

THE NAMURIAN SUCCESSION IN THE AREA AROUND THE COMBES BROOK,
NEAR LEEK, NORTH STAFFORDSHIRE

by

Paul Geoffrey Morris

Summary

A succession of Upper Carboniferous (Namurian) rocks outcropping in the vicinity of the Combes Brook, near Leek, North Staffordshire, is described. An account of certain fossil localities occurring in the area is given and correlations of some of the fossil bands are made with other localities in the central and southern Pennines.

Introduction

The Combes Brook rises near Ipstones Station (SK 03055214), some four miles south-east of Leek, in North Staffordshire (see Text-fig.1). The brook flows in a north-north-westerly direction until Gorsthead Mill (SK 02405351) is reached. Here it swings to flow in a west-south-westerly direction. Finally, near Cloughmeadow Cottage (SK 00725268), the stream flows generally in a south-south-westerly direction.

The positions of the localities mentioned in the text are indicated on the map (Text-fig. 1). Exact positions are listed at the end of the paper, with grid references as an additional check.

The area has received only passing attention up to the present time. Indeed, the only references to faunas occurring here are those of Wardle (1862) and Hull and Green (1864; 1866). These authors recorded goniatites and other fossils from a locality downstream from Cloughmeadow Cottage.

The Stratigraphic Succession

A geological map of the Combes Brook area is presented in Text-figure 2. Because of faulting and the absence of diagnostic faunas some outcrops are not easy to date, but a generalised succession is given in Text-figure 3.

The lowest beds represented in the area, the Morredge Grits, were named by Challinor (1929, p.111) after the prominent escarpment which they form. Hudson (1945a, pp. 320-321) redefined the term Morredge Grits and divided them into an upper group, the Thorncliffe Sandstones, a middle group, the Crowstones, and a lower group, the Onecote Sandstones. The latter unit was shown to be of Upper Viséan (P_2) age. Hudson considered that one of the sandstones of the Onecote Sandstones group formed the top of Morredge.

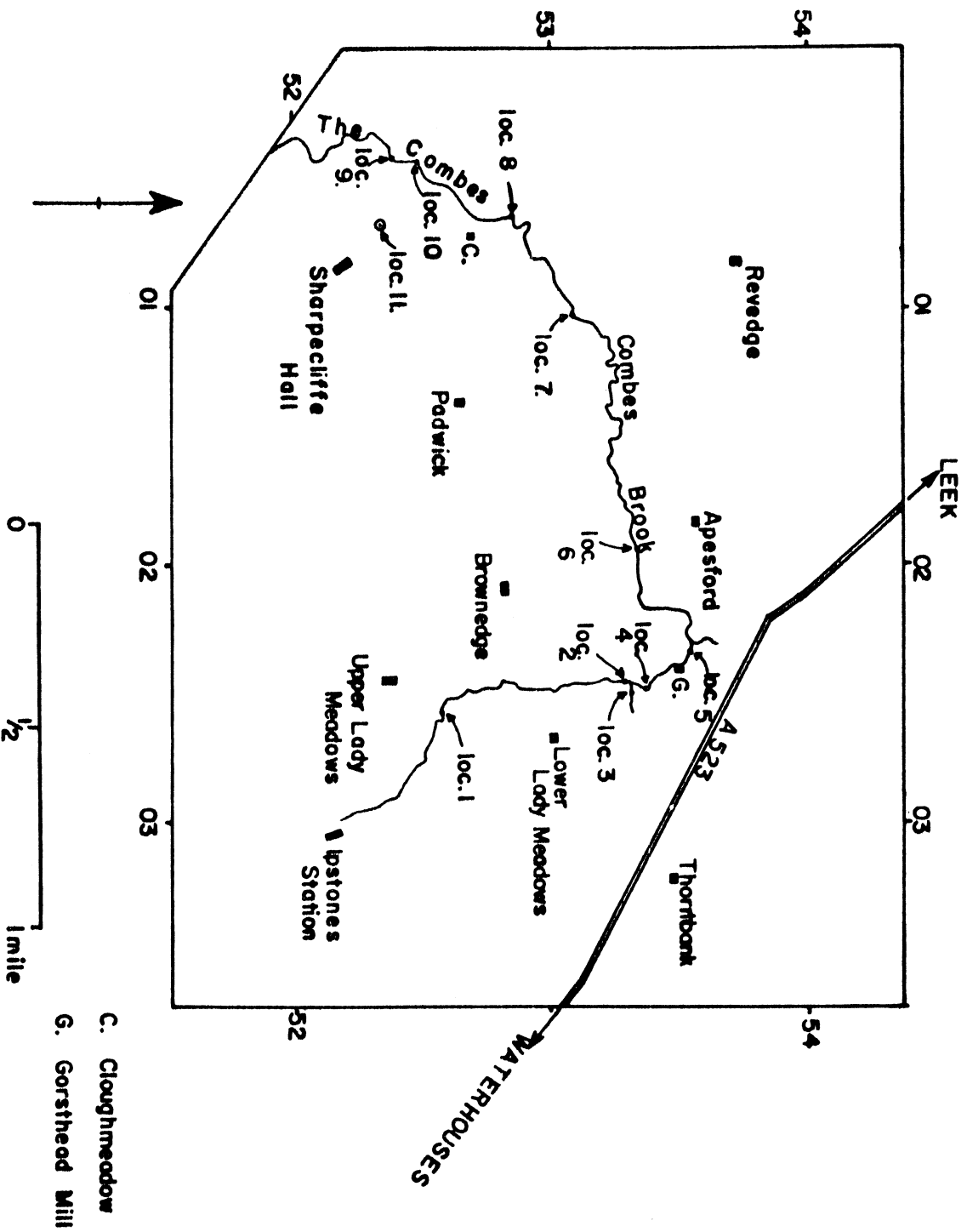


Fig. 1. Map showing fossil localities and other points mentioned in the text.

