# A REVISION OF PART OF THE MATLOCK GROUP AT MASSON HILL, MATLOCK, DERBYSHIRE

by

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## Summary

Detailed mapping of the sedimentary and volcanic rocks along the summit of Masson Hill, and new borehole evidence, has led to a revision of the stratigraphy of the area. The sequence of rocks is shown to include a tuff at the base of the Matlock Lower Lava, and at least four volcanic clay horizons within the Matlock Lower Limestone Formation.

## Introduction

Masson Hill is a prominent topographical feature, rising to about 335 metres, and situated 1500 metres west of Matlock, Derbyshire. Masson Hill contains extensive mineralization and especially an intermittent fluorspar flat which was exposed within opencast workings on the summit (SK 284591).

The first geological sections of the Matlock area were given by Farey (1811, p. 29) and Green *et al.* (1887, p. 22). Later Wedd (1907, p. 12) sub-divided the limestones on faunal evidence. More recently the stratigraphy of the Matlock area has been divided into four local groups (Eden *et al.* 1959, p. 33):

Cawdor Group
Matlock Group
Hoptonwood Group
Griffe Grange Bed

At Masson Hill only the middle two groups, the Hoptonwood Group and Matlock Group are present at outcrop. The limestones of these two groups are irregularly dolomitized, silicified and mineralized, whilst a wide variety of interbedded volcanic rocks occur, including basaltic lavas, tuffs and bentonitic clays, colloquially called wayboards. The stratigraphy of the Hoptonwood and Matlock Group has been especially studied because of the controls that varying lithologies have exerted on the mineralization. The detailed stratigraphy of the Matlock Group has been given by Dunham (1952, p. 97-101), and both the Hoptonwood and Matlock Group by Smith *et al.* (1967, p. 15-20).

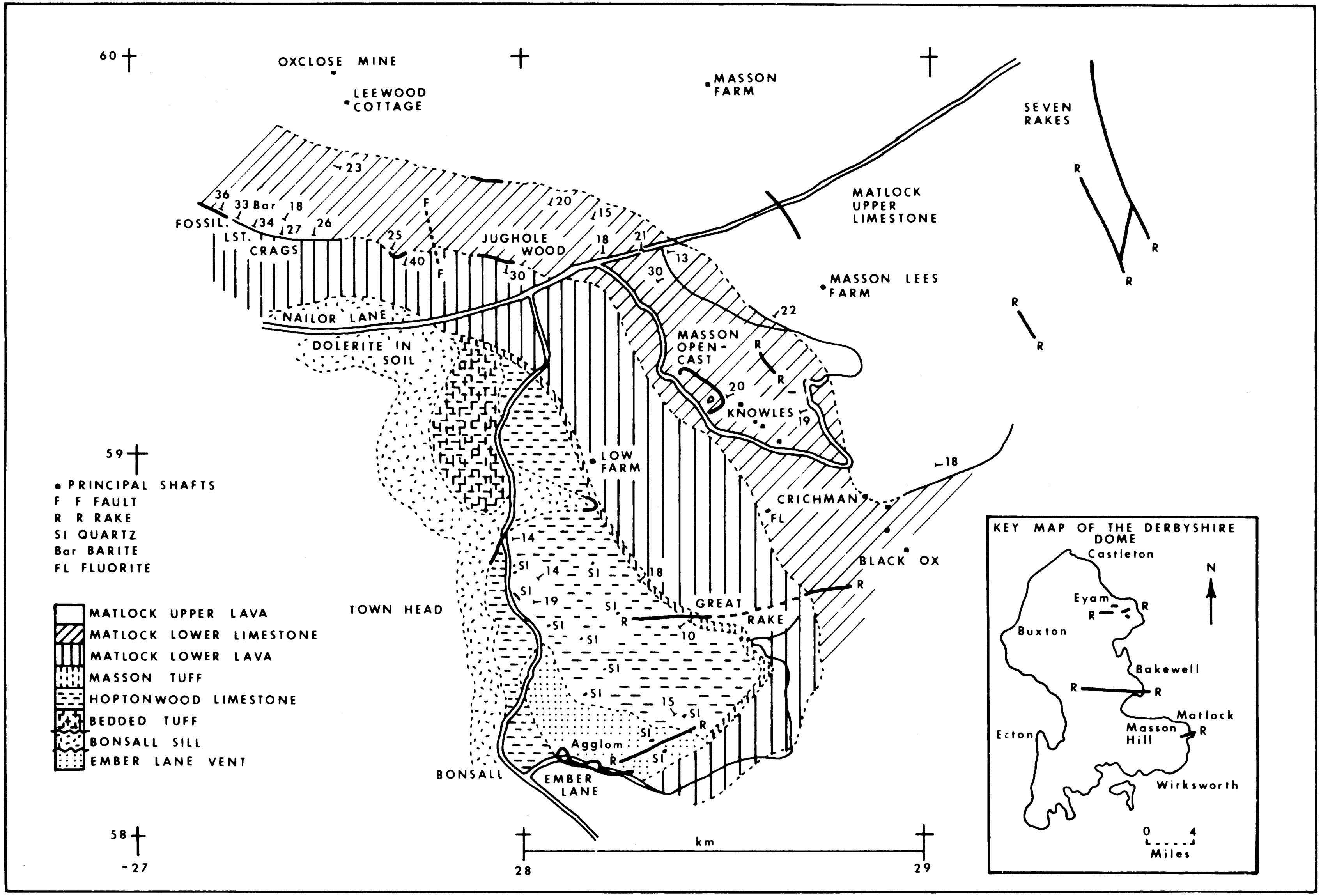
The Masson Hill area was mapped in detail, especially the continuous 300 metre outcrop within the Masson Opencast, of the Matlock Lower Limestone Formation. Together with information obtained from a borehole drilled by Laporte Industries Ltd., the mapping has provided new evidence to modify the stratigraphical interpretation of Eden *et al.* 1959, 1967). The borehole was drilled within the opencast site, starting at the junction of the Matlock Lower Limestone Formation and Matlock Lower Lava and continued until the underlying Hoptonwood Limestone Group was penetrated. Core was only obtained of the Masson Tuff.

## Stratigraphy

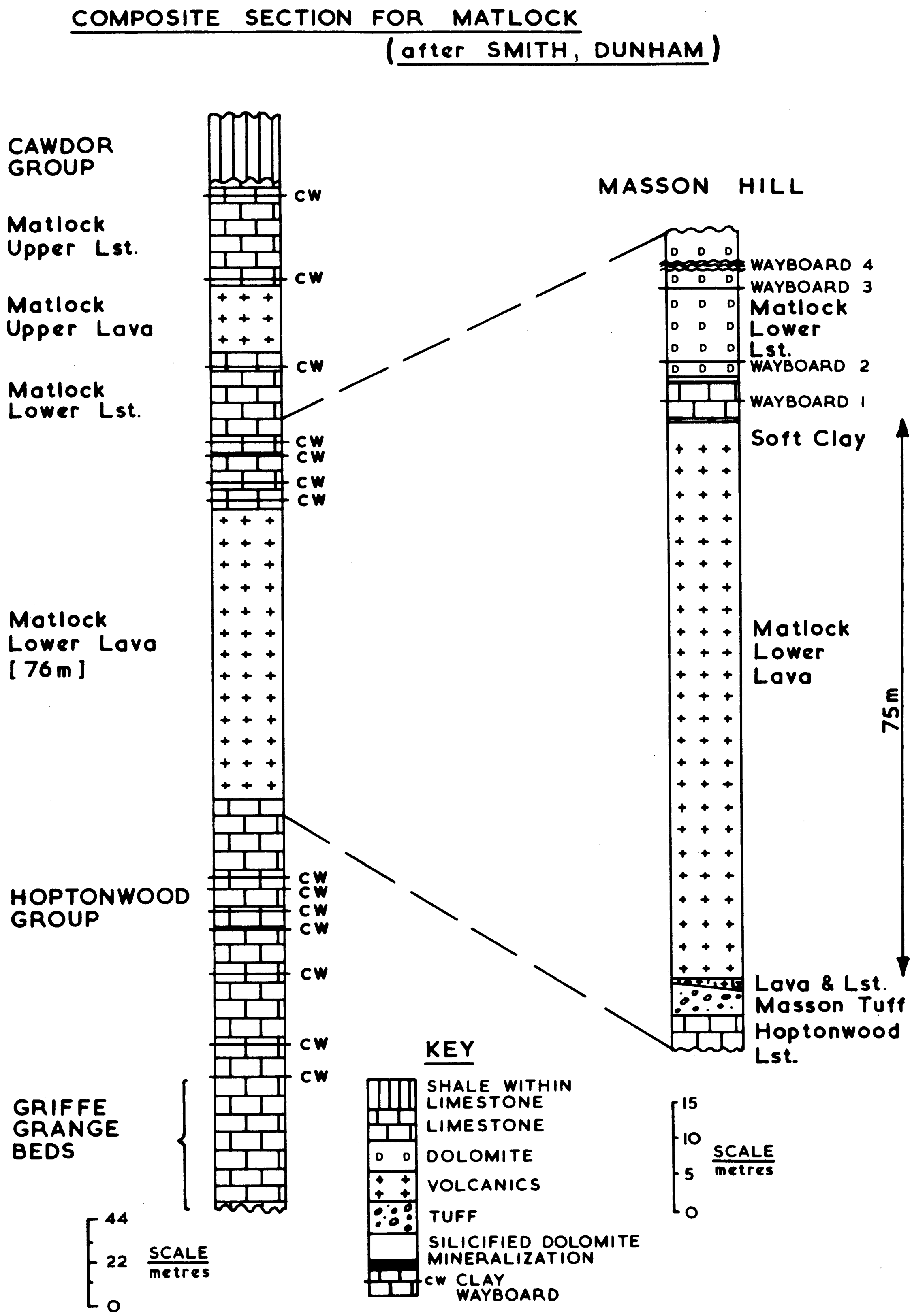
The general geology is shown in text-fig. 1 and the present interpretation is essentially similar to that of Smith *et al.* (1967, p. 9-27). An area of uncorrelated tuffaceous limestone, now only located in field walls (SK 279591) is, however, again reinterpreted as a bedded tuff (Arnold-Bemrose 1907, p. 265) rather than as a vent agglomerate (Smith *et al.* 1967, p. 27).



Mercian Geol Vol 5, No 3, pp. 181-188, 2 text-figs.




Text-fig. 1. Geology of Masson Hill, Derbyshire.




Text-fig. 2. Vertical sections of rocks, Matlock and Masson Hill.

Essentially, the interbedded limestones and lavas of the Matlock Group occur on the northern flank of an anticline. Their dips are variable but at the opencast site are 18° - 20° to the north-east.

A composite sequence for the Matlock area based on the sequences of Dunham (1952) and Smith *et al.* (1967), together with the present revised sequence, is given in text-fig. 2. The detailed stratigraphy of the revised sequence measured at the Masson Opencast Quarry and from the borehole is given in table 1.

TABLE 1

| | | | metres |
|---|---|---|---|
| | Lava | | |
| | No measurements | | |
| | Dolomite | approx. | 8.0 |
| | Dolomite & limestone lenses | | 5.50 |
| | Clay wayboard 4 | | 0.30 |
| | Dolomite | | 2.65 |
| | Clay wayboard 3 | | 0.10 |
| | Dolomite and sporadic mineralization | | 10.40 |
| Matlock | Clay wayboard 2 | | 0.05 |
| | Dolomite | | 2.10 |
| Lower | Partially silicified and dolomitized limestone | | 0.90 |
| Limestone | Fluorite and galena metasomatic mineralization | | 0.15 - 0 30 |
| | Bioclastic limestone and fluorspar flat | | 2.45 |
| | Clay wayboard 1 | | 0.05 |
| | Bioclastic limestone and fluorspar flat | | 3.05 |
| Matlock | Soft altered lava or clays | | 3.95 |
| Lower | Hard basalt with soft clays | | 74.35 |
| Lava | Lava with limestone blocks | | 0.90 |
| Masson Tuff | Tuff with grey limestone | | 3.05 |
| Hoptonwood Limestone | Massive grey limestone with rare tuff fragments seen down to | | 5.00 |

## Description of Formations

### The Masson Tuff

The tuff is made up of dark green volcanic lapilli and limestone fragments in highly variable proportions set in a foraminifera-rich biomicrite. The lapilli are composed of greatly altered olivine-basalt, with calcite and chloritic pseudomorphs after olivine, 200 - 800$\mu$ in length, and plagioclase, 150 - 300$\mu$ in length; they are set in a chloritic or indeterminate brown groundmass. Vesicles are commonly infilled with spherulitic chlorite, calcite spar or calcite mud. No primary oxides have survived; however, secondary haematite, anatase and goethite are common.

The limestone fragments are very similar to the matrix but show less intense silicification.

The tuff is exposed along Great Rake at Low Mine (SK 283585), where the limestone fragments and matrix show replacement by fluorite.

## The Matlock Lower Lava

No core was taken of the Lower Lava. The indicated borehole thickness is 79·2 metres, much nearer to the previously measured thickness of 76·2 metres (Dunham 1952, p. 98) than the calculated thickness of 115·8 metres (Smith *et al.* 1967, p. 17). Examination of specimens of Lower Lava collected from the Masson Opencast site and from along Great Rake (SK 287587) has confirmed previous descriptions (Arnold-Bemrose 1894, 1907 and Harrison, in Smith *et al* 1967, p. 261) of the lava as a calcitized, chloritized, vesicular olivine-basalt. X-ray diffraction has shown the 'chlorite' to be a mixture of kaolinite, mixed illite-montmorillonite and mixed chlorite-montmorillonite clays. Similar results for other Derbyshire 'chlorites' have been obtained by Sarjeant (1967, p. 85) and Walkden (1972, p. 156).

Progressive hydrothermal alteration has increased the calcite and silica content of the lava until finally a pseudotuff has resulted. This consists of haematized basalt 'fragments' in a matrix of calcite spar, quartz and chalcedony. Pyrite and occasional chalcopyrite are associated with the calcite spar.

The hydrothermal alteration differs markedly from that caused by weathering. The junction of the Lower Lava and Lower Limestone within the opencast site locally contains a perched watertable, which has converted the lava into a mixture of montmorillonite, kaolinite, illite-montmorillonite, with accessory calcite, albite, anatase and quartz.

## Matlock Lower Limestone

The basal limestone is thickly bedded and poorly jointed, containing noticeable fossil debris and with calcite veining. Incipient dolomitization, especially common within brachiopod fragments and the calcite mud matrix, has subsequently recrystallised as calcite. The euhedral dolomite rhombic crystals, 180$\mu$ in length, are now transformed to a random mosaic of calcite crystals.

Above the limestone, dolomite occurs in beds 0·60 - 1·80 metres thick. Textural evidence in thin section shows that the dolomitization is totally epigenetic. Its intensity is related to the proximity of the clay wayboards and to the grain size of the original limestone. The amount of dolomitization is substantially reduced adjacent to the wayboards and to a distance of 0·30 - 0·50 metres away from these clay horizons. In addition, within the dolomite, isolated limestone beds occur, generally one or two metres thick and 5 - 10 metres wide, comprising light grey, poorly jointed biomicrite. These limestone beds are generally enveloped in a thin (0·05 - 0·10 metre) skin of metasomatic mineralization.

Petrographically the dolomite contains a biomodal distribution of small, 50$\mu$, euhedral dolomite crystals in a subhedral to anhedral dolomite groundmass of average grain size 270$\mu$. Subhedral to euhedral quartz is common often partially replacing relict calcite. Chemically the dolomites, remarkedly uniform throughout the sequence, can be classified slightly calcitic, following the classification of Chillinger *et al.* (1967) with a Ca/Mg ratio of 1·7 to 2·0.

The junction between the basal limestone and overlying dolomite is marked by a persistent horizon of mineralization which has the generalized sequence:

| | | |
|---|---|---|
| | Dolomite | |
| Replacement Void Infilling | Silicified dolomite with fluorite and barite<br>Banded barite and fluorite<br>Void<br>Banded barite, galena and fluorite | |
| Replacement | Barite and galena with silicified limestone | |
| | Limestone | |

The mineralized horizon varies in thickness between 0·10 - 0·15 metres and is probably due to the entrapment of the mineralizing fluids between the well jointed dolomite and more impermeable underlying limestones.

## The Clay Wayboards

The presence of volcanic clay wayboards within the Matlock Lower Limestone has been discussed by Dunham (1952, p. 98) and Ford (1967, p. 67). Dunham paid particular attention to the 'Little Toadstone' a 0·80 metre thick clay horizon lying 5·5 metres above the base of the Lower Limestone. This thickness of impermeable clay appears to have been responsible for the massive replacement deposit described by Dunham. The wayboard is not exposed in the open pit and does not appear to correlate with wayboard 1.

Four wayboards of varying thickness were established within the Lower Limestone sequence. Wayboards 1 and 3 are orange-brown, slightly laminated pyritic clays, lying on a reddened mammilated surface that has an average relief of 0. 03 - 0. 10 m and hollows 0. 12 - 0. 12 m wide.

Wayboard 2 is a thin, 0·05 metres, clay parting, present in all the measured sections, making correlation between these sections possible.

Wayboard 4 is more complex than the others and has the following subdivisions:

| | |
|---|---|
| Dolomitized Limestone | |
| Yellow laminated clays | 0·07 - 0·08 metres |
| Dolomitized limestone rich in brachiopods | 0·05 - 0·09 metres |
| Blue laminated clays | 0·10 - 0·13 metres |
| Reddened mammilated surface. | $<$ 0·01 metres |
| Dolomitized limestone | |

Within the included dolomitized limestone horizon, the brachiopod shells, up to 0·08 metres across, lie concave upwards amid shell debris and compacted clay. The undersurface of the layer is extensively pseudo-mammilated with abundant goethite pseudomorphs after pyrite.

Goethite is also responsible for the reddened appearance beneath the wayboard. The junction of the wayboard clays and underlying dolomitized limestone is marked by an 80 - 100$\mu$ thick aggregate of goethite replacing pyrite with relict pyrite in the core.

The mineralogy of the four clay horizons is largely uniform, although the relative proportions vary. The mineralogy of the clays was determined by X-ray diffraction techniques The clays are composed of a mixed illite-montmorillonite fraction, kaolinite, quartz with accessory calcite, dolomite, anatase and chlorite. This mineralogy is typical of Derbyshire bentonites (Walkden 1970, 1972) except for their high carbonate and silica content. Much of the carbonate may be adventitious but the quartz forms part of the wayboards and reflects the strong silicifaction of the Masson area.

## Conclusions

The borehole and field mapping has provided additional information on the stratigraphy of the Matlock Group. The borehole data has confirmed the thickness of the Matlock Lower Lava as given by Dunham (1952) and has proved the presence of an undiscovered tuff horizon. The detailed mapping and petrographic studies of the Matlock Lower Limestone Formation has shown it to have a varied lithology including four typical Derbyshire bentonite clay horizons.

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## References

ARNOLD-BEMROSE, H. H. 1894. The microscopical structure of the Carboniferous dolerites and tuffs of Derbyshire. *Q. Jl. geol. Soc. Lond.*, vol. 50, pp. 603-644.

ARNOLD-BEMROSE, H. H. 1907. The toadstones of Derbyshire; their field relations and petrography. *Q. Jl. geol. Soc. Lond.*, vol. 63, pp. 241-281.

CHILLINGER, G. V., BISSELL, H. J. and FAIRBRIDGE, R. W. 1967. *Carbonate Rocks.* Developments in sedimentology. vols. 9A and 9B. Amsterdam.

DUNHAM, K. C. 1952. Fluorspar. *Spec. Rept. Min. Res.*, vol. 4, 4th ed., pp. 143, Geol. Surv. G. B.

EDEN, R. A., RHYS, G. H. and SMITH, E. G. 1959. Summary of Progress (1958) *Mem. Geol. Surv. G. B.*, pp. 33.

FAREY, J. 1811. *A general view of the agriculture and minerals of Derbyshire.* vol. 1, London.

FORD, T. D. 1967. *Some mineral deposits in the Carboniferous Limestone of Derbyshire*, pp. 53-75 (in Neves and Downie 1967, below)

GREEN, A. H., FOSTER, C. LE NEVE, and DAKYNS, J. R. 1887. The geology of the Carboniferous Limestone, Yoredale Rocks, and Millstone Grit of North Derbyshire. *Mem. Geol. Surv. Eng. and Wales*, 2nd ed. pp. 212.

NEVES, R, and DOWNIE, C. 1967. *Geological excursions in the Sheffield region and Peak District National Park.* 163 pp. Sheffield.

SARJEANT, W. A. S. 1967. Fibrous chlorites in volcanic rocks of Derbyshire. *Mercian Geol.*, vol. 2, p. 85.

SMITH, E. G., RHYS, G. H. and EDEN, R. A. 1967. Geology of the country around Chesterfield, Matlock and Mansfield. *Mem. Geol. Surv. G. B.*, 430 pp.

WALKDEN, G. M. 1970. *Environmental studies in the Carboniferous Limestone of the Derbyshire Dome.* Ph.D. Thesis, Univ. of Manchester.

WALKDEN, G. M. 1972. The mineralogy and origin of interbedded clay wayboards. *Geol. Jl.*, vol. 8, pp. 143-160.

WEDD, C. B. 1907. Summary of progress (1907) *Mem. Geol. Surv. G. B.*, pp. 12.