CARBONACEOUS AND FOSSILIFEROUS MATERIAL FROM SOME DERBYSHIRE CLAY WAYBOARDS

by

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Summary

Investigations of a carbonaceous clay wayboard in the Matlock Lower Limestone at Masson Hill, Matlock, Derbyshire have demonstrated that an assemblage of miospores and plant fragments is present, comparable with similar assemblages obtained from Dinantian rocks in Northumberland and Scotland. In conjunction with stratigraphical observations it is argued that the depositional environment of the clay wayboards is related to topographical highs on the limestone shelf and that the carbonaceous material was derived from terrestrial soils on contemporaneous volcanic islands. Some other carbonaceous and fossiliferous clay wayboards are demonstrated to have been formed in a similar environment.

Introduction

Interbedded within the Carboniferous Limestone of the Peak District are a series of clay beds long referred to as clay wayboards. They have been described by Walkden (1972, 1975), who demonstrated that most of the clays were K-bentonites consisting of crystallographic mixed-layer illite/smectite with kaolinite, and accessory anatase, quartz, and pyrite. He concluded from an extensive survey that all clay wayboards were free from organic influences and contained no macro or micro-fossils. Walkden (1974) suggested that many of the erosional bases of the thicker clay wayboards represented palaeokarstic surfaces exposed to subaerial erosion for periods between 30,000 and 100,000 years. Veneers or coatings of the karstic limestone surfaces were attributed to alteration beneath a soil cover.

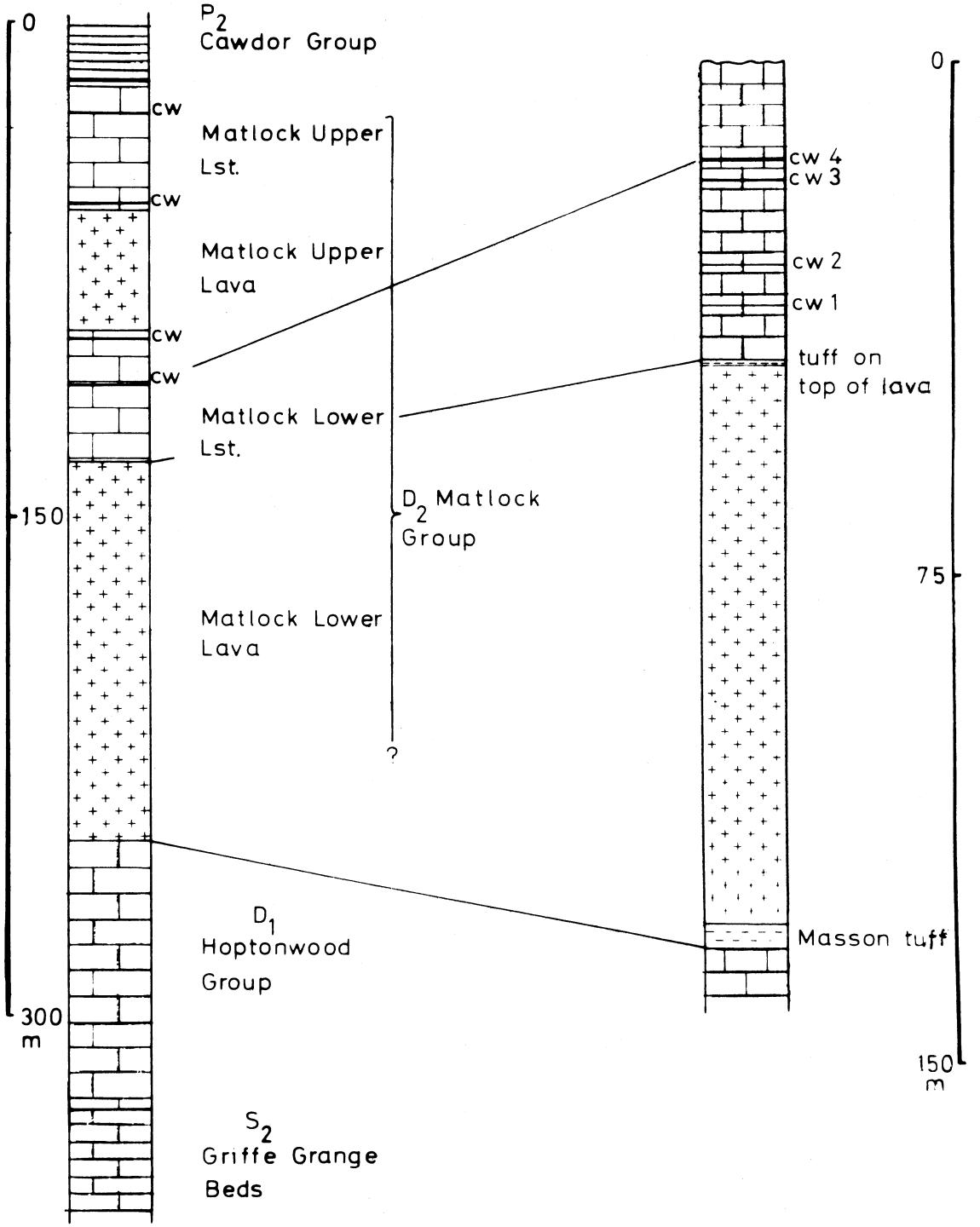
In the light of new findings, some of these clay wayboards noted by Walkden have been re-examined, and others not previously recorded are herein described from underground exposures in old lead mines and caves, demonstrating that numerous clay wayboards with carbonaceous and fossiliferous material occur at a number of stratigraphical horizons. Some of these have been described in the past from the Matlock area by De la Beche (1853), who noted that an impure 'coal' seam rested on a true underclay of the Coal Measures type. Similar 'coals' were also recorded in Rutland Cavern (SK 293586) in the Matlock Lower Limestone (De la Beche 1853). Green *et al.*, (1887, p.22) described a bright 'coal' which outcrops in Coombes Dale (SK 231748), resting on a potholed limestone surface. Brown (1973) noted that this coal in fact consisted largely of carbonaceous material, which occurs as a thin seam within a thick clay wayboard.

One of these carbonaceous clay wayboards in the Matlock area has been examined to determine for the first time the microfossil content and the assemblages contained therein are described. The depositional environment of this clay wayboard is assessed below in relation to the limestone massif, and the other carbonaceous and fossiliferous wayboards in Derbyshire are re-examined in the light of the new evidence.

Mercian Geol., Vol. 6, No. 3, 1977.
pp. 145-154, 2 text-figs. Plates 8-9.

Composite stratigraphy of the Matlock area after Smith *et al*, 1967

Stratigraphy of Masson Quarry based on Ixer 1975 amended by Worley 1976



Text. fig. 1. Correlation of strata, Matlock and Masson Quarry.

Carbonaceous and fossiliferous clay wayboards from Masson Hill, Matlock

The stratigraphy of the Masson Quarry (text-fig. 1) has been described by Dunham (1952) who noted that three clay wayboards or volcanic ashes were present in the partly dolomitised Lower Matlock Limestone. He called the lower one the "little toadstone"; it attained a thickness of 0.65 m resting 5.9 m above the Lower Toadstone (= Matlock Lower Lava). Recently, Ixer (1975) revised the geology of the quarry, and established, largely from boreholes, that four clay wayboards were present (text-fig. 1). He also noted that the "Masson Tuff" was intersected in boreholes at the base of the Matlock Lower Lava, which attains a thickness of about 80 metres. The clay wayboards were numbered upwards from 1 to 4, and X-ray studies showed them to be uniformly mixed illite-montmorillonite-kaolinite clays with accessory quartz, calcite, dolomite, anatase and chlorite. Clay wayboard no. 4 is the highest in the succession, and lies 21 m above the Matlock Lower Lava in the quarry. The details of the stratigraphy of the clay wayboard no. 4 were given in Ixer (1975, p. 186), who noted that blue laminated clays occurred at the base, and that a band rich in brachiopods 0.05 m thick was developed towards the top (Plate 9, fig. 1). Examination of this brachiopod band has shown that all the valves are approximately the same size, and lie with a thick (20 mm) ventral valve lying convex downwards, indicating that they were fossilised in a living position. The brachiopods are productids, too poorly preserved to be classified further. An earthy black coal, up to 20 mm thick, occurs sporadically within that part of the clay wayboard which is beneath the brachiopod band.

Palynology

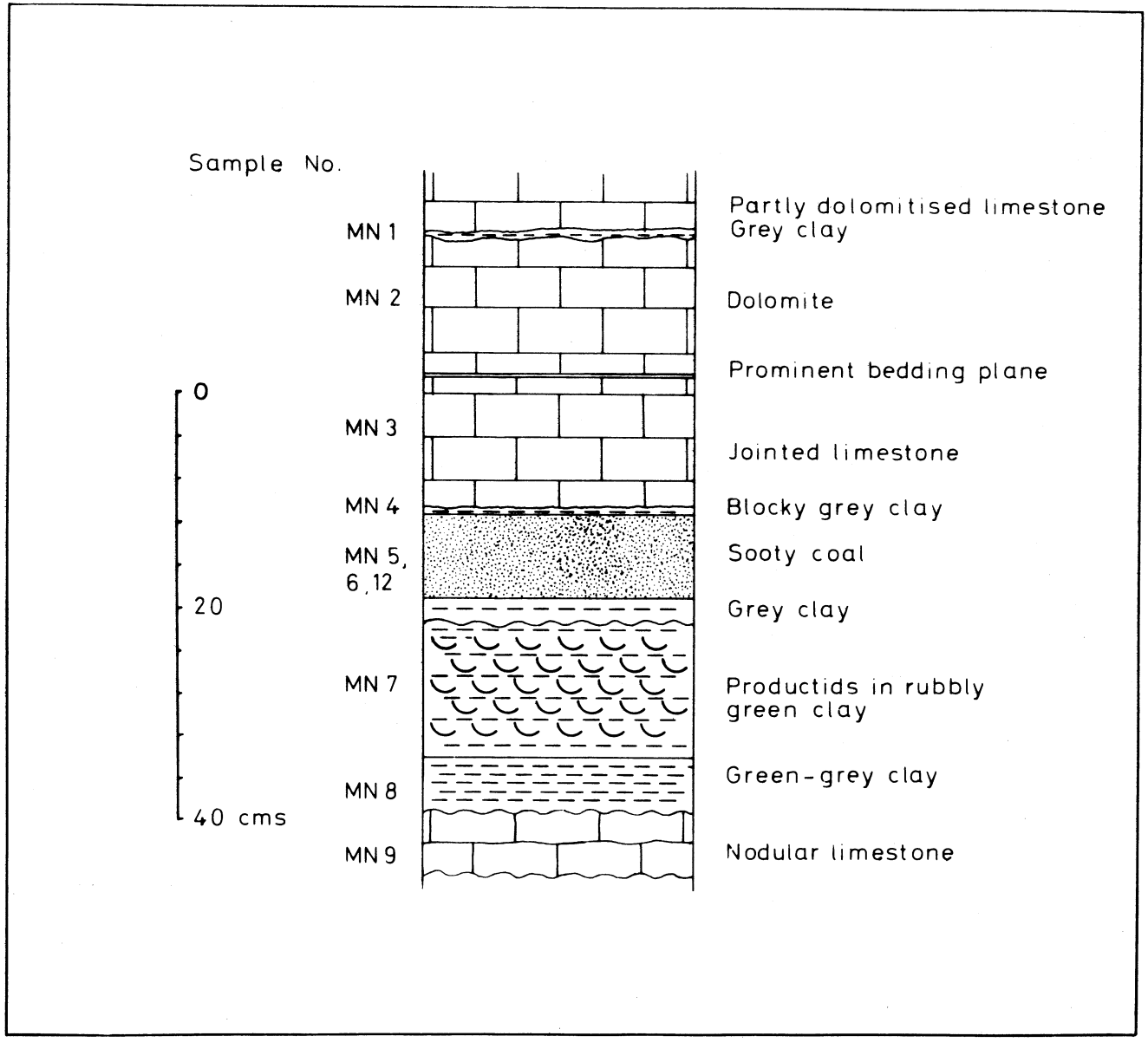
Ten samples were collected from the coaly horizon and dark blue clays (text-fig. 2). They were processed for palynomorphs using standard techniques; hydrochloric acid followed by hydrofluoric acid disaggregated the material to a fine slurry. The residue was macerated with concentrated nitric acid for 12 hours to clear the material. The composition of the samples is summarized in Table 1.

Table 1 Palynological composition of clay wayboard 4.

	Sample Number									
Composition	MN1	MN2	MN3	MN4	MN5	MN12	MN6	MN7	MN8	MN9
Fusinite	X	X	X	A	A	A	A	X	X	X
Inertinite	X			X	X	A	X			
Scolecodonts						X				
Miospores					X	A				

[X] present [A] abundant

Of the ten samples, only two yielded miospores (Plate 8); this is not surprising as miospores are rarely well preserved in pure limestone environments. The impure coal (MN12) yielded the best miospore assemblage, though many of the specimens are rather poorly preserved, and show distortion due to pyrite growth (Plate 8, fig. 2). Brown phytoclasts of inertinite were abundant in MN5. Sample MN12 yielded the miospore assemblage listed below as well as scolecodonts.



Text. fig. 2. A generalised section through clay wayboard number 4.

Miospores from sample MN12

Acanthotriletes cf. *falcatus* (Knox) Potonie and Kremp 1955.
Acanthotriletes sp.
Apiculatisporis sp.
Dictyotriletes sp.
Granulatisporites granulatus Ibrahim, 1933
Laevigatosporites spp.
Lycospora pellucida (Wicher) Schopf, Wilson, and Bentall, 1944
Lycospora sp.
Punctatisporites sp.
Raistrickia sp.
Schulzospora elongata Hoffmeister, Staplin, and Malloy, 1955.

The miospores are the first recorded from the Dinantian of Derbyshire. None of the taxa recorded are particularly diagnostic of the Upper Dinantian in either the Midland Valley of Scotland, or Northumberland, where miospore zonation for the Lower Carboniferous has been carried out by Neves *et al.*, (1972). However, none of the taxa are inconsistent with an Upper Dinantian D_2 (Brigantian) age. (George *et al*, (1976), have recently revised the stratigraphical nomenclature of the Dinantian and the P_2 and D_2 zone limestones which include the Cawdor, Eyam, Matlock and Monsal Dale Limestones are now referred to as the Brigantian Stage).

Clay wayboard no.4 in the Masson Quarry can be mapped underground as far west as Tearsall Farm (SK 263599). In the Jugholes Caves (SK 279596) and Oxclose Mine (SK 277598) it attains a thickness of 1 metre and contains nodules of fine-grained limestone in a green laminated clay. At Tearsall Mine the same clay wayboard contains numerous large colonies of in-situ *Lithostrotion junceum* and small brachiopods. A carbonaceous clay wayboard has been detected also in the Oxclose Mine 1.5 metres beneath the base of the Matlock Upper Lava somewhat higher in the Matlock Limestone.

The Upper Masson Tuff

Recent workings in the quarry have revealed a tuff horizon which was not recorded by Ixer (1975) resting on top of the Matlock Lower Lava. This has now been named the Upper Masson Tuff. The full thickness is not exposed but it is probably less than 1 metre in thickness. The principal outcrops lie in the present floor of the quarry, which has recently been deepened. In fresh specimens the tuff is dark grey in colour, compact and hard to break. Pyrite as both cubes and anhedral grains is common, and occasionally small thin-shelled brachiopods approximately 20 mm wide are seen. The tuff weathers rapidly on exposure to a dark grey sticky clay, and the outcrops now consist of mainly unweathered fragments in a weathered clay matrix. In thin section (Plate 9, fig. 3) the tuff consists of 25% foraminifera 0.30 mm in diameter, with well rounded clasts of a clay mineral, probably montmorillonite, which often has a radial fibrous structure. These grains, attaining 0.012 mm, are set in a clear calcite spar matrix. Pyrite occurs as both anhedral and euhedral grains and cuts across the fabric of the rock, indicating that it has replaced the original matrix and allochemical constituents.

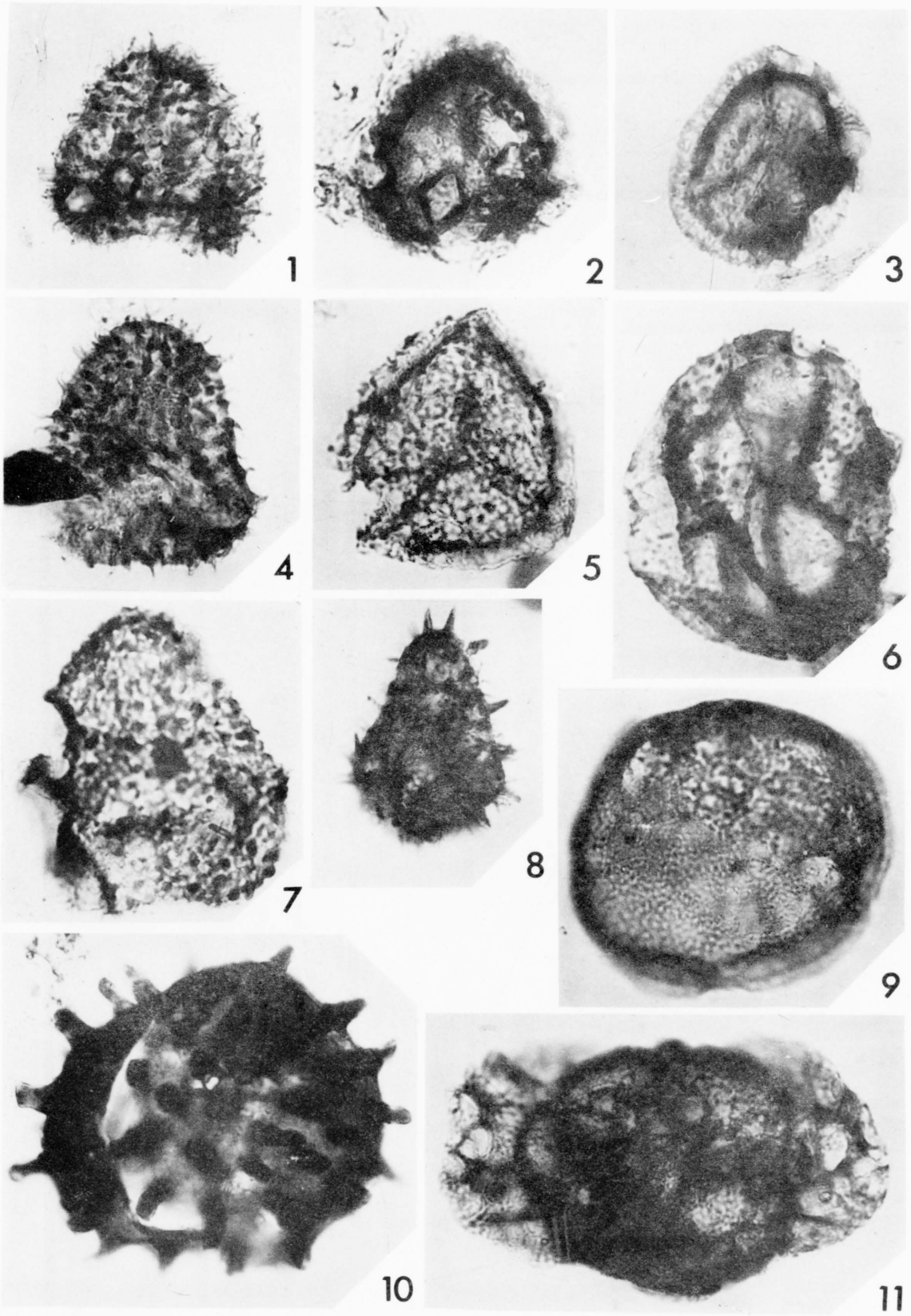
The Limestones

Preliminary petrographic studies on the undolomitised limestones have been carried out. Most of the limestones exposed in the quarry are pale grey thickly bedded biomicrudites (Folk, 1959). The main allochemical constituents are, in order of abundance, brachiopod spines and tests, crinoid ossicles, foraminifera, bryozoa, and algae. The limestones exhibit a mottling of dark, sometimes diffuse spots of fine-grained limestone up to 15 cms across in a paler grey matrix (Plate 9, fig. 2), which appear to represent pseudobrecciation due to animal burrowing, or calcite grain growth as suggested by Bathurst (1959). These pseudobrecciated limestones are characteristic of the lower 15 to 20 metres of the Matlock Lower Limestones. Mapping in the area on surface, and underground in old mines, has demonstrated that they outcrop over a strike length of three kilometres to the west as far as Tearsall Farm (SK 263599),

Explanation for Plate 8

1.	*Acanthotriletes* cf. *falcatus*	MN12	K7	033/1
2.	*Lycospora pellucida*	MN12	K6	N42/0
3.	*Lycospora pellucida*	MN12	K7	032/2
4.	*Acanthotriletes* cf. *falcatus*	MN12	K5	043/3
5.	*Lycospora* sp.	MN12	A1	044/0
6.	*Apiculatisporis* sp.	MN12	K7	D40/3
7.	*Granulatisporites granulatus*	MN12	K5	E41/4
8.	*Acanthotriletes* sp.	MN12	A1	K44/1
9.	*Punctatisporites* sp.	MN12	K5	G30/4
10	*Raistrickia* sp.	MN12	K5	B39/3
11.	*Schulzospora elongata*	MN12	K6	B31/4

All × 1000 magnification. The last reference letter and numbers are England Finder reference coordinates. The slides are deposited in the Department of Geology, University of Sheffield.



Worley and Dorning - Derbyshire Clay Wayboards.

where the texture of the limestone has been obliterated by dolomitization. Most of the fluorite replacement orebodies known in the area (Dunham 1952), including the one at Masson, occur in this type of limestone pseudobreccia, above the Matlock Lower Lava. Similar limestones have been previously recognised by Harrison (1967) in the Matlock Upper Limestone but their distribution and significance was not described. Mapping by the authors has failed to delimit the distribution due largely to lack of exposures and absence of penetration of the limestone by mines and quarries in appropriate places.

Depositional Environment

The presence of foraminifera. algae and burrows suggests that the pseudobrecciated limestones, were deposited in a shallow marine environment where extensive burrowing and reworking of the sediment took place. The whole Brigantian (D_2) succession in the Matlock area attains a thickness of 141 m. including lavas (Smith *et al.* 1967) compared with an average 213 m. further north in the Millers Dale area (Stevenson and Eden 1976); this represents considerable southwards thinning of the stage. The attenuation is consistant with the facies changes observed within the Matlock Group and Monsal Dale Limestone, as in the Millers Dale area dark shaley limestones of a deeper water basinal aspect are common whereas the Matlock succession is a thinner shelf sequence characterised by shelly pseudobrecciated limestones. The facies and thickness changes may represent a response to contemporaneous tectonic and volcanic activity. Masson Hill forms the crest of a major east - west trending anticline where the lavas reach their thickest development, and a series of vent agglomerate exposures indicate that it was once a major volcanic centre. Uplift during deposition of the limestone occurred intermittently, and coincided with sporadic extrusive volcanic episodes; these are now represented in the succession by the clay wayboards. The miospore assemblages, phytoclasts of inertinite and fusinite, and scolecodonts imply that the wayboards were deposited in shallow marine conditions; the organic components were derived from the weathering of soils with a terrestrial plant assemblage, suggesting that there may have been a temporary island associated with the volcanicity.

The presence of a band crowded with productid brachiopods, which are bethonic filter feeders, is difficult to reconcile with a volcanic clay in a terrestrial environment. The brachiopods probably colonised the top of the clays during a lull in the volcanic activity in a tranquil marine situation, only to be buried during a later eruption. A similar depositional environment is envisaged for the formation of the calcareous Upper Masson tuff which rests on top of the Matlock Lower Lava.

Other carbonaceous and fossilferous clay wayboards

Other clay wayboards with fossiliferous and carbonaceous material occur elsewhere in Derbyshire at a variety of stratigraphical horizons, often associated with erosional bases. They probably represent deposition in similar environments to the clay wayboards in Masson Quarry and may coincide with local depositional topographic highs such as volcanic islands on the carbonate platform.

At the base of the Eyam Limestone in Coombes Dale (SK 231748) a thin coal seam 5 mm - 25 mm thick rests on a grey clay wayboard which lies on a dolomitised, brecciated limestone surface (Brown 1973). This coal was first described by Green *et al.* (1887, p.22) as a 'bright, clean coal' resting on light-grey fire-clay. Further west in the Glebe Mine, Eyam, a thick clay wayboard at the same stratigraphical horizon contains a sooty coal lying on a pot-holed limestone surface. At the Raper Quarry, Youlgrave (SK 217653), again at the base of the Eyam Limestone a thick clay wayboard with carbonaceous material has been exposed in the north face of the quarry beneath dark cherty limestones. A similar clay wayboard was also described at the Millclose Mine (Traill 1940) at the base of the Eyam Limestone ('black beds') with a 2 cm. coal seam. Also in the Millclose mine Traill described a number of clay wayboards with carbonaceous material in the 'Main' = Matlock Group Limestone

which passed laterally into basalt lavas. A comparable lateral passage has been observed in the case of the Matlock Lower Lava which thins rapidly from Matlock, in the north, to Wirksworth, in the south, where it is represented by a thin (0.3 m) carbonaceous clay wayboard.

The author's underground mapping has revealed a previously unknown coal seam in the Middleton by Youlgrave area, 0.3 m thick, in a dark cherty facies of the Monsal Dale Limestones.

Carbonaceous clay wayboards also occur in the lower part of the Holkerian (S_2) Woo Dale Limestones (Cope 1933, p.129), and contain specimens of *Archaeosigillaria vanuxemi* (Göpp). A thin bed of shaley limestone outcropping near Topley Pike also in the Woo Dale Limestone was described by Arnold Bemrose (1900 p.173) who noted the occurrence of '*Calamites* sp'.

Concluding Remarks

This study serves to illustrate that there is considerable scope for future palaeontological and palynological investigation of clay wayboards. When further assemblages have been described from the Derbyshire area, a more precise correlation with other regions may be possible. Palynological determination of the age of the Brigantian limestones and the overlying shales should prove useful in refining the complex chronostratigraphic correlations at around the Brigantian/Namurian boundary.

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Explanation for Plate 9

Figure 1. Photograph of the clay wayboard no.4. The erosional base is clearly defined and the brachiopod band can be seen in the centre of the wayboard. The coal lies on the horizon of the lens cap. Scale lens cap measures 40 mm.

Figure 2. A block of spotted pseudobrecciated limestone in Masson Quarry floor. Scale lens cap 40 mm.

Figure 3. Photomicrograph (plane polarised light, ×200) of the Masson Upper Tuff with a foraminiferan surrounded by dark rounded clasts of clay minerals in a clear calcite spar matrix.

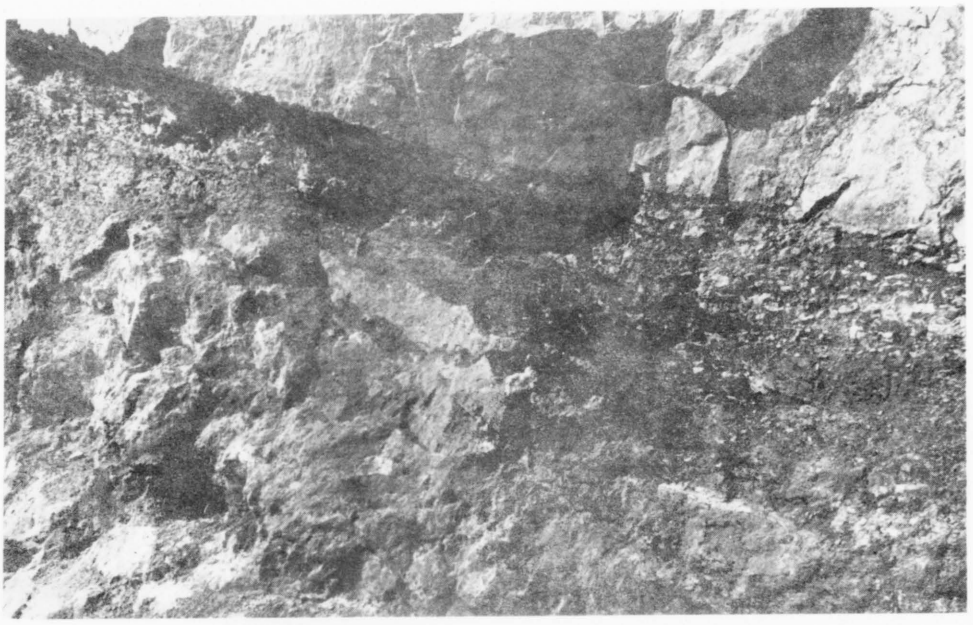

Fig. 1.

Fig. 2.

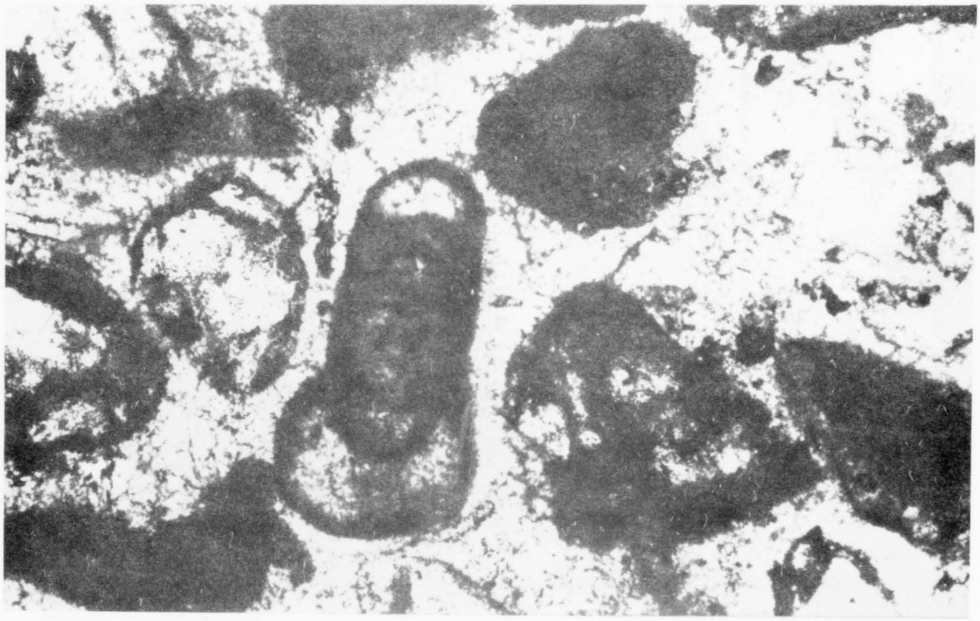

Fig. 3.