THE UPPER PERMIAN AND LOWER TRIASSIC FORMATIONS IN SOUTHERN NOTTINGHAMSHIRE

by

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Summary

Geological information obtained from temporary exposures and supplemented by bore-hole data has added to the knowledge of the Upper Permian and so-called Lower Triassic Formations, west of Nottingham. It suggests that the Lower Magnesian Limestone does not grade laterally into the Mottled Sandstones but underlies the latter formation, the time interval between the two being as yet not determined. The relationship of the Mottled Sandstones to the Middle Permian Marl is also discussed but,as certain underground information may not be available from North Nottinghamshire for some years, this article is restricted to clarifying the relationship of the Permian and the Lower Trias in South Nottinghamshire.

Data has also been obtained regarding the sinuous course of certain east - west faults, which may be explained by local variation in the angle of hade of the fault plane, drag on the beds bordering the fault plane,and topographical effects.

Introduction

The relationship between the Upper Permian and the Lower Triassic Systems,in the North-East of England and in Nottinghamshire particularly, has always provoked lively discussion. The Mottled Sandstones and the Pebble Beds were considered by the early workers to be Triassic in age, in consideration of circumstances found elsewhere in the Midlands, and to rest unconformably on the Permian rocks below. These were the views of people like Sedgwick (1829), Aveline (1877), Irving (1882) and Trechmann (1930), and although ideas about the size of the unconformity have been modified, Officers of the Geological Survey continued to map the Mottled Sandstones and Pebble Beds of Nottinghamshi re as Trias (Derby Sheet, No. 125). In the latest revision published (Chesterfield Sheet, No. 112, 1963), some lithologies similar to that of the

'Lower Mottled Sandstone' have been mapped as Permian but the 'Lower Mottled Sandstone' as a whole remains firmly in the Trias.

The idea that the extent of the unconformity was over-estimated was first advanced by Wilson (1876, 1881) and fully discussed by Sherlock (1911), who went further and stated that the Mottled Sandstones and the Pebble Beds were the lateral equivalent of certain Permian beds. Trechmann (1930) actively criticised these conclusions, but no other author has strongly recommended that the Lower Trias in North East England just does not exist. The situation has not been simplified by Swinnerton (1948), who described the occurrence of dolomite in the lower beds of the Mottled Sandstones. These were the lowest beds at outcrop, and in fact are about mid-way in the Mottled Sandstones sequence.

Extensive building and road improvement schemes have provided numerous temporary exposures in the vicinity of Nottingham University, which have yielded valuable geological information regarding the relationship of the Lower Magnesian Limestone and the Mottled Sandstones at the Southern end of the Permian outcrop. An examination of text-fig. 1 shows the north - south outcrop of the Upper Permian rocks terminating south of a line from Strelley to Aspley, where the unconformity continues eastwards to the Leen Valley near Old Radford, where the Upper Permian rocks are overlain by Mottled Sandstones and Pebble Beds. To the south, separated by a narrow inlier of Middle Coal Measures, are lithologically similar rocks striking east - west. These formations rest directly on Coal Measures, lithologies normally assigned to the Upper Permian not being apparently present.

The exposures described in this article are located in the critical area, where the Upper Permian sediments terminate and are succeeded to the south by the Mottled Sandstones and Pebble Beds. The character of the lithological formations of the Systems at these localities is compared with the succession elsewhere in Southern Nottinghamshire and the relationship of the Mottled Sandstones to the Lower Magnesian Limestone and the Red Marls above, in the area west of Nottingham, is discussed. Unfortunately, until further information is made available from North Nottinghamshire, no decisive conclusions can be drawn regarding the relationship of the Mottled Sandstones and the Pebble Beds to the Upper Permian as a whole (including now the Upper Magnesian Limestone and the Upper Red Marls of Yorkshire and Durham). This is considered to be outside the scope of the present contribution.

The temporary exposures described are:-

(a) The Catstone Hill opencast site near Strelley.

(b) The Beechdale Road - Bobbers Mill sewer improvement scheme.

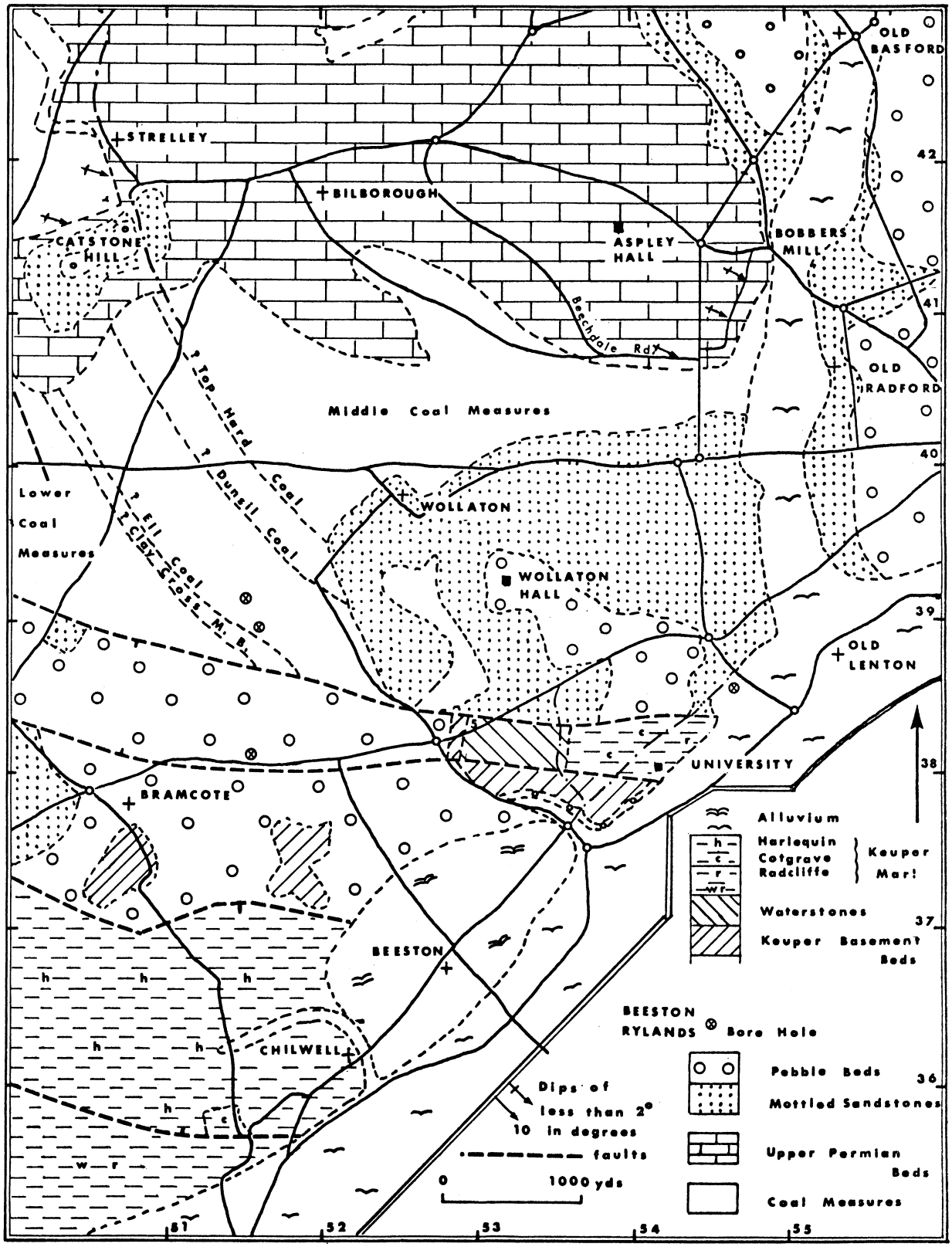
(c) The Derby Road (A. 52) dual carriage way.

(d) Nottingham University expansion programme.

Bore-holes described are at Nottingham University; Derby Road, Bramcote (N. C. B.); Beeston Rylands (Boots Ltd.,); Plumtree (N. C. B.); and information is also used from bore-holes entirely in Coal Measures situated close to Model Farm, near Wollaton (N. C. B.). With the exception of the Plumtree bore-hole, the positions of the bore-holes are shown on text-fig. 1.

Permo-Triassic stratigraphy of the Nottingham area

The Kimberley railway cuttings (SK 500450) still offer the most complete Permian lithological sequence to be found in the Nottingham area. To the east, at Bulwell, beds hitherto presumed to be Lower Triassic are found, ending with the Pebble Beds, and east of Nottingham the Triassic sequence is completed by the Keuper Basement Beds, Waterstones and Keuper Marl. The sequence given below is compiled from these areas. Earlier descriptions can be found in Geological Survey Memoirs, especially Gibson et al.(1908).



Text-fig. 1 The geology of the area to the west of Nottingham

Swinnerton (1910, 1914, 1918) has written a number of papers on this topic and lately the stratigraphy of the Keuper Series has been revised by Elliott (1961); this paper is the first modern description of the Upper Triassic formations. The lithological divisions are tabulated below:-

	Lithological divisions	Thickness	Previous Stratigraphical terminology
Upper Trias	Keuper Marl	600 feet	Trent Formation, Edwalton Formation, Harlequin Formation Carlton Formation, Radcliffe Formation.
	Waterstones	100 feet	Waterstones Formation
	Keuper Basement Beds	0 - 25 feet	Woodthorpe Formation
		non-sequence	
?Lower Trias	Pebble Beds	100 - 200 feet	Bunter Pebble Beds
	Mottled Sandstone	0 - 100 feet	Lower Mottled Sandstone
Upper Permian (Zechstein)	Red Marls	0 - 25 feet	Middle Permian Marls.
	Magnesian Limestone	17 - 25 feet	Lower Magnesian Limestone
	Dolomitic Siltstones	0 - 20 feet	Marl Slate or Lower Permian Marls
	Basal Breccia	0 - 8 feet	Permian Breccia
		unconformity	
Middle Coal Measures including;-	Top Hard Coal Group Dunsil Coal Waterloo Coal Group and the Ell Coals	about 300 feet	
-----	Clay Cross Marine Band	----------	Lower Coal Measures
Lower Coal Measures including:-	Deep Soft Coal Deep Hard Coal 1st Piper Coal	about 200 feet	

The Permian System

The Basal Breccia. Lying on top of the Coal Measures, north of Nottingham, occurs a thin but remarkably persistent breccia. Its maximum thickness in the Mansfield area is 8 feet, but it is usually much thinner than this. The rock has been described by Wilson (1876 & 1881) and by Gibson (1908 p. 103). The fragments, generally up to 2 inches in length, are angular and are composed of the underlying Carboniferous rocks, including Coal Measures and Millstone Grit Sandstones, limestones and blocks of shale and coal. Other fragments, consisting of volcanic and intrusive rocks, could have been derived from the Charnwood Forest area, or other outcrops of similar rocks. They are all set in a sandy calcareous matrix making a well cemented rock, extremely hard, differing from other unconsolidated breccias described from younger beds in the text below. The underlying Coal Measures are coloured green and red, the possible result of subaerial weathering before deposition of the breccia.

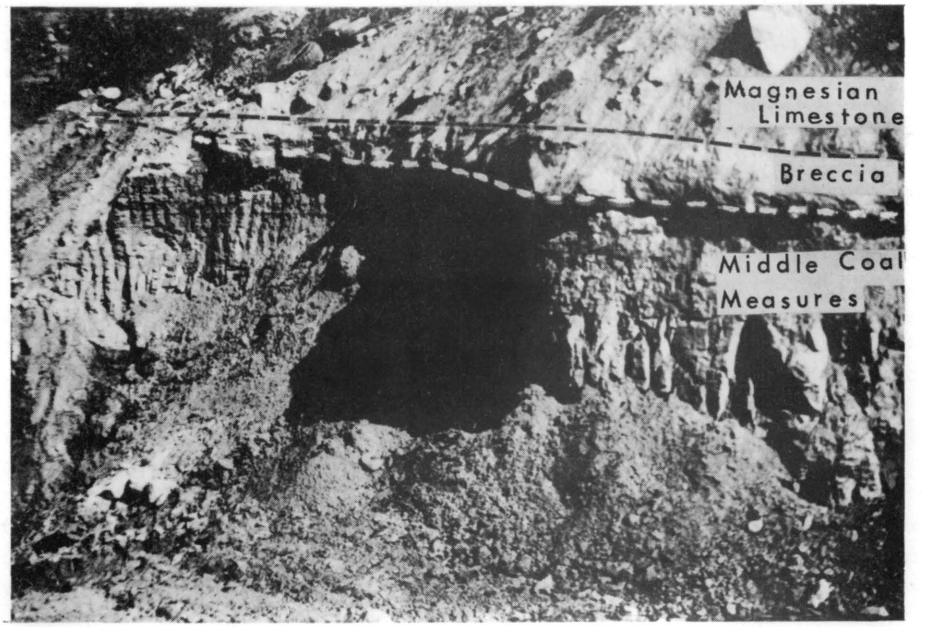


Fig. 1. The Permian Unconformity at Catstone Hill.

Fig. 2. General view of the north east corner of the Catstone Hill opencast coal site, looking down onto the Dunsil Coal.

Photos: F. M. Taylor

The Dolomitic Siltstones. The succeeding beds are fine grained siltstones, rich in dolomite and containing abundant plant remains and mica. The beds are frequently finely laminated, showing sedimentary structures, including current bedding and 'cut and fill' structures. When freshly exposed the beds are grey in colour, but they quickly turn buff or brown when exposed to the atmosphere. The plants in these beds are similar to those found in the Marl Slate of Yorkshire and Durham, which contain in addition fish remains. The details of the flora have been described by Stoneley (1958), who compares it with the Hilton Plant Beds of Westmoreland and the 'Kupferscheifer' of Germany. The fossils from the Marl Slate thus fix the Upper Permian (Zechstein) age of the Permian deposits of North East England generally, and Nottinghamshire in particular; this conclusion is supported by correlations determined from the abundant shelly fauna of the overlying Magnesian Limestone of Yorkshire and Durham.

The Magnesian Limestone. The Dolomitic Siltstones quickly change to the Magnesian Limestone, which, in South Nottinghamshire, is medium to coarse grained; the dolomite crystals frequently attain a length of 2 mm. Most of the rock is soluble in boiling acid, the insoluble residue being a small amount of fine detrital silica (sand). The deposit is thinly bedded and current bedding can be traced in most exposures. The large size of the dolomite crystals may be due to the agitation of the growing crystals by currents. This formation of the Permian is probably the most consistent in character, increasing in thickness northwards, but the southern margin, the main subject of this paper, shows a number of changes. The only fossils found are casts of lamellibranchs, showing little morphological detail but generally referred to Schizodus sp.. The Magnesian Limestone of Nottinghamshire is correlated with the Lower Magnesian Limestone of Yorkshire, a correlation supported by the plants found in the Dolomitic Siltstones below.

The Red Marls. Throughout the greater part of the Nottingham area, the highest Permian beds consist of dark red or maroon mudstones and fine siltstones, with frequent green seams and patches. They are brighter in colour than the Keuper Marls and are typically fine grained. Evaporite minerals are rare in the mudstones, but these mudstones have only been examined in the weathered zone and the minerals could have been leached out. Hard dolomitic siltstones and limestones, up to two feet thick, are frequent. Lateral facies changes are common, the mudstones changing into red siltstones, accounting for the irregular commercial exploitation of this deposit. Less frequently, sand deposits occur (Sherlock 1911), similar in lithology to the mottled sandstones, although the colours are usually much lighter.

The Triassic System. Descriptions of the Triassic formations, from the Mottled Sandstones up to the Keuper Marl have been given in a previous paper (Taylor, 1964, pp. 24 - 27) and are not elaborated further here. It can be said that both the Pebble Beds and the Mottled Sandstones thicken eastwards and northwards, as shown by Swinnerton (1948 p. 58, text-fig. 6 - 1), and that these two formations are lithologically distinct as far north as Mansfield.

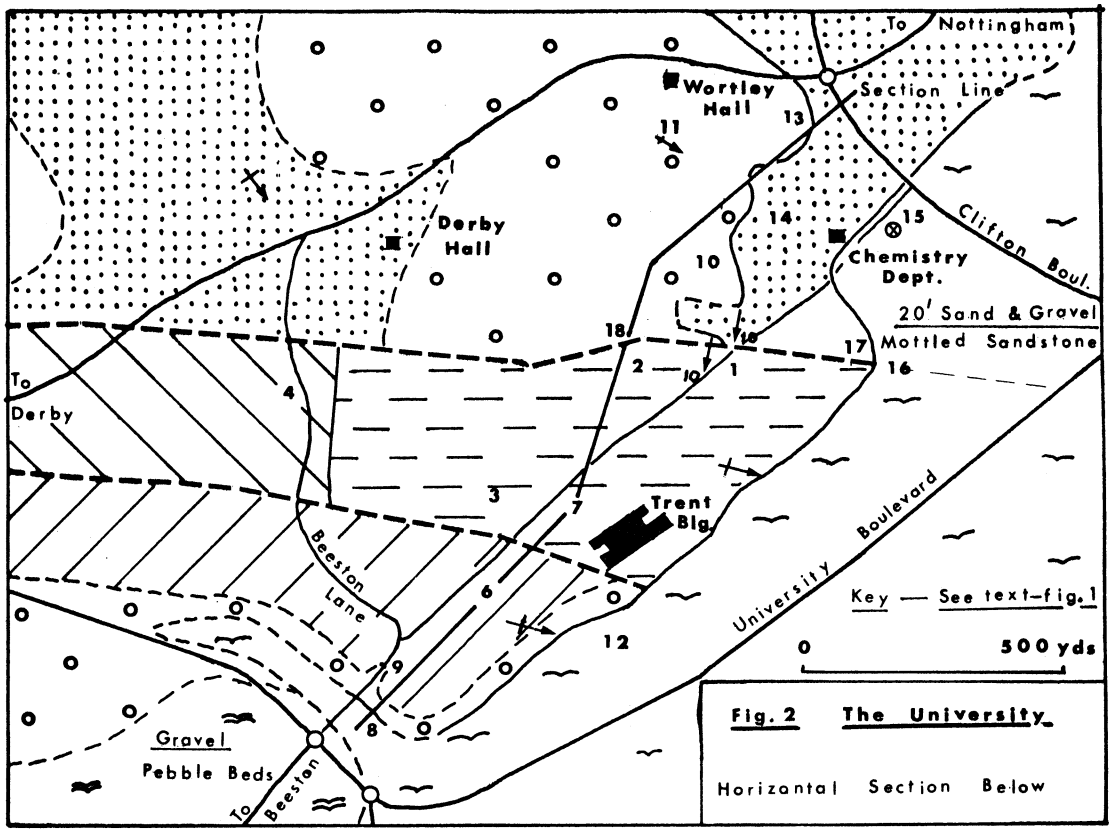
The Catstone Hill open-cast coal site

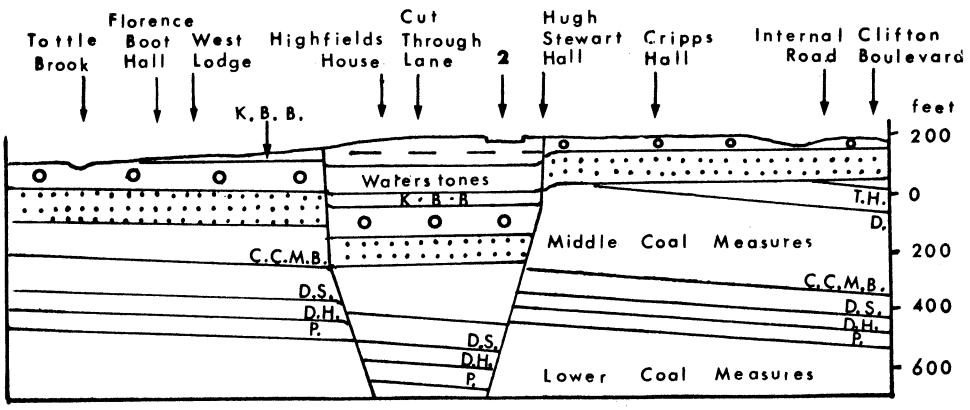
Post-Carboniferous beds were formerly to be seen in the eastern part of this site (SK 506417) in that part found south of Strelley Church and north of Catstone hill Farm. The open-cast site is adjacent to the Catstone Hill sand quarry which allows an extension upwards of the sequence. The local sequence is:-

?Lower Trias	Pebble Beds	2 - 3 feet	Sand Quarry
	Mottled Sandstones, dune bedded	20 feet	
	Gap	approx. 5 feet	
Upper Permian	Magnesian Limestone, thinly bedded and with thin beds of unconsolidated breccia	20 feet	Open-cast Coal Site
	Breccia	0 - 5 feet	

unconformity

Middle Coal Measures — Top Hard Coals, Dunsil and Waterloo Coals.





Text-fig. 2 Locality numbers: (1) Cut Through Lane; (2) Clay Pit (tennis court) at Hugh Stewart Hall; (3) Social Science Building; (4) Beeston Lane; (5) The Priory, on text-fig 1 only; (6) Trench connecting (7), Highfields House and (8) Florence Boot Hall; (9) West Lodge; (10) Old quarry north of Cut Through Lane; (11) Wortley Hall; (12) University Park Lake; (13) Internal Road; (14) Chemistry Department; (15) Tower Block; (16) Geology and Psychology Departments; (17) Biology Departments; (18) Hugh Stewart Hall.

Details of the Permian sequence. The breccia was seen to form a prominent bed, about four feet thick, occurring at the southern end of the exposure, but northwards the sandy limestone rested directly on a Coal Measures sandstone (Plate 10). Within the sandy Magnesian Limestone thin seams of breccia could be found, consisting of small (less than $\frac{3}{4}$ inch in length) fragments, embedded in a sandy matrix.

In this locality, then,the Dolomitic Siltstones were not found having thinned out to the north. The Magnesian Limestone contains a high percentage of sand, and is comparable with the old quarry close to Strelley Church (SK 505423); thin seams of breccia are frequent. These types of sediments continue to the top of the opencast coal site, where they were overlain by recent pebbly gravels. Less than 80 yards to the south east is the adjacent sand quarry, excavated about 15 feet below the surface;but the beds have an easterly dip of a few degrees. By projection, this would bring the level of the floor of the quarry a few feet above the top beds in the opencast quarry. Unfortunately no information is available regarding the continuation of the Mottled Sandstones at depth, although it seems unlikely that the quarry would have been abandoned if the lower limit of the sands had not been reached. In the field separating the quarry from the opencast coal site there was no indication of marl overlying the Magnesian Limestone. If it is present it must be very thin, probably less than 5 feet (see also below).

It would seem likely,then, that at Catstone Hill, the Mottled Sandstones rest directly on the sandy dolomites and breccias of the Lower Magnesian Limestone. The exposure compares with other localities to the north at Cinderhill and Hempshill Lane, Bulwell, where Shipman (1889) recorded the Mottled Sandstones overlying Magnesian Limestone, the junction marked by a layer of breccia and with thin seams of breccia occurring just above the base. The presence of marl in the lower part of the Mottled Sandstones is one of the important characteristics of this formation which enables its exploitation as a moulding sand. The clay occurs as a distinct fraction of the deposit, up to 15%,and may have been obtained by erosion of the underlying marl and its incorporation into the sandstones above. This would suggest a subsequent deposition of the Mottled Sandstones to the Middle Permian Marl, rather than a contemporaneous sediment.

In other localities (Sherlock 1911) there appears to be an upward passage of the marl into sandstone, with a varying thickness of marl underneath. This is said to be evidence for continuity of the Permian and the 'Trias', but again the upper beds of marl could be eroded by currents supplying the sand.

Lateral passages of the marl into sandstone have been claimed in a few exposures. It is not now possible to examine these in detail at outcrop, but the sandstone seen above the marl at the White Sandstone Quarry, Mansfield, and said to pass laterally into the marl, is of a different lithology and colour to that seen in the Berry Hill Quarries above and does not in fact apparently correspond to the Mottled Sandstone.

Beechdale Road to Bobbers Mill

A deep trench, in places cut down to 24 feet was excavated from Beechdale Road (SK 538408), Western Boulevard, to Bobbers Mill (SK 544414). The trench was cut along the dip and strike directions of the Magnesian Limestone throughout its length. In many places the underlying Coal Measures were penetrated, giving the following characteristic sequence:-

Red Marl	0 - 12 inches
Sandy Magnesian Limestone with thin breccias	10 - 20 feet

unconformity

Coal Measures.

At Beechdale Road, the complete thickness of the Magnesian Limestone was exposed at the extreme southern end of its outcrop, possibly for the first time. It maintains a uniform thickness throughout

and although sandy, and containing breccias, shows little sign of passing into shore-line sediments, for example conglomerates or scree deposits, or of changing into coarse sandstones. Indeed, the rocks at Catstone Hill opencast coal site indicated a closer proximity to a shore-line than the Beechdale Road exposures. Throughout the excavation, about 1 mile in length, there was no sign of Dolomitic Siltstones, hard Basal Breccia or Mottled Sandstones lithology.

The Red Marl forms a thin cover above the limestone in the trench. Soil characteristics suggest that a similar cover is present over the Limestone in the Aspley-Bilborough area (cf. Lamplugh, 1908).

Nottingham University

The geological survey of the University site (SK 541380) was made possible because of the present extensive building programme with ancillary schemes, involving the description and logging of numerous trenches. A deep bore-hole is recorded, and also underground information kindly supplied by the National Coal Board. The distribution of the rocks and the area surveyed is shown in detail in text-fig. 2.

The local geological sequence is as follows:-

Keuper Marl	100 feet
Waterstones	80 feet
Keuper Basement Beds	20 feet
Pebble Beds	100 feet
Mottled Sandstones	100 feet

unconformity

Middle Coal Measures including the	Top Hard Coal
	Dunsil Coal
	Waterloo Coals
	Ell Coals
Lower Coal Measures including the	Deep Soft Coal
	Deep Hard Coal
	Piper Coal

The Mottled Sandstone. The oldest formation seen on the University site is well exposed behind the Chemistry Building (14); localities are indicated by these numbers on text-fig. 2. It consists of fine to medium grained red sandstones, with buff seams and irregular patches. The deposit is poorly cemented, exhibits current bedding, and is without pebbles. A small percentage of marl is associated with the lower beds. The most interesting factor regarding the deposit is the rare occurrence of evaporite minerals in the lowest beds of this exposure. These usually take the form of dolomite crystals (Swinnerton 1948, p. 55), possibly blown into the sand from the north, which acts as a cement giving locally a relatively hard bed. The full thickness of the Mottled Sandstones was proved in a bore-hole situated near the Electrical Engineering/Architecture tower building (15) (See Appendix A). 63 feet of sandstones were cored in the hole, which was situated about 35 feet below the junction of the Pebble Beds giving a total thickness of 98 feet. Towards the base of the sandstones, sub-angular pebbles were recorded, up to 2 inches in length. These were concentrated into a breccia in the lowest 4 feet.

A more recent bore-hole at Plumtree (Appendix B), south of the River Trent, has also pierced the Mottled Sandstones. The breccia was made up of green and grey sandstone fragments, angular and up to three inches in length, being set in a red sandy matrix. The sandstone above was medium grained, somewhat coarser than that at the University but without pebbles or marl disseminated through the deposit. The base of the Pebble Beds in the bore-hole was marked not only by a colour change but also by a breccia similar to the one at the base of the Mottled Sandstones.

The Pebble Beds. Old Quarries for these beds were located adjoining Cut Through Lane(10), below Wortley Hall (11) and alongside the University Park Lake (12). The pebble beds are of the variety found throughout Nottingham - buff coloured, coarse sandstones with pebbles scattered throughout. The rocks are poorly cemented and exhibit current bedding structures. The concentration of pebbles at the top of the formation is comparable with that described by Swinnerton (1948 p. 57). At the University this layer at outcrop has been greatly disturbed by landscaping, which has partially destroyed the features at its boundaries. The junction of the Pebble Beds with the Mottled Sandstones is gradational and occurs at the level of the road (13) linking the Derby Road - Middleton Boulevard entrance with Cut Through Lane. First of all pebbles become extremely rare, and then a colour change from buff to red occurs, accompanied by a decrease in grain size.

The Keuper Basement Beds. The beds above the Pebble Beds were exposed for a short time in a trench (6) running from Highfields House (7) to Florence Boot Hall (8). They consist of alternating layers of red marl and fine, buff coloured sandstones, only poorly consolidated and infrequently containing small angular pebbles. Each of these layers is approximately 3ft.6 ins. thick.

The junction of the Keuper Basement Beds with the Pebble Beds below was seen at Beeston Lane (9), where a thick bed (3 ft. 6 ins.) of Bunter Pebbles was overlain by three feet of red marl. There was no sign of conglomerate (the Keuper Conglomerate) although this bed is recorded east and west of the University (Swinnerton 1948, p. 57). No Keuper Basement Beds were recorded in the Beeston Rylands bore-hole, (Appendix C) sunk to the south of the University.

The Waterstones. A series of fine sandstones, thinly bedded, brown in colour and with interbedded marl, overlie the Keuper Basement Beds. The junction has not been seen on the University site (but see Elliott 1961, p. 226) and the rocks are only seen in temporary exposures, as at Beeston Lane (4), although a more permanent exposure exists just outside the University on Derby Road, close to the Priory Inn (5; text-fig. 1). The formation is distinguished by the presence of mica and by the absence of gypsum. From the extent of this formation on the map it is thought that the Waterstones must be about 100 feet thick, which would compare with the 120 feet noted in the Beeston Rylands bore-hole (Appendix C).

The Keuper Marl. An old marl pit, (2) (now Hugh Stewart Hall tennis court) and an embankment along Cut Through Lane (1) still expose the Keuper Marl. Good sections were also seen in the foundation excavations for the Social Science Building (3), where the Keuper Marl consisted of dark red mudstones with thin green seams and patches. Fine siltstones may replace the mudstone lithology. Throughout the University site, the marl has been leached of any gypsum it may have contained. A series of skerry beds (thin grey-green dolomitic siltstones and fine sandstones) form the top of the sequence. The beds are very hard and contain sedimentary structures which include ripple marks, slump structures, and salt pseudomorphs. Gypsum, calcite and dolomite occur throughout. Although the layer of marl containing ramifying greenish patches referred to by Elliott (1961, p. 218) has not been located by the writer, this series of skerry beds would seem to be approximately the same horizon as that of the Plains Skerry; hence the formation names given in text-figs. 1 and 2.

Structure. Cutting across the University site are two large east - west faults. The Clifton fault to the north is well exposed at Cut Through Lane (1) where Keuper Marl on the south side is thrown against Pebble Beds, lighter in colour than is usual, on the north. The drag of the beds close to the fault plane can clearly be seen and accounts for the presence of the Mottled Sandstones only a few yards to the north, these beds also dipping south at 10°. The vertical throw of the fault, estimated from formation thicknesses, must be about 250 feet, which compares with the figure of 70 to 80 yards obtained from data supplied by the National Coal Board. The Clifton fault hades to the south at angles which differ in the Coal Measures and the Trias. From the N. C. B. data, the hade is from 65 - 70°, whilst in the Triassic rocks it has been seen to vary from 75 to 85°, more commonly 85° (text-fig. 2). The fault can be traced from the site of the Geology Department (16) to the Biology Building (17), where a very hard conglomerate is involved with the fault plane. There is nothing like it recorded 'in situ' from elsewhere on the University site, although it is

lithologically similar to the Pebble Beds the cement hardening the rock could have been introduced along the fault plane) or the Keuper Conglomerate, although this is not found elsewhere on the University campus. The fault continues across Cut Through Lane and underneath Hugh Stewart Hall (18). Here, the hade of the fault decreases and it continues westwards with a slightly different strike.

The Highfields fault to the south hades north at 65 - 70° in the Coal Measures and 85° in the Triassic rocks. At the surface, Keuper Marl is thrown against Keuper Basement Beds, the vertical displacement in both Coal Measures and Trias being about 150 feet.

The effect of the two faults is to produce a trough, in the centre of which the Keuper Marl is located. Both faults can be traced eastwards until they become overlain by the alluvial deposits of the River Trent, and westwards into Bramcote, where the throw gradually decreases.

The re-survey of the University grounds shows that all the supposed Triassic formations are present, but that there is little indication of Permian deposits. This indication is limited to the occurrence of dolomite crystals in the Mottled Sandstones which may have been blown into the sand during wind erosion of dolomitic limestones to the north. In the short distance south from Beechdale Road the littoral facies of the Lower Magnesian Limestone is overstepped by the Mottled Sandstones. Further south still, at Beeston Rylands and Plumtree, the Mottled Sandstones increases in grain size, suggesting approach to a shoreline.

It can be seen from Text-fig. 2, which shows the surface outcrop of the Clifton Fault , that rather abrupt changes of strike occur which may be explained by variations (a) in the angle of hade, (b) in the dip of the beds close to the Fault plane, and (c) in topography. Abrupt changes of strike can also be detected in other east - west faults, for example, the Beeston Fault to the south, although details of this fault have yet to be determined (Taylor 1964, p. 25, text-fig. 1).

The Derby Road Dual Carriage Way

The Highfields Fault has been traced westwards to Bramcote where the fault cuts through Pebble Beds. Records of an old (1922) N. C. B. boring indicate 125 feet of 'Trias' on the north side of the fault (see Appendix D), but the record does not differentiate the Mottled Sandstones from the Pebble Beds, nor does it indicate the nature of the 'Trias' - Coal Measures unconformity. Pebble Beds in this area, exposed during the re-alignment and widening of of Derby Road, are red in colour; the change from buff shades occurs immediately west of the Priory Inn. Within the Pebble Beds, thin layers of red marl were present, with calcite and gypsum crystals on the bedding planes. The throw of the fault in this area is probably less than 50 feet, which would agree with the figure quoted for the westward continuation of the Clifton Fault by Elliott (1961, p. 266).

Conclusions

Exposures at Catstone Hill and Beechdale Road have allowed examination of the Lower Magnesian Limestone at the southern limit of its outcrop. In both localities, although containing sand, it is still lithologically distinct from the Mottled Sandstones. This latter rock, exposed in the grounds of Nottingham University, may contain some wind blown dolomite but is still distinct lithologically from the Lower Magnesian Limestone.

On the evidence available the Lower Magnesian Limestone underlies the Mottled Sandstones separated by an unconformity representing a time factor as yet not determined. The relationship of the Mottled Sandstones with the Middle Permian Marl is still in doubt; it could pass laterally into marl in some localities but in many the Mottled Sandstones overlie the marl and possibly incorporate a varying amount of the Marl on their lower portion. This leaves open the question whether or not the Mottled Sandstones and Pebble Beds are equivalent laterally to the Upper Magnesian Limestone and Upper Marls until evidence from further north provides confirmation or otherwise.

The re-survey of the Nottingham University site has extended the outcrop of the Plains Skerry westwards, to the west of Nottingham (see also Taylor 1964) and recorded the occurrence of the Keuper Basement Beds in that area.

Variations in the angle of hade and in the dip of the beds close to the fault plane combine with topographical effects to explain the sinuous course of certain east-west faults and to suggest they are more complicated than hitherto supposed. It is agreed with Elliott (1961, p. 226) that all the movement on the Clifton Fault is post - Triassic.

Acknowledgements

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APPENDIX A

Record of a bore-hole log at the University of Nottingham

Grid Reference SK 461864

Height above O. D., 93 feet 4 inches

Lithology	Thickness		Depth		Formation
	feet	inches	feet	inches	
Sub-soil	7	9	7	9	
Red, fine - medium grained sandstone, poorly consolidated, marl partings, buff seams, small flattened pebbles at the base.	52	10	60	7	Mottled
-ditto- with common sub-angular pebbles.	7	6	68	1	Sandstones
Hard breccia, red matrix, green sandstone and shale fragments.	3	7	71	8	
					— unconformity —
Black shales, nodules, fish scales.	2	0	73	8	
Dark grey shales, plant remains abundant, listric surfaces.		11	74	7	Middle
Black fissile shale		3	74	10	
Coal		4	75	2	Coal
Grey mudstone, plant remains.		4	75	6	
Coal		5	75	11	
Rootlet Bed, grey mudstones	1	10	77	10	Measures
Grey mudstones		5	78	3	
Coal	6	9	85	0	The Top Hard Coal
Rootlet Bed, grey mudstones	4	6	89	6	
Laminated siltstones	11	0	100	6	
					End of bore-hole

APPENDIX B

Record of a bore-hole at Plumtree

Grid Reference SK 611334

Height above O.D. 144 feet

Lithology	Thickness feet	Thickness inches	Depth feet	Depth inches	Formation
Red marls and siltstones.	57		57		Trent
Thin hard green siltstones.	20		77		Hollygate Skerry
Red mudstones with occasional green siltstones.	25		102		
Red mudstones with fibrous gypsum.	94		196		Edwalton
Green siltstones and fine sandstones dolomitic and occasional gypsum.	12		208		Cotgrave Skerry
Red marls with thin dolomitic siltstones. (No definite record of the Plains Skerry)	262		470		Harlequin, Carlton, Radcliffe
Fine grained brown sandstones with mica, no gypsum, interbedded marl.	110		580		Waterstones
Bright red marls and thin buff sandstones. (No conglomerate).	16		596		Keuper Basement Beds
Coarse buff sandstones, with rounded pebbles, marl fragments, red sandstone.	194		790		Pebble Beds
Angular breccia, 2 inch fragments.	2	6	792	6	
Red medium grained sandstone without pebbles. Angular fragments towards the base.	28	6	821		Mottled Sandstones
Breccia, 2 inch green-grey fragments in red sandy matrix.	7		828		
					— unconformity —
Green and red variegated mudstones.	4		832		
Black and grey mudstones with shell fragments - Carbonicola, Naiadites Ostracods, Spirorbis, Ironstone nodules.	13		845		
Black and grey mudstones with shell fragments and worm borings, faulted, Gastrioceras carbonaria.	27		872		
Black mudstone with shell fragments.	4		876		
Coal.	5	8	881	8	Deep Soft Coal
Black and grey mudstones, laminated siltstones.	32	4	914		
Coal.	4	2	918	2	Deep Hard Coal
Grey siltstones, laminated, thin mudstones.	52	10	971		
Black carbonaceous shales with shell fragments.	6		977		
Coal.	2	4	979	4	1st Piper Coal
Seatearth.	4	8	984		

APPENDIX B (Continued)

Lithology	Thickness feet	Thickness inches	Depth feet	Depth inches	Formation
Laminated grey siltstones.	58		1042		Includes the horizon of 2nd Piper Coal
Black and grey mudstones with shell fragments. Carbonicola.	24	8	1066	8	
Coal.	1	4	1068		Tupton Roof Coal
Grey mudstones with rootlets.	4		1072		
Grey laminated siltstone, worm tubes.	8		1080		
Black carbonaceous mudstone with shell fragments. Ostracods.	6		1086		
Coal.	3	2	1089	2	Tupton Coal
Black and grey mudstone, plant remains, rootlets.	7	10	1097		
Coal.	2	4	1099	4	Three-quarter Coal
Grey mudstones with rootlets and shells. Thin coal at base.	9	8	1109		
Laminated siltstones grading into sandstones.	30	6	1139	6	
					End of bore-hole

(Identification of coals by National Coal Board).

APPENDIX C

Record of a bore-hole at Beeston Rylands (Boots Ltd.)
Grid Reference SK 545364
Height above O. D. 90 feet

Lithology	Thickness feet	Thickness inches	Depth feet	Depth inches	Formation
Gravels.	30		30		
Red marls, thin green dolomitic siltstones at the base.	75		105		Keuper Marl
Red mudstones and fine siltstones traces of gypsum.	89		194		
Fine grained red and brown sandstones with marl partings.	120		314		Waterstones
			(No Keuper Basement Beds or Conglomerate)		
Coarse red sandstones, pebbly, occasional buff layers.	120		434		Pebble Beds
Red medium grained sandstone without pebbles.	54		484		Mottled Sandstones
					End of bore-hole

APPENDIX D

Record of bore-hole at Sandy Lane, Bramcote (N. C. B.)

National Grid Reference SK 516381

Height above O. D. 151 feet

As this core has not been seen by the author, only general remarks can be made concerning the lithology of the formation present.

Lithology	Thickness		Depth		Formation
	feet	inches	feet	inches	
Red Pebbly sandstones, with marl beds.	125		125		Pebble Beds
					– unconformity –
Coal Measures.	53		178		
Coal.	3	10	181	10	Deep Soft Coal
Coal Measures.	43	2	225		
Coal.	4	11	229	11	Deep Hard Coal
Coal Measures.	32	1	262		
Coal.	3	2	265	2	1st Piper Coal
Sandstone.	3	10	269		
					End of bore-hole

Note:- The absence of Mottled Sandstones in the record does not necessarily mean they are not present.

(Manuscript received 31st May, 1965)

ERRATA

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

p. 194 line 30:

For Carbonicola read Anthracosia

p. 194 line 34:

For Gastrioceras read Gyrochorte