THE BASAL PERMIAN BEDS NORTH OF KIMBERLEY, NOTTINGHAMSHIRE

by

Leonard Hugh Waring

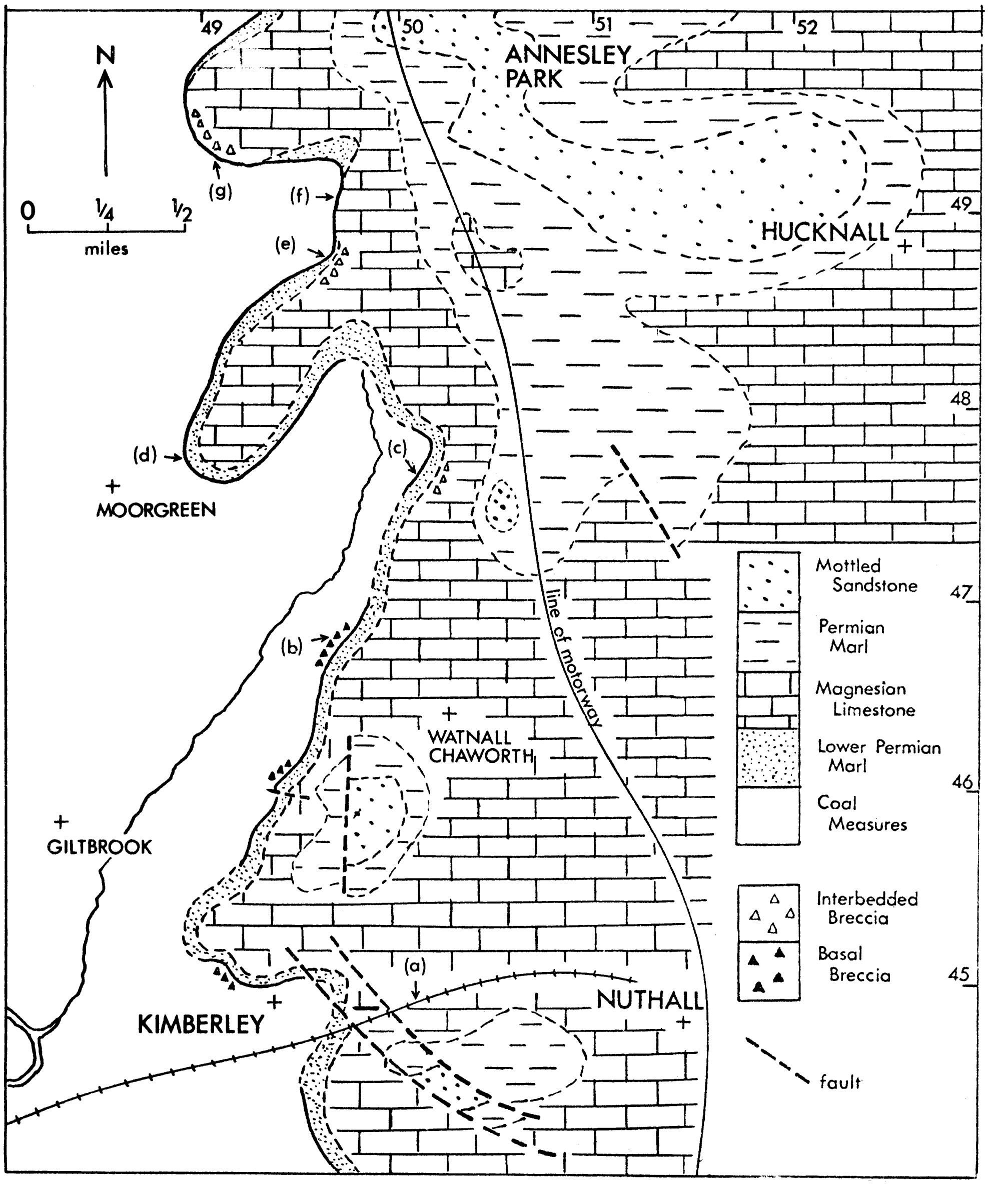
Summary

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.

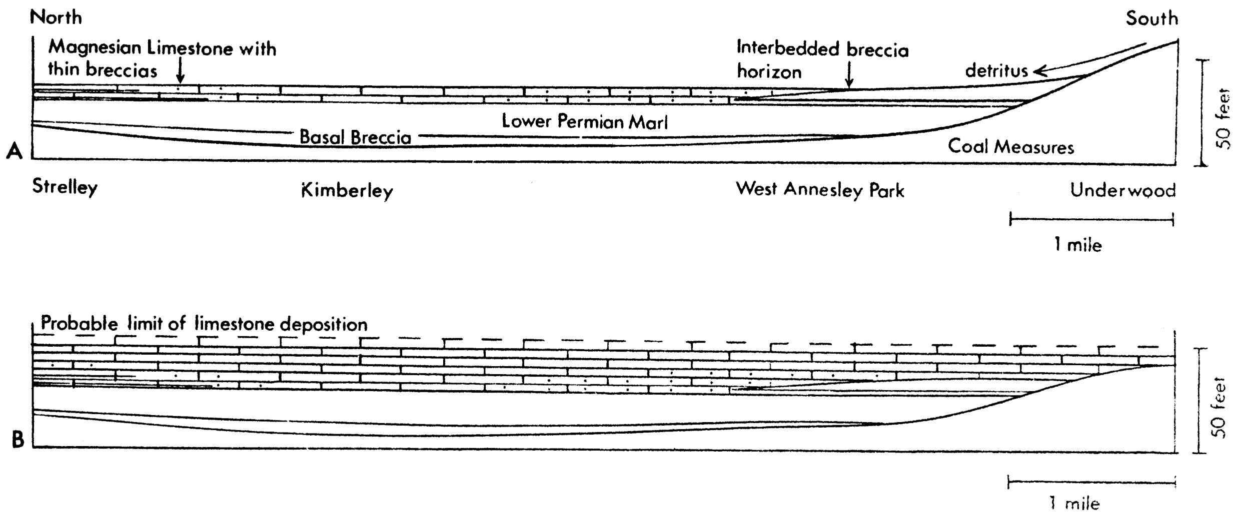
In addition to standard mapping techniques, borehole data, from the M. 1. motorway contractors and the Coal Board, were used to determine the thickness of the Lower Zechstein beds. Difficulties in mapping the base of the Permian were partially overcome by using a hand auger and by digging trial pits.

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.

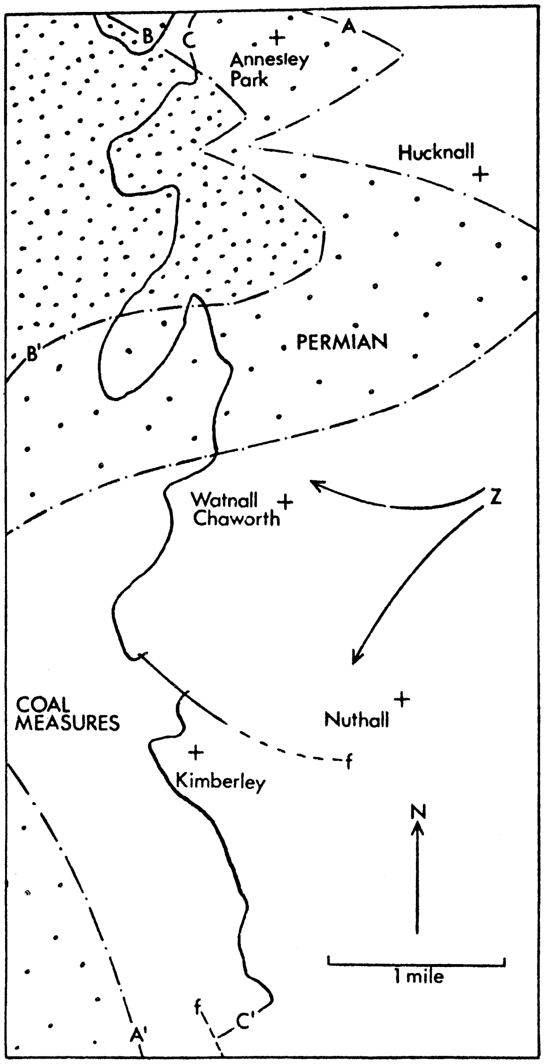
(c) Crowhill Farm, spring (502478). About 12 feet of Lower Permian Marl is exposed, but no Basal Breccia underlying the Marl was discovered in situ. Dolomitic breccia and coarse Magnesian Limestone fragments were observed in the field east of, and at least 10 feet vertically above, the spring. They had 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)

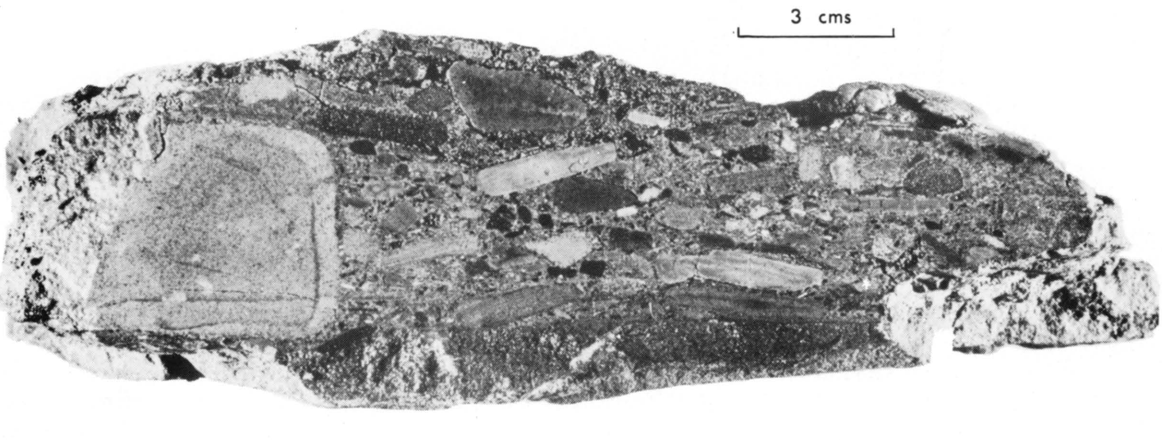


fig. 2. Interbedded breccia. Old Quarry, Abbey Wood (g). Tabular fragments are aligned parallel to bed margins. Soft coarse sandstone and black mudstone fragments occur with larger fine grained sandstone and siltstone fragments. The matrix consists of small quartz pebbles and sand grains cemented by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

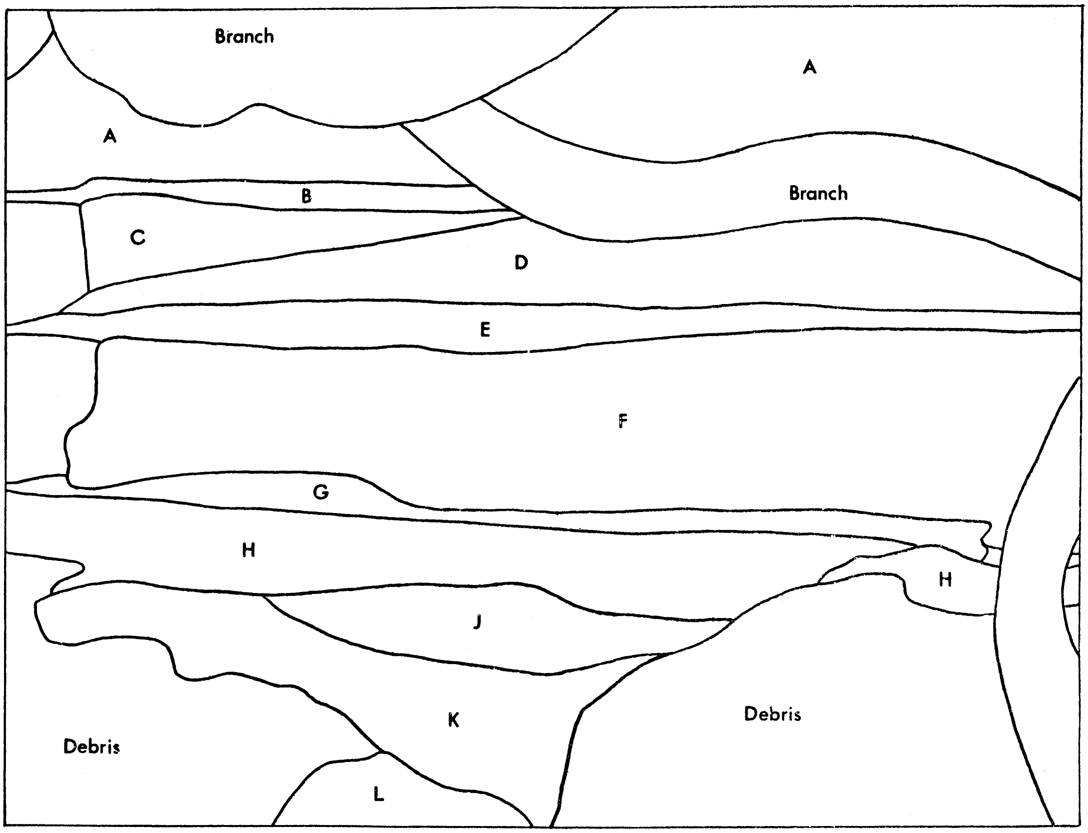
George (1963, p. 50) has written, concerning the Permo-Trias, "Variations in the succession must therefore be read as revealing the interplay of several factors, of which the occurrence of 'barriers' is only one." These barriers which obstructed the advance of the Zechstein Sea are here interpreted as 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.

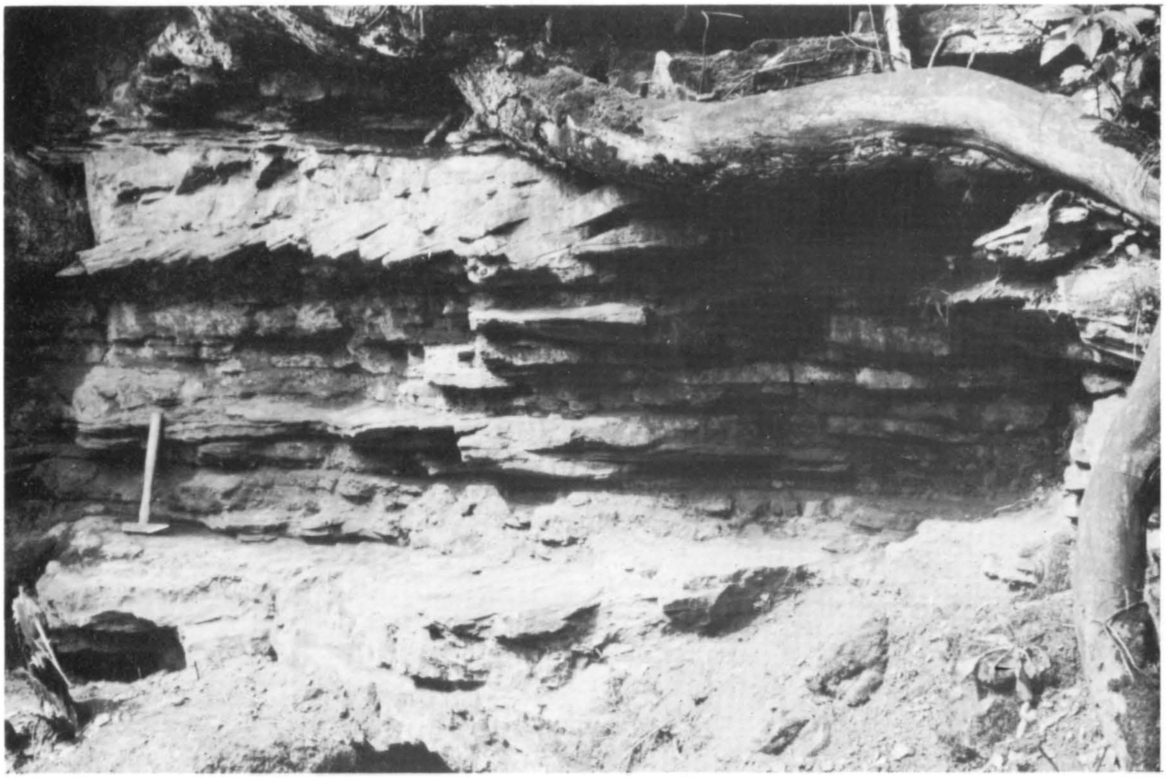
Acknowledgements

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.

L. Hugh Waring,
Nottingham Regional College of Technology,
Burton Street, Nottingham



A Flaggy and fractured limestone, 4½ 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)

REFERENCES

EDWARDS, W. 1951. The concealed coalfield of Yorkshire and Nottinghamshire. 3rd Ed. Mem. Geol. Surv. U.K., 285 pp.

GEORGE, T.N. 1963. Tectonics and Palaeogeography in Northern England. Sci. Prog., vol. 51, pp. 32 - 59.

GIGNOUX, M. 1950. Stratigraphic Geology. 4th Ed., London: Freeman, 682 pp.

LAMPLUGH, G.W. and GIBSON, W. 1910. The Geology of the country around Nottingham. Mem. Geol. Surv. U.K.

LAMPLUGH, G.W., GIBSON, W., SHERLOCK, R.L. and WRIGHT, W.B. 1908. The Geology of the country between Newark and Nottingham. Mem. Geol. Surv. U.K.

SHERLOCK, R.L. 1911. The relationship of the Permian to the Trias in Nottinghamshire. Quart. J. Geol. Soc. London, vol. 67, pp. 75 - 117.

1926. A correlation of the Permo-Triassic Rocks. Part 1, Proc. Geol. Assoc., vol. 37, pp. 1 - 72.

1928. A correlation of the Permo-Triassic Rocks. Part II, Proc. Geol. Assoc., vol. 39, pp. 49 - 95.

1947. The Permo-Triassic Formations. London: Hutchinson. 367 pp.

SMITH, B. 1913. The Geology of the Nottingham District. Proc. Geol. Assoc., vol. 24, pp. 205 - 240.

TAYLOR, F.M. 1965. The Upper Permian and Lower Triassic Formations in Southern Nottinghamshire. Mercian Geologist, vol. 1, pp. 181 - 196.

WILLS, L.J. 1956. Concealed Coalfields. London: Blackie. 208 pp.

WILSON, E. 1876. On the Permian of the north-east of England (southern margin) and their relationship to the under and overlying formations. Quart. J. Geol. Soc., London, vol. 32, pp. 533 - 537.

Manuscript received 20th October, 1965