of the sets frequently bear nearly horizontal slickensides. At many outcrops only two or three of the sets are well exposed, but here all four can be seen juxtaposed in the north-eastern corner of the quarry. Two of the sets show conspicuous slickensides in vein calcite, and the relationship between them and the unslickensided sets is also well displayed. (The author is preparing a separate account of jointing in the Cotswolds which he hopes to present shortly).

From the Old Slate Quarry the party drove eastwards into the core of the Cleeve Hill syncline.

Locality D. Rolling Bank Quarry, Cleeve Cloud (SO 988268)

At this classic locality the following succession is exposed:-

Upper Inferior Oolite	(Clypeus Grit	about 12'	
	(Upper Trigonia Grit	9'	0"
Middle Inferior Oolite	(Phillipsiana Beds	10'	1"
	(Bourguetia Beds	about 10'	

The Bourguetia and Phillipsiana Beds are the youngest Middle Inferior Oolite rocks preserved in the Cotswolds. Fossil collecting from these horizons is now difficult owing to the large number of parties which visit the exposure. The rocks dip W. N. W. at 12 degrees. This unusually high dip for the Cotswolds is due to the past outflow of the underlying Liassic clay into the Vale of Severn, and the consequent lowering of the limestones on the scarp edge. A small normal fault, also a result of the clay outflow, cuts the cambered sheet of limestone. These phenomena were the first superficial structures (cf. Hollingworth, Taylor and Kellaway 1944) the party had seen in the Cotswolds.

From the Rolling Bank Quarry the party returned to Cheltenham for the evening.

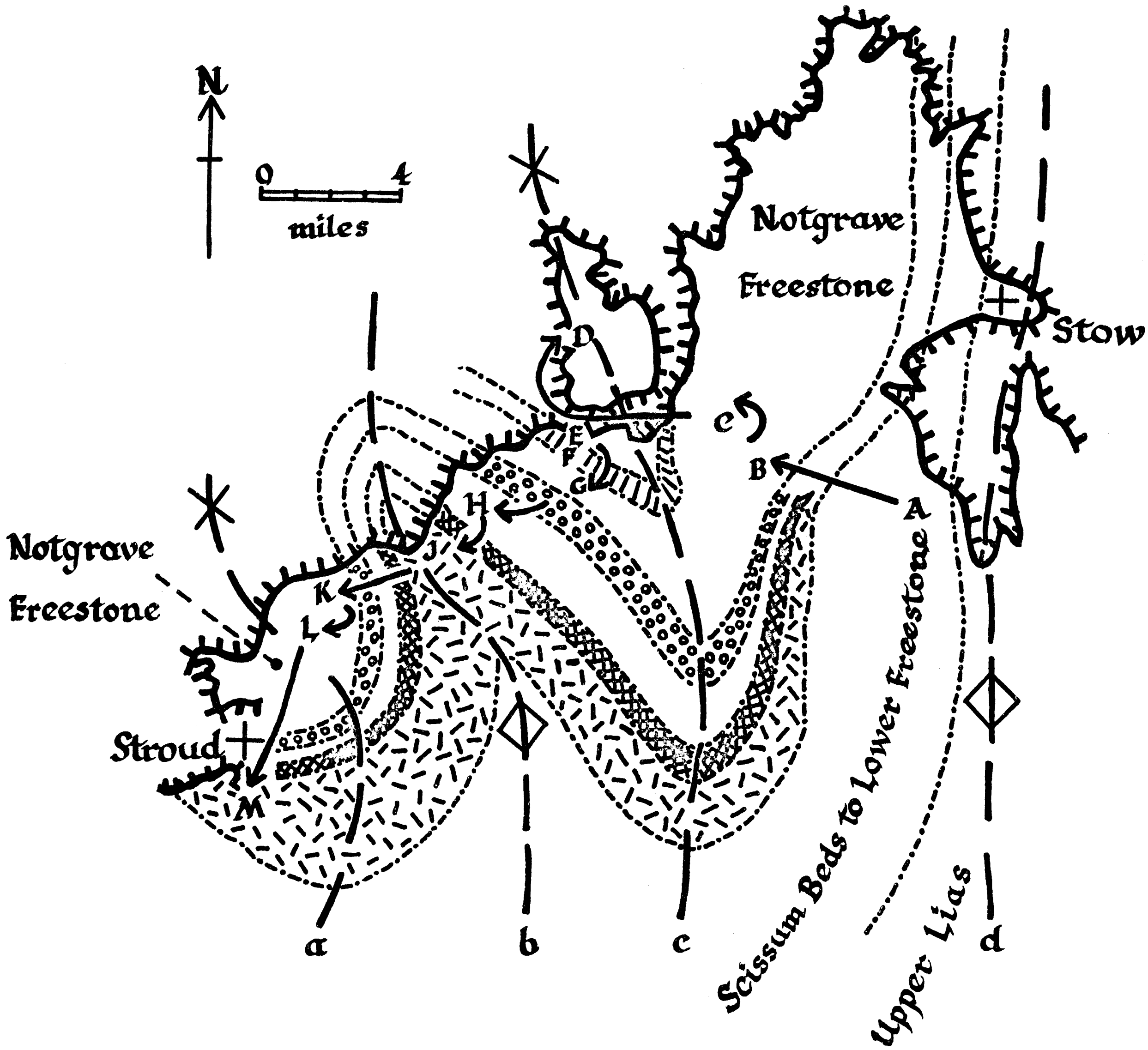
After dinner the party visited the Geological Department of St. Paul's College of Education at the kind invitation of Mr. W. Dreghorn, Senior Lecturer in Geology. He demonstrated a number of models illustrating the geology of the Cotswolds, and explained his techniques for instructing teachers in methods of presenting rock studies to children.

Locality F. Salterley Grange Sanatorium Quarry, Cheltenham (SO 946177)

In this quarry the top bed of the Pea Grit is overlain by at least 40 feet of cross-bedded Lower Freestone. The main interest of the quarry, however, lies in the structural details it shows.

The western face displays what appears to be a small moderately-dipping fault, striking at right angles to the exposure, which according to Ager (1964 p. 10) is a reversed fault. Close inspection reveals that it is a vertical fault, striking parallel to the quarry face and downthrowing about 3 feet east-north-east. Its apparently reversed nature is an effect produced by the rocks on the downthrow side standing a few feet east of the main face, and being separated from that face by a gently sloping track.

Two master sets of vertical kathetal-joints at right angles to each other are present. The N. E. -S. W. trending set bears gently plunging slickensides. Joints of the N. W. -S. E. set frequently



Text-Fig. 2. The route followed and the localities visited, shown on a map of the floor beneath the Upper Bajocian Unconformity.

The generalised base of the Middle Jurassic is shown by a continuous line hachured on one side. The approximate route followed is shown by the arrows and the locality positions by their index letters. Fold axes are shown using the conventional symbols. The lower case index letters accompanying then are used as on Text-Fig. 1. The ornamentation of the beds is also the same as that used on Text-Fig. 1.

Based in part on Crown Copyright Geological Survey diagram (Fig. 22, Kellaway and Welch 1961) by permission of the Controller of H. M. Stationery Office.

gape for a few inches. This incipient "gulling" was attributed by Dury (1959, Plate 75) to frost action. An alternative explanation is that because the outflow of the underlying Liassic clay towards the Vale of Severn was in a direction nearly normal to the set, it caused the gaping. The generally more closed nature of the joints of the N.E.-S.W. set is also accounted for by this explanation, since they strike sub-parallel to the postulated flow direction. Widening by frost action should be non-selective with respect to joint trend.

Locality H. Leckhampton Hill Top Quarry, Cheltenham (SO 951180)

Leckhampton Hill is situated south of the Cleeve Hill syncline axis. The Upper Trigonia Grit rests upon about 2 feet of Notgrove Freestone, itself overlying Gryphite Grit. The bored and oyster covered non-sequence is well displayed on the north face of the uncultivated part of the quarry. The oyster pavement in the Gryphite Grit is now poorly exposed owing to a thin rubble cover on the quarry floor. Abundant specimens of the bivalve Trigonia costata and the brachiopod Acanthothyris spinosa were obtained from the Upper Trigonia Grit. The Gryphite Grit yielded some imperfect specimens of Gryphaea sublobata.

Locality I Tuffley's Quarry near the Air Balloon (SO 933158)

The succession, which is well preserved seventy years after it was first described by Buckman (1895, p. 408), shows:-

Upper Inferior Oolite	Upper Trigonia Grit	about 4'	
Middle Inferior Oolite	(Buckmani Grit	6'	4"
	(Lower Trigonia Grit	3'	10"
Lower Inferior Oolite	Upper Freestone	about 10'	

The Notgrove Freestone, which was present at the last locality, is absent here because Tuffley's quarry lies 2 miles closer to the Birdlip anticline axis.

On the other side of a small valley in the escarpment from the quarry, Lower Freestone is exposed in another quarry at the same topographic level. The northerly downthrowing Shab Hill fault follows the valley.

After collecting in the quarry, the party visited the Air Balloon for lunch.

Locality J. Road cut below the Royal George Hotel, Birdlip (SO 926145)

Situated on the Birdlip anticline axis, this exposure shows the Clypeus and Upper Trigonia Grits resting directly on Upper Freestone. The non-sequence surface is bored and oyster encrusted. The lower part of the section also displays the Oolite Marl and Lower Freestone.

From Birdlip the party drove to Painswick Beacon and climbed the hill for the splendid panorama it affords of the Cotswolds, Vale of Severn, Malvern Hills and Forest of Dean. Whilst descending the hill due west from the Trig. point to the upper lip of the next quarry, it was possible to see the cambered nature of the limestones forming the hill. In the quarry immediately below the vantage point (Locality K) limestones dipping west at 30 degrees are visible, while nearly half a mile to the north, on the eastern side of the narrow steep-sided hill, another quarry (Locality L), containing limestones dipping 30 degrees east, can be seen. This apparently anticlinal structure is due to the limestones having been tilted valleywards during cambering.

Locality K. Painswick Beacon Quarry (SO 867121)

The party went down into the quarry for a closer view of the cambered limestones of the Freestone Group. A small normal strike fault downthrowing 3 feet east disrupts the limestones of the southern face.

Locality L. Catsbrain Quarry, Painswick (SO 867114)

Mr. H.W. Bingham, the manager for Portcrete Limited, kindly gave permission for the party to visit the quarry, which contains much of both stratigraphical and structural interest and which is unrecorded in Cotswold geological literature.

The succession is:-

Middle Inferior Oolite	(Gryphite Grit (Buckmani Grit (Lower Trigonia Grit
Lower Inferior Oolite	(Upper Freestone (Oolite Marl (Lower Freestone

The Oolite Marl, Buckmani Grit and Gryphite Grit are very fossiliferous. The sand bed in the Buckmani Grit is thick and conspicuous. Bottom structures in the limestone overlying it are well developed. The Lower Trigonia Grit is soft and in-weathering. The three Middle Inferior Oolite members are preserved here because the locality lies near the Painswick syncline axis.

The moderate easterly dip of the rocks due to cambering has been referred to already. Three normal strike faults downthrowing west, one displaying a maximum slip of about 15 feet, make up, with the cambered limestone, a "dip and fault" structure like those described by Hollingworth et al.(1944) from the Northampton Ironstone Field. In the Lower Trigonia Grit, at the western end of the south quarry wall, there is a conjugate system of small normal faults with displacements of up to 6 inches. Tilted calcite ribs of travertine-coated joint surfaces of all sets demonstrate that the cambering occurred after the joints were formed. The ribs were deposited at the successive surfaces of evaporation of underground water which partly filled the joints before cambering. Four kathetal-joint sets are developed, and can be seen together in the Lower Freestone at the southern end of the quarry. A conjugate pair of moderately dipping joints, at about 60 degrees to the bedding, cuts the Freestones of the southern quarry wall. The joints strike east to west sub-parallel to the principal normal fault system in the Cotswolds. Master joints of this attitude are restricted to the neighbourhood of Painswick.

Locality M. Leigh's Quarry, Selsey Hill, Strough (SO 826026)

The final locality visited lies four miles south of the Painswick syncline axis. As at Birdlip, the Clypeus and Trigonia Grits rest on the Upper Freestone. Middle Inferior Oolite rocks are no longer preserved this far south. In the quarry the Upper Freestone is underlain by the Oolite Marl and the Lower Freestone. The Oolite Marl is unusual; it consists of three beds of hard limestone containing marl partings, rather than being a soft chalky freestone as in the mid- and north-Cotswolds.

The party returned to Nottingham via Moreton-in-Marsh, the Fosse Way and the Motorway. A vote of thanks to the leader was proposed by Mr. R.E. Elliott.

P.L.H.

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THE VOLCANIC VENTS AND POCKET DEPOSITS OF DERBYSHIRE

Leader: Dr. F. Moseley — Sunday, 5th September, 1965

A Sunday excursion was held in the Buxton area, visiting three localities. Two of these, Hughes Bros. quarry at Waterswallows (080750) and Calton Hill Quarry (Derbyshire Stone Ltd.) (118715) were concerned with old volcanic vents; and the third, the Derbyshire Silica Firebrick Co. pit at Friden (179619), with one of the large Trias and drift filled solution holes in the limestone.

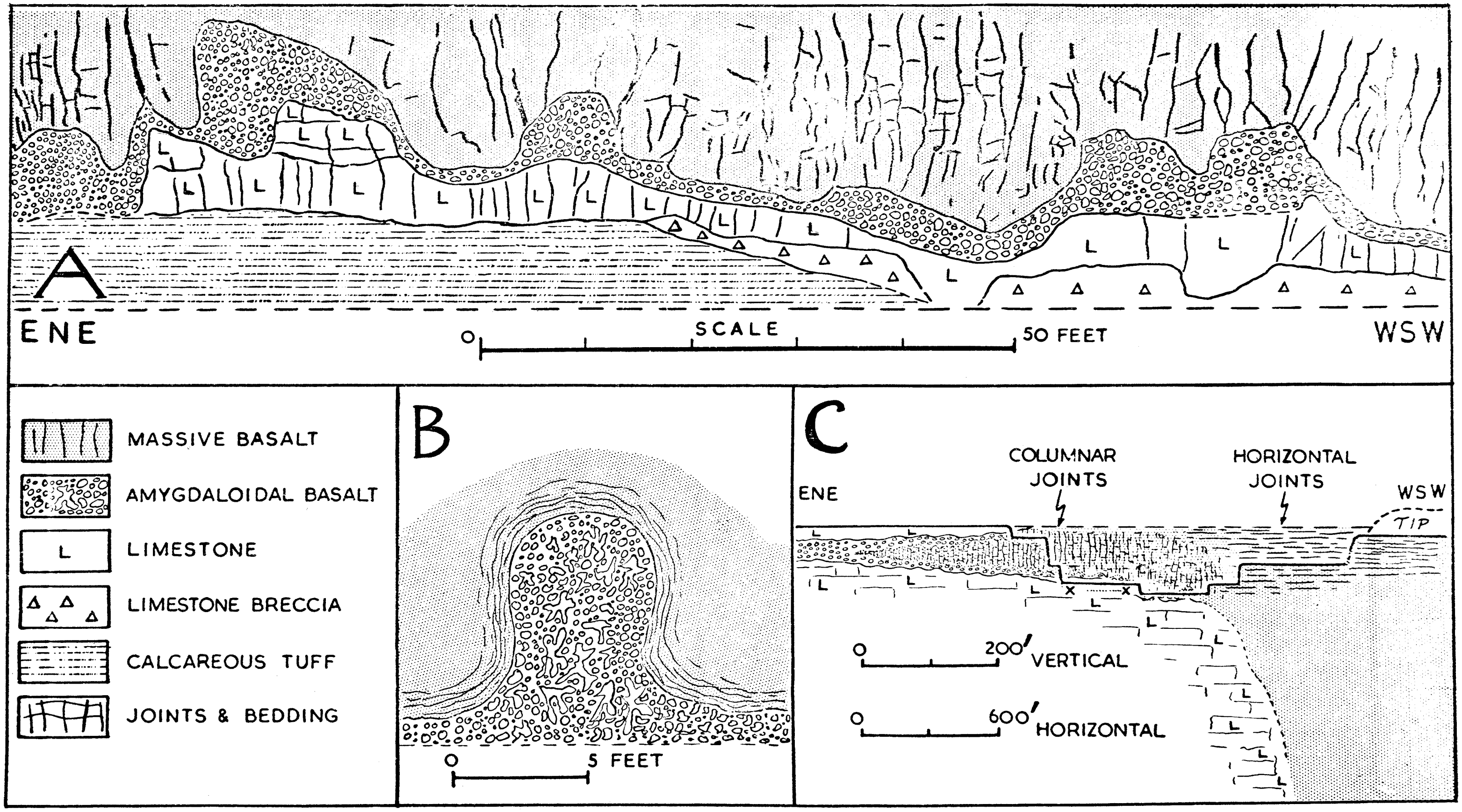
The party assembled at Waterswallows in the soft gentle rain which had been falling for eighteen hours, and waded through a few feet of mud into the large working roadmetal quarry. (Those members with gum boots had a distinct advantage.) The field relations between the basalt and limestone could be clearly seen. Over much of the southern part of the quarry basalt lava with some columnar jointing rests either on tuff or on limestone, whilst immediately to the north of this the basalt - limestone contact plunges steeply, as shown on Text-fig. 1 . The interpretation offered here is of a former volcanic vent with its associated lava and tuff.

The sequence of the lava and tuff is well displayed, especially in a cutting now used for draining the quarry (Text-fig. 1). Limestones overlying the basalt (horizon of *Cyrtina septosa*) can be seen at the top of the quarry. Below it there is amygdaloidal basalt and then massive basalt with crude columnar jointing. The section in the cutting exposes the lower part of this massive basalt and the rocks underlying it. The massive basalt, which becomes finer grained towards the base, overlies amygdaloidal basalt with a sharp contact. There is no transition; the amygdaloid varies from a hard white rock, where it is impregnated by calcite (presumably from the underlying limestone), to a green crumbly chloritic rock and to a dark amygdaloid with irregular calcite geodes. The highly irregular junction between the massive and the amygdaloidal basalt exhibits a number of interesting features. There is for example a series of upward bulges or domes of the latter into the former, whilst within the lower two feet of the massive basalt there is a belt of narrow calcite veins which closely parallel the contact, even where there are sharp upbulges. The lower part of the amygdaloid is frequently decomposed yellow brown, and rests sharply on slightly marmorized limestone. It should be noted that in the lowest level of the quarry 100 yards south west of the cutting, the basalt is underlain by a rather coarse volcanic breccia made up of ash and lava fragments. The limestone in the cutting is only about 5 feet thick and is in turn underlain by calcareous tuff and limestone breccia, the limestone fragments in the breccia being quite strongly altered.

The limestone-basalt junction can be observed to drop quite steeply beneath the lowest levels of the quarry to the west and south-west of the cutting, and at the same time the basalt assumes different characteristics. The columnar joints are replaced by horizontal joints and along these joints there are thin calcite veins. This suggests that there has been vertical extension, and it is likely that this state of affairs could exist in the region of a volcanic pipe.

The exposures to the south of the quarry were not visited but it is worth observing that the massive central part of the basalt eventually thins out, leaving only a vesicular lava, and about 1 mile to the south this also thins out. A similar situation exists to the north of the quarry.

The conclusion therefore is that Waterswallows represents the site of a former volcanic vent with



Text-Fig. 1. Sections at Waterswallows

A. Cutting on the E. N. E. side of the quarry.

B. Upbulge of black amygdaloidal basalt into massive basalt. Amygdaloid with calcite geodes, massive basalt with calcite veins (black lines) parallel to junction. Centre of quarry.

C. Interpretation of the structure of the Waterswallows volcano. X....X is the position of the cutting of section A. E. N. E. end of the section at Hardybarn (089752).

the basalt (accompanied by some tuff) rising up a central pipe and spreading out sideways as a lava flow (the "lower lava" of this part of Derbyshire).

After lunch the party visited Calton Hill Quarry, with the rain still keeping the dust down. The mud here, in fact, was a little deeper than at Waterswallows, but nowhere, in my recollection, was it waist deep. This quarry has changed considerably in character since Tomkeieff described it in 1928, and could well be redescribed, although this would require a detailed resurvey. Little time was spent examining details but alternations of lava and bedded tuff were observed, the latter present in far greater amount than at Waterswallows; and the "olivine nodules" were also in evidence. The exact position of the "true" vent does not seem to be too clear since limestone underlying the volcanic rock has apparently been encountered at a number of points. We did not observe this on the day, perhaps because of the large number of temporary lakes.

The third locality to be visited was the silica sand pit at Friden (the Greater Friden Pit). For some unaccountable reason, and much to everyone's sorrow, the rain had stopped. It thus became impossible to claim that it had poured with rain all day.

There is an excellent private publication describing the "Pocket deposits of Derbyshire" by Dr. Courtenay Yorke, of which many geologists must be unaware (there are only a few copies in existence). The Greater Friden Pit (along with many others) is described in this publication and has also been recently investigated by F.W. Shotton (not yet published; see also Kent 1957).

An upper boulder clay at the top of the pit rests unconformably on early Pleistocene grey clay with wood fragments (spruce and probably larch, see Yorke p. 80) and on sands of various colours; unfortunately the section is not so well exposed now as it was a few years ago. Yorke regards the pit as part of an infilled channel exceeding half a mile in length.

Thus the day's proceedings came to an end and the party departed for home, getting drier every minute, with one hardy member who survived in gym shoes and pullover positively steaming. Gratitude was expressed to the managements of the three quarries visited.

F.M.

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Secretary's Report, June - November 1965

In a sense, this report serves also as an Annual Report in that this issue of the "Mercian Geologist" appears a few weeks before our second Annual General Meeting.

The East Midlands Geological Society, in its two years of existence, has made its mark on the world of geology; our membership is national and the circulation of "The Mercian Geologist" is international. This has inevitably meant an increasing burden of administrative and secretarial work; increased postal charges have caused heavy extra demands on our funds, but nonetheless the Society remains financially sound. A recent problem which has been causing difficulty is that the duplicator, used hitherto in the production of circulars, has had to be given up owing to its advanced age. If any member has, or knows of, a duplicator that might be made available to the Society, the Secretary would like to hear of it.

The summer months have brought a varied programme of excursions. Attendance at these meetings was somewhat less high than last year; nonetheless, the excursions remained popular.

Owing to an alteration of dates enforced by accommodation difficulties, the weekend meeting was postponed. The excursion to view the geology of the M.1. was therefore held earlier, under Dr. Taylor's leadership; this provided an opportunity of examining rock sequences in areas normally not exposed.

The weekend excursion to the Cotswolds, the first such held by our Society, was led by Dr. Hancock. The weather could not have been better had we arranged it ourselves. Members interested in structure and palaeontology found plenty to look at and collect. An unexpected, but welcome, item on the programme was a visit to the Department of Geology of the Teachers' Training College in Cheltenham, where a most pleasant evening was spent.

The excursion in September to view Waterswallows Quarry, Buxton, under the leadership of Dr. F. Moseley, was less fortunate weather-wise. Heavy morning rain failed to prevent us from examining this interesting volcanic complex. The rain cleared in the afternoon for visits to other localities, the party welcoming the opportunity to dry out a little!

Owing to rebuilding currently in progress, the planned October outing, to view the geological collections of the British Museum (Natural History), could not be held. Our indoor session commenced on Saturday, October 30th at Loughborough, with a lecture by Dr. W.A. Cummins entitled "4004 B.C. and All That - Evidence for the antiquity of Man". This was a joint meeting with the Loughborough Naturalist's Society, over 70 people attending.

The second meeting was held at the Regional College of Technology, Nottingham, on Thursday, 11th November. Dr. R.A. Howie, of Kings' College London, lectured on "Gemstones" to an audience over 80 members. The speaker provided an attractive display of gemstone material.

The winter programme includes talks from Dr. F.M. Broadhurst, Dr. T.D. Ford and Professor P.C. Sylvester-Bradley, in addition to the Presidential Address. It is hoped to plan a varied programme for 1966, possibly including a long excursion abroad. We seek to cover all geological interests of our members: the Council are always pleased to receive suggestions for meetings or visits. The past year has seen an increase in our activities and trust this healthy trend will be maintained in the year to come.

R.W. Morrell

Papers treating with any aspect of Midlands geology or on topics of general geological interest will be welcomed for consideration for publication by the Editorial Board. (Authors need not be members of the East Midlands Geological Society). Format should follow that adopted for papers included in this number.

Manuscipts should be addressed to:-

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