C. Cloughmeadow
 G. Gorsthead Mill

Recent investigations in the Morredge area (Morris 1966) have shown that the Onecote Sandstones do not outcrop on Morredge. In addition, Holdsworth (1964) has demonstrated that the term Crowstones has been used in widely differing senses for rocks of Namurian age in the southern Pennines.

The Thorncliffe Sandstones and "Crowstones" of Hudson are not well exposed except upstream of Thorncliffe village. Therefore, since the two groups of rocks cannot be separated on a geological map, there seems to be little point in introducing a new stratigraphic name for the "Crowstones" on Thorncliffe Bank or for retaining the term Thorncliffe Sandstones. The two terms are therefore abandoned in favour of the term Morredge Grits, which is also restricted to beds of Lower (E_1) and Upper (E_2) Eumorphoceras age.

The Morredge Grits are succeeded by mudstones and shales containing, near their base, the goniatite Homoceras cf. subglobosum Bisat (Hester 1932, p. 38). The outcrop from which this species was collected is no longer exposed and only a few other fossiliferous localities occur in the shales, none of which have yielded diagnostic goniatites. The mudstones and shales are succeeded by sandstones and shales, which are here called the Ipstones Edge Sandstones and which will be shown to be of Upper Namurian (R_1) age.

Consequently, the mudstones and shales underlying the Ipstones Edge Sandstones, which have been referred to by Hester (1932, p. 43) as the Churnet Shales, can only be regarded as equivalent to a small part of the Churnet Shales succession described by Challinor (1929, pp. 111-113) in the area north of Thorncliffe, north-east of Leek, the type area of the Churnet Shales. In this latter area the Churnet Shales range from the top of the Upper Eumorphoceras (E_2) Stage to the base of the Roches Grits which belong in the Upper Reticuloceras (R_2) Stage.

Descriptions of selected sections

The Combes Brook

Between Ipstones Station and Gorsthead Mill, the ground to the east of the brook is flat, low-lying and underlain by mudstones and shales covered by a thin veneer of boulder clay. However, the ground on the western side of the Combes Brook rises abruptly, presenting a marked feature. Outcrops in the brook are not abundant and, for some 200 yards or so downstream from Lower Lady Meadows farm (SK 02685300), they consist solely of mudstones, often heavily iron-stained and badly shattered, together with thin ironstone bands. At only one point (locality 1) are fossils found upstream of Lower Lady Meadows; here, fragments of pectiniform lamellibranchs occur.

Elsewhere, notably in the river cliffs lying E. N. E. of Upper Lady Meadows (SK 02435238), the mudstones are of interest for the occurrence of thin lenses of coal, usually no more than 1/4" thick. These mudstones also contain fragments of slightly crushed, petrified plant stems. Downstream from Lower Lady Meadows the mudstones give way to thin siltstones, which are overlain by a further sequence of shales and shaly mudstones. The siltstones are well exposed at locality 2 where these beds are faulted. The fault at this locality runs more or less along the strike, and though the fault plane is not well exposed, the fracture can be seen to be a high angled reverse fault. Only a few yards downstream from locality 2, two further fossiliferous horizons (localities 3 and 4) occur in mudstones which are dipping in an easterly direction. These localities are only sparsely fossiliferous. The mudstones at locality 3 yields a small fauna consisting of the lamellibranchs Leiopteria longirostris Hind and Posidoniella sp. Coalified plant fragments are not uncommon, including pinnules of Neuropteris sp.

Locality 4, a river-bluff a short distance downstream from locality 3, consists of some 13 feet of ferruginous mudstones. The lowermost 30" of the beds are sparsely fossiliferous, the remainder of the sequence being barren. The fauna collected from the base, consists entirely of small lamellibranchs and includes:

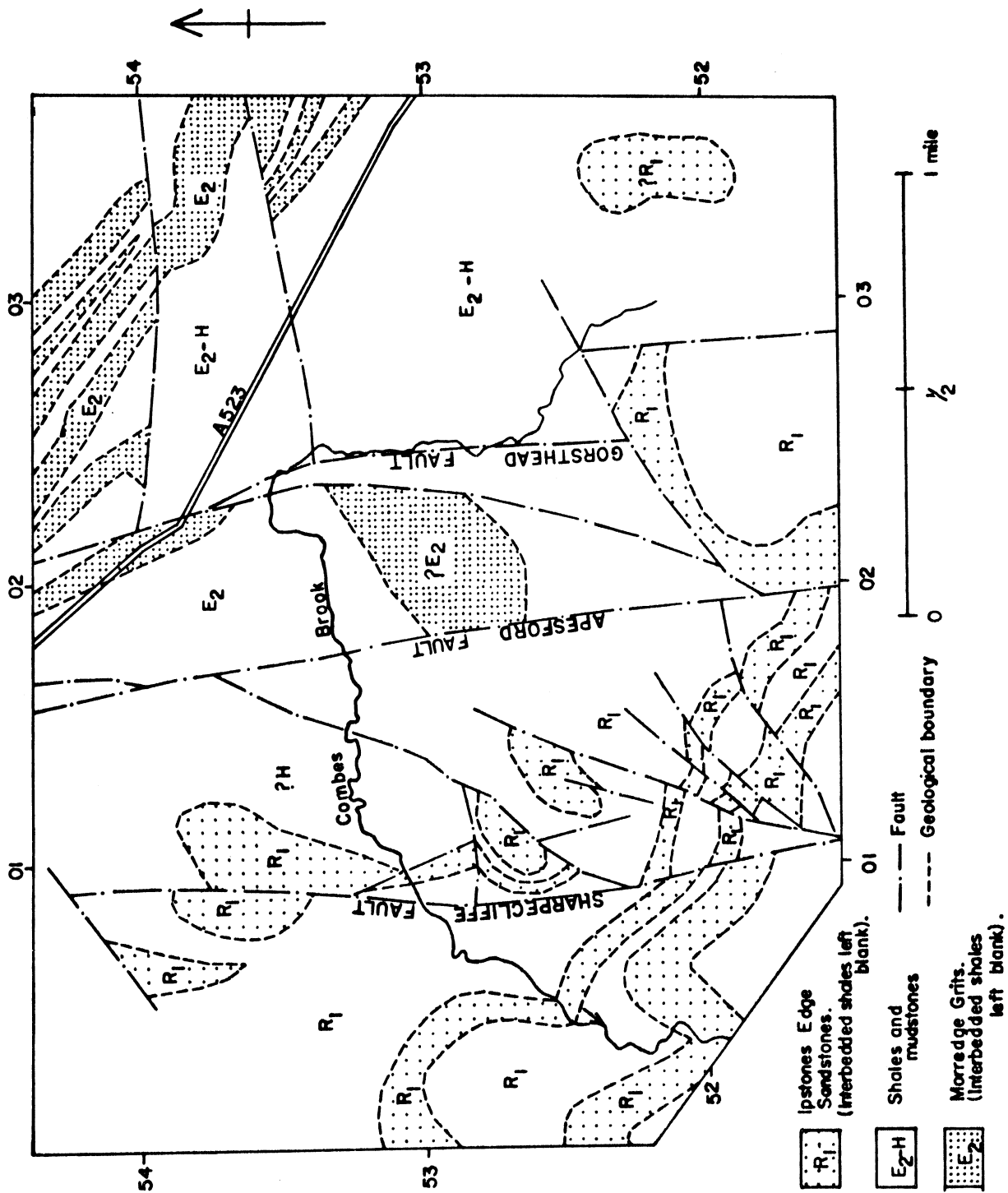


Fig. 2. Geological map of the area adjacent to the Combes Brook.

Posidoniella cf. variabilis Hind

? Posidoniella sp.

Myalina sublamellosa Etheridge

Leiopteria longirostris Hind

Actinopteria sp.

Pectiniform fragments

The entire fauna occurring at this locality is composed of small specimens.

No further exposures are seen downstream until the footbridge at Gorsthead Mill is reached. Here (locality 5), alongside a small weir, is an exposure in which the following succession is seen:

3.	Massive, fine-grained sandstones separated by siltstone partings into four bands	9' 6"
2.	Shales. Poorly exposed, apparently barren and with very thin sandstone bands	13' 10"
1.	Fine-grained sandstones	1' 10"

----- Fault plane obscured by vegetation -----
Sandstones

Beds 1, 2 and 3 dip steeply east-north-east; the beds on the western side of the fault plane dip steeply west-south-west. The direction of the dip on the eastern side of the fault plane is the same as that at locality 2, although the amount of dip at the latter locality is rather less. The faults seen at localities 2 and 5 are regarded as the same fracture. It is likely that this fault continues southwards along the western bank of Combes Brook; the marked feature seen on this bank is therefore possibly a fault scarp. The presence of a fault would also account for the very marked easterly dips seen in the exposures near Lower Lady Meadows.

The age of the beds to the east of this fault line is problematical.

On the northern side of the Waterhouses - Leek road the uppermost beds of the Morredge Grits occur; their apparent top is marked by a very abrupt change of slope. This boundary is probably high in the Upper Eumorphoceras (E₂) Stage. Thus the succeeding beds may belong to higher E₂ horizons and to the succeeding Homoceras Stage. The sandstones outcropping on the east side of the fault around Gorsthead Mill are thought to represent some of the highest beds of the Morredge Grits. The mudstones forming the ground between the fault scarp and Thornbank farm (SK 03215347) would therefore represent horizons high in the Upper Eumorphoceras (E₂) Stage and possibly in the Homoceras (H) Stage. Palaeontological evidence for such a conclusion is unfortunately still lacking in the Combes Brook area. Diagnostic goniatites have not been found, but the lamellibranch faunas seen at localities 3 and 4 may represent horizons somewhat higher than those met with at other Upper Eumorphoceras Stage localities in neighbouring areas on Morredge.

Continuing downstream from Gorsthead Mill footbridge, a succession of mudstones, silty shales and siltstones are seen with a general westerly dip. Occasional dips at variance with the main W. - S.W. trend indicate the presence of slight folds or minor faulting. The siltstones and thin sandstones outcropping in the river bluff due east of Apesford (SK 01805355) commonly show ripple marks and worm tracks. Similar tracks may also be seen on sandstone slabs in the banks of a small stream about 100 yards west of the ford at Gorsthead Mill. Exposures downstream of the Apesford river bluff become fewer and smaller, consisting

predominantly of mudstones. One of these mudstone outcrops (locality 6) to the south-west of Apesford yields rare fragmentary specimens of the lamellibranch *Actinopteria* cf. *persulcata* with plant fragments. Lithologically, the mudstone has a characteristic "soapy" texture.

No exposures of any significance occur downstream from locality 6 until a sharp bend in the brook is reached in Sixoaks Wood. Here, a mudstone outcrop (locality 7) some 30' high contains large but virtually barren bryllions. Fragmentary lamellibranchs (*Posidoniella* sp. and *Posidonia* sp.) occur with rare orthocone nautiloids.

Exposures become more abundant and prominent downstream from locality 7. As the stream passes through Sixoaks Wood it cuts down through massive sandstones. Outcrops of these sandstones show a westerly dip of 70° - 80° and the sandstones can be traced as a distinct ridge running south-south-east through Sixoaks Wood. In the upper part of this wood, between Padwick (SK 01345263) and Cloughmeadow Cottage, sandstones with a gentle south-easterly dip outcrop as a capping to the hill. A small E - W fault is thought to separate the sandstones in the northern and southern parts of the wood. A further fault also separates the steeply dipping sandstones from those extending towards the wood from the neighbourhood of Revedge (SK 00825370). Further sandstones occur downstream of the weir in Sixoaks Wood where the brook bends sharply southwards. It is considered that the line of the Sharpecliffe Fault (see fig. 2) passes between this series of sandstones and those forming the ridge in Sixoaks Wood.

A further series of large shale and mudstone outcrops occur downstream from Sixoaks Wood but only one (locality 8) is fossiliferous. At this point, some 200 yards N. N. W. of Cloughmeadow are shaly mudstones and thin earthy limestones. The succession here is:

5.	Iron-stained shales and shaly mudstones with occasional plant fragments	15'	0"
4.	Thin, earthy, fossiliferous limestones	0'	3"
3.	Shaly mudstones, calcareous mudstones and thin earthy limestones	5'	2"
2.	Fossiliferous earthy limestone	0'	6"
1.	Shales with small unfossiliferous nodules	3'	0"

Band 2 yields the lamellibranchs *Dunbarella* sp., *Posidoniella variabilis* Hind, *Myalina* sp. and *Posidonia* sp. and a goniatite, *Dimorphoceras* (*Paradimorphoceras*) sp. nov. From band 4 the following have been obtained; *Dunbarella* sp., *Posidoniella* sp. and *Dimorphoceras* sp., the latter represented by casts showing external ornament only. This ornament closely resembles that seen in the specimens from Band 2; the forms from the bands 2 and 4 are therefore regarded as conspecific.

The vertical distribution of known species of *Paradimorphoceras* is limited, with large parts of the stratigraphical succession in which the sub-genus is unrepresented. For instance, the earliest member of the sub-genus is the Upper Viséan (P2) form *Dimorphoceras* (*Paradimorphoceras*) *marioni* Moore, which is succeeded in the Lower Namurian (E1) by *D. (P.) plicatilis* Moore. No further species are known until *D. (P.) looneyi* (Phillips) appears in the Kinderscoutian (R1). Therefore, although the form *Dimorphoceras* (*Paradimorphoceras*) sp. nov. appears from a sutural point of view to be intermediate between *D. (P.) plicatilis* and *D. (P.) looneyi*, its exact stratigraphic position cannot be deduced. The field evidence suggests a horizon in high E2, or H, but no more accurate assessment can be made at present.

In the stream running down from Backhill Wood towards Cloughmeadow Cottage are a number of outcrops of mudstones and shales. Occasional thin calcareous and ferruginous silty bands occur. The only organic remains so far seen consist of indeterminate plant fragments. The beds maintain a steep dip of

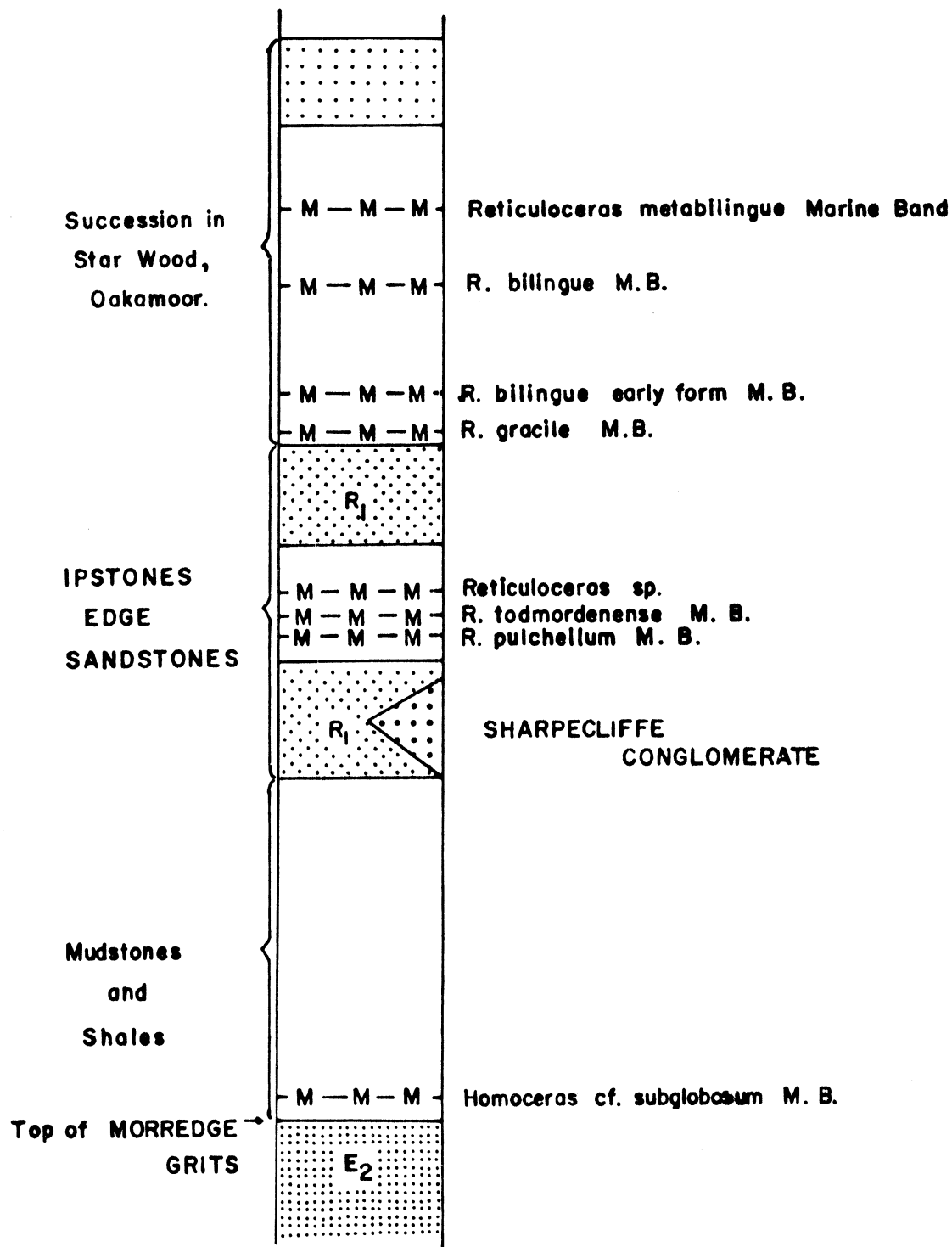


Fig. 3. COLUMNAR SECTION (not to scale) SHOWING THE SUCCESSION IN THE COMBES BROOK AREA AND THE ADJACENT AREA TO THE SOUTH.

about 45° at W 25° S along the whole course of the stream and underlie the sandstones of Ipstones Edge, shown later to be of Lower Reticuloceras (R₁) age. The mudstones in the vicinity of Cloughmeadow Cottage, then, are of lowermost R₁ or possibly of Homoceras (H) Age.

A short distance downstream of Cloughmeadow, in the wood known as The Combes, the lowest band of the Ipstones Edge Sandstones outcrops. Further downstream, at a point (SK 00435238) some 100 yards below Horsley's Stone, is a thin sequence of badly weathered black shales and mudstones (locality 9) containing three marine bands. The fossils in these bands are commonly pyritised; the bedding planes and joint surfaces are usually strongly iron-stained, presumably a result of the oxidation of the pyrites. Exposure at the time of examination of this river cliff was not good and the cliff itself has been almost completely hidden by a land-slip, the result of storms in the winter of 1960-61.

Bullions consisting for the most part of fine-grained argillaceous limestone, but occasionally with large amounts of coarsely crystalline calcite, gradually weather out and may be found either in situ or in the stream bed. The succession at this point is:-

6.	Poorly exposed mudstones, weathering into iron-stained laminae. Some bands remain relatively unstained and retain a blue-grey colour. These beds become soft and rather greasy to the touch.	5' 0" +
5.	Mudstones. Faunal band C	0' 9"
4.	Poorly exposed mudstones similar to those of band 6	9' 0"
3.	Mudstones weathering out into shaly laminae. Crowded with fossils, mostly goniatites with some lamellibranchs. Fossils become sparse towards the top. Occasional bullions. Faunal band B.	3' 2"
2.	Unfossiliferous blue-grey clay	0' 10"
1.	Mudstones cleaving along certain planes with difficulty. Mostly unfossiliferous but the top 8" yield goniatite impressions. A single bullion. Faunal band A.	3' 8"
		<hr/>
		22' 5" +
		<hr/>

The Combes does not appear to have attracted much attention from geologists, the main reference occurring in the account of North Staffordshire given by Hull and Green (1866). These authors record the following fauna, presumably from locality 9 of the present account:-

Goniatites	<u>Glyphioceras micronotus</u> ? <u>G. reticulatus</u> <u>Glyphioceras</u> sp.
Nautiloids	<u>Orthoceras cinctum</u> Sowerby <u>Nautilus subsulcatus</u>
Lamellibranchs	<u>Anthracoptera</u> sp. <u>Aviculopecten papyraceus</u> Goldfuss <u>Cardiomorpha</u> sp. <u>Ctenodonta gibbosa</u>

Brachiopod	<u>Discina nitida</u> Phillips
Worm tubes	<u>Spirorbis carbonarius</u> M'Coy
and	Annelid tracks

In a slightly earlier reference to the area, Wardle (1862), writing in John Sleigh's "Ancient History of Leek", mentions the fossils of The Combes, some of which are figured on Plate 4 of the above history.

Of the fauna recorded by Hull and Green, the occurrence of several fossils has not so far been confirmed in the present work; these include the lamellibranchs Anthracoptera sp., Cardiomorpha sp. and Ctenodonta gibbosa Salter (= Nucula gibbosa Fleming 1828). "Solid" coiled nautiloids have not been collected and fragmentary internal casts of nautiloid whorls preserved in mudstone have proved to be indeterminate. Orthocone nautiloids are not uncommon in the mudstones of faunal band B, locality 9. Very small incomplete specimens have been collected from bullions but these have proved to be generically indeterminate.

Vague tracks are occasionally seen and spirorbids occur, usually as very small specimens associated with fragments of plant stems. Dunbarella rhythmica (Jackson) is not uncommon in the mudstones and is presumably the form recorded as Aviculopecten papyraceus Goldfuss by Hull and Green. The goniatite fauna is an extremely interesting one, with the genera Dimorphoceras, Homoceras and Reticuloceras well represented. Fossils recorded from the three faunal bands are as follows:--

Faunal band A

Goniatites:	<u>Reticuloceras pulchellum</u> (Foord) <u>R. "davisi"</u> (Foord and Crick) <u>Reticuloceras sp. nov.</u> <u>Homoceras aff. striolatum</u> (Phillips) ? <u>Homoceratooides sp.</u> <u>Dimorphoceras sp.</u>
Lamellibranchs:	<u>Dunbarella rhythmica</u> (Jackson) <u>Posidoniella sp.</u>
Brachiopod:	<u>Orbiculoidea nitida</u> (Phillips)

Faunal band B

Goniatites:	<u>Reticuloceras todmordenense</u> Bisat and Hudson <u>R. paucicrenulatum</u> Bisat and Hudson <u>R. umbilicatum</u> Bisat and Hudson <u>R. pulchellum</u> (Foord) - a late form <u>Reticuloceras sp.</u> - (see Bisat and Hudson 1943 Pl. xxiv fig. 5) <u>Dimorphoceras sp.</u>
Lamellibranchs:	<u>Dunbarella rhythmica</u> (Jackson) <u>Posidoniella laevis</u> (Brown)
Brachiopods:	<u>Orbiculoidea nitida</u> (Phillips) <u>Lingula sp.</u>

Worm tubes: Spirorbis sp.
 Conodonts: Hindeodella sp.

Faunal band C

Goniatites: Reticuloceras sp.
Homoceras sp.
Dimorphoceras sp.

Lamellibranchs: Posidonia obliquata (Brown)
Caneyella aff. rugata (Jackson)
Dunbarella sp.
Posidoniella sp.

The conodonts (Hindeodella sp.) occurring in faunal band B are commonly present as an amorphous calcium sulphate, presumably the result of attack by sulphuric acid derived from the oxidation of pyrites, on the original calcium phosphate.

Bisat and Hudson (1943) divided the Lower Reticuloceras Stage into six zones. Later, Hudson (1945b) emended this sub-division so that the original six zones now become sub-zones thus:-

Table 1

<u>Stage 1</u>	<u>Zone</u>	<u>Sub-zone</u>
Kinderscoutian	(<u>R. reticulatum</u>	(<u>R. co-reticulatum</u>
	((= R _{1c})	(<u>R. reticulatum</u>
or	(
Lower Reticuloceras Stage	(<u>R. eoreticulatum</u>	(<u>R. nodosum</u>
	((= R _{1b})	(<u>R. dubium</u>
	(
	(<u>R. inconstans</u>	(<u>R. todmordenense</u>
	((= R _{1a})	(<u>R. inconstans</u>

Ramsbottom (in Ramsbottom et al. 1962 p. 125) has suggested that the zonal index of Zone R_{1a} should be changed to Reticuloceras circumplicatile (Foord) because the species R. inconstans cannot be identified with any certainty.

The Reticuloceras todmordenense sub-zone is only thinly developed in the Central Pennines. For instance, at Lumbutt's Clough and Salmesbury it is about six feet thick (Bisat and Hudson 1943, p. 431). The sub-zone contains a fauna which included R. todmordenense, R. paucicrenulatum, R. aff. umbilicatum and occasional Homoceras aff. striolatum. The fauna from the outcrops seen in The Combes at locality 9 allow these beds to be accurately dated (see Table 1). Faunal band B of locality 9 in The Combes may be placed in the R. todmordenense sub-zone. The band (A), below, contains a fauna including R. pulchellum and Homoceras aff. striolatum. Bisat and Hudson (1943, p. 430) record a fauna from Wharfedale, Yorkshire

and from the Ashop road cutting at Edale, Derbyshire, in which R. pulchellum occurs. These authors place the fauna in their R. inconstans zone. It therefore appears that the faunas from Wharfedale, the Ashop cutting and Band A in The Combes can be correlated. Faunal band A is placed at or just below the junction of the R. inconstans and R. todmordenense sub-zones.

Band C in The Combes contains a fauna with Reticuloceras sp. and Homoceras sp., the latter being fairly common. This fauna may lie within the R. dubium sub-zone.

The succession at locality 9 in The Combes is the only one seen in the area south - and south-east of Leek which yields a Kinderscoutian goniatite fauna. It is therefore of some importance in dating the underlying and overlying strata. Mapping has shown that the mudstones outcropping at locality 9 are some 40 feet thick. They are overlain and underlain by sandstones, which are well exposed in the valleys sides and also to the east of Sharpecliffe Hall, where the lower bed locally becomes conglomeratic.

Sandstone development is unusual at this horizon in the Central Province. The lower part of the Lower Reticuloceras (R₁) Stage consists of shales only, in the Longnor area of North Staffordshire, in North Derbyshire, in the Huddersfield - Halifax area and in the Wharfe Valley. Indeed, the only areas where sandstones are recorded are in the Ingleton - Clapham and Knaresborough Forest areas. In the former area, the Clapham Grit Group may represent the whole of the H, R₁, R₂ and G₁ Stages of the Namurian (Bisat and Hudson 1943, p. 400). In the Knaresborough Forest area, beds lying immediately below shales containing Reticuloceras of the R. inconstans group are known as the Upper Follifoot Grit.

The top of the sandstone group, outcropping in The Combes and forming Ipstones Edge and here referred to as the Ipstones Edge Sandstones, is taken to lie at the base of the Reticuloceras gracile Bisat Marine Band. This band occurs in Star Wood, Oakamoor, and is succeeded by a series of mudstones with a sequence of marine bands containing R. bilingue (Salter) early form, R. bilingue (Salter) and R. metabilingue Wright (see Morris 1966). The Ipstones Edge Sandstones are therefore to be equated with the Kinderscout Grit Group of the Central Province.

The area to the south of The Combes Brook

The area may conveniently be divided into two for the purpose of description. Firstly, in the south-west is the high ground of Ipstones Edge in the vicinity of Sharpecliffe Hall. Secondly, between Ipstones Edge and The Combes Brook is the slightly less elevated ground on which stand the farms Padwick and Browndge.

The Ipstones Edge area

Ipstones Edge is a prominent escarpment running south-eastwards from near Sharpecliffe Hall towards Black Heath where it dies away near Windy Harbour (SK 06034850). The escarpment is very variable in form. For instance, in the area under discussion in the neighbourhood of Sharpecliffe Hall, it is a relatively small feature some 20 feet high formed from a single band of pebbly sandstone. Further south-east the escarpment becomes much more prominent, notably in the area between the Red Lion Inn (SK 02805124) and Hallbarn (SK 04535089). Eastwards again the escarpment gradually becomes less prominent until it is no longer seen near to Windy Harbour. The escarpment is formed from a series of sandstones interbedded with mudstones, shales and silty shales, a group of rocks which have been referred to above as the Ipstones Edge Sandstones.

The sandstones naturally form the strongest features and probably represent the thickest members of the group. Lithologically the sandstones are somewhat variable. Over most of the area the beds are medium to coarse-grained, occasionally becoming very coarse-grained and pebbly. In the vicinity of Sharpecliffe Hall (SK 00845218) the lowermost sandstone unit becomes highly conglomeratic. Elsewhere,

apart from variations in grain-size, the mineral content remains fairly uniform with occasional flakes of mica forming the main accessory mineral.

Good exposures of these sandstones occur on the valley sides in The Combes just below Cloughmeadow Cottage. In the area between The Combes and Summer Hill (SK 02175155) two distinct sandstones occur. The lower sandstone can be seen in the valley bottom some 250 yards south-west of Cloughmeadow. Here the sandstone is vertical, probably the result of local faulting, and is coarse-grained though containing few pebbles. Overlying this sandstone are the fossiliferous mudstones described above (p.). These beds are in turn overlain by a further series of sandstones which are well exposed high up on the eastern side of the valley about 250 yards west of Sharpecliffe Hall.

The south-eastward extension of both of these sandstone bands can be traced quite easily in the vicinity of Sharpecliffe Hall. In particular, the lower sandstone produces the prominent scarp eastwards through Sharpecliffe Wood and Sharpecliffe Rocks Plantation. The area east of Sharpecliffe Hall is much faulted. This is emphasised by the displacement of the sandstone outcrops, particularly in the area between Home Farm (SK 01005207) and Little Rocks Plantation. Most of these faults have a relatively small throw and represent branches of the main Sharpecliffe Fault which strikes towards Revedge. The line of the Sharpecliffe Fault can be traced between Home Farm and the Hall; the fault strikes southwards from the Hall towards Collyhole (SK 00895109). The northerly line of the fault has already been referred to (see p.).

As mentioned above, the lowermost sandstone unit of the Ipstones Edge Sandstones locally becomes conglomeratic. This development is seen in a small buttress in Sharpecliffe Rocks Plantation where about 20 feet of rocks may be grouped thus:-

3. An upper conglomeratic unit.
2. Coarse-grained sandstone unit in which current-bedding is prominent. The "set" of the current-bedding planes is predominantly southerly.
1. A lower, more massive conglomerate.

The conglomerate consists predominantly of quartz pebbles ranging from the size of a pea up to two inches in diameter. A pinkish feldspar is not uncommon, some crystals being half an inch or more in cross-section. One of the most curious features of this conglomerate is the presence of thin slabs of iron-stone, some measuring up to six inches in diameter but usually no more than half an inch thick. These slabs lie at various angles and are not aligned in any way.

The provenance of the material is problematical, for vein quartz is not seen affecting any of the beds of the area beyond that under discussion. In addition the feldspars are probably derived from a not too distant source which is at present unknown. The iron-stone slabs might be more local in origin, for Wardle (1862, p. 250) comments on the remains of old workings on the hillside not far from Winkhill. These old workings are still to be seen, in beds which are now known to be of Upper Eumorphoceras (E₂) age (Morris 1966). There is, however, no evidence of uplift and erosion in the area and it is thought unlikely that the Winkhill area represents the source of the iron-stone slabs.

Few outcrops of the interbedded mudstones are seen in the Ipstones Edge Sandstones succession. The main outcrop has already been described as locality 9 in The Combes. Two further outcrops of these mudstones yielding sparse faunas have been located. One, locality 10, lies some 30 yards upstream from Horsley's Stone and Dunbarella sp. and Posidoniella sp. have been obtained from it. From the second outcrop, locality 11, high up on the valley side about 250 yards north-west of Sharpecliffe Hall only occasional specimens of Posidoniella sp. have been recorded.

The area between Ipstones Edge and Gorsthead Mill

Between the stream running from Backhill Wood towards Cloughmeadow and the Gorsthead Mill - Upper Lady Meadows section of the Combes Brook, there lies the high ground on which stands the farms of Padwick and Browndedge. This area is much faulted and it is not easy to correlate the sandstones which cover the areas of Browndedge, Padwick and the south-eastern part of Sixoaks Wood with other areas, particularly in the absence of diagnostic fossils.

The sandstone outliers may be correlated with the Morredge Grits and they would therefore represent up-faulted blocks. There is some support for this suggestion in the Gorsthead Mill area, where high-angle reverse faulting occurs (see p.). The outcrops on Browndedge are here regarded as part of the Morredge Grits. Other outcrops near Padwick and in Sixoaks Wood might be correlated with the Ipstones Edge Sandstones, but their true affinities are at present uncertain.

The area to the north of Combes Brook

North of the Combes Brook, about Revedge (SK 00825370), sandstones occur again. The main outlier of sandstone, capping the hill of Revedge itself, can be mapped fairly easily along its northern and eastern boundaries. The western boundary, also easily mapped, represents the line of the northward extension of the Sharpecliffe Fault. West of this fault is another small, arcuate outcrop of sandstone (on which stands the farm, Revedge) and north-west of this is yet another small knoll, comprised of sandstone affected by faulting, in the area of Roost Hill (SK 00615386). The age of these sandstones is uncertain and they are here tentatively correlated with the lower band of the Ipstones Edge Sandstones.

Between Revedge and Bradnop the ground is fairly flat and featureless, except for a small sandstone outlier forming a knoll just south of Bradnop Station. The sandstones comprising this knoll are correlated with the sandstones outcropping in Bradnop village, which are part of the Morredge Grit succession.

Acknowledgements

My sincere thanks are due to Mr. and Mrs. G.A. Lovenbury of Cloughmeadow Cottage, Bradnop, for their many kindnesses during the author's visits to North Staffordshire.

P. G. Morris, B.Sc., Ph.D., F.G.S.,
Department of Geology,
Chelsea College of Science and Technology,
Manresa Road,
LONDON, S.W.3.

List of localities

1. A stream-section 1050 yards S 10° E of Gorsthead Mill, Bradnop (SK 02565369)
2. A stream-section 235 yards S 12° E of Gorsthead Mill, Bradnop (SK 02445330)
3. A stream-section 220 yards S 21° E of Gorsthead Mill, Bradnop (SK 02475332)
4. A stream-section 197 yards S 29° E of Gorsthead Mill, Bradnop (SK 02485335)
5. A stream-section 53 yards W 31° N of Gorsthead Mill, Bradnop (SK 02355354)
6. A stream-section 540 yards W 22° S of Gorsthead Mill, Bradnop (SK 01935322)
7. In Combes Brook 543 yards N 39° of Cloughmeadow Cottage, Bradnop (SK 01035306)
8. In Combes Brook 190 yards N 30° W of Cloughmeadow Cottage, Bradnop (SK 00645285)
9. In "The Combes" some 510 yards W 25° N of Sharpecliffe Hall, Bradnop (SK 00425239)
10. In "The Combes" some 30 yards upstream of Horsley' Stone, Bradnop (SK 00425248)
11. In Spiritholes Wood 247 yards W 42½° N of Sharpecliffe Hall, Bradnop (SK 00685233)

REFERENCES

- BISAT, W. S. & HUDSON, R. G. S. 1943 The Lower Reticuloceras (R₁) Goniatile succession in the Namurian of the North of England. Proc. Yorks. geol. Soc., Vol. 24, pp. 383-446 1 text-fig., 8 plates.
- CHALLINOR, J. 1929 Notes on the Geology of the North Staffs. Moorlands. Trans. N. Staffs. Fld. Cl., Vol. 63, pp. 111-113, 1 plate.
- HESTER, S. W. 1932 The Millstone Grit Succession in North Staffordshire. Summ. Progr. geol. Surv. Gr. Br. for 1931, pp. 34-48, 1 text-fig., 2 tables.
- HOLDSWORTH, B. K. 1964 The "Crowstones" of Staffordshire, Derbyshire and Cheshire. N. Staffs. Journ. Fld. Studies, Vol. 4, pp. 89-102.

- HUDSON, R. G. S. 1945a (in appendix II of Hudson R. G. S. & Cotton, G.)
The Upper Viséan and Lower Namurian of North Staffordshire
Proc. Yorks. geol. Soc., Vol. 25, pp. 318-330, 1 text-fig.
- 1945b The Goniatite Zones of the Namurian. Geol. Mag.,
Vol. 82, pp. 1-9
- HULL, E. & GREEN, A.H. 1864 On the Millstone Grit of North Staffordshire. Quart. J.
geol. Soc., Lond., Vol. 20, pp. 242-267
- 1866 The Geology of the Country around Stockport, Macclesfield,
Congleton and Leek. Mem. Geol. Surv. Gr. Br., pp. 1-102, 1 plate.
- MORRIS, P. G. 1966 The Stratigraphy and Palaeontology of the Upper Dinantian
and Namurian Rocks in the area east and south-east of Leek, North
Staffordshire. (Ph. D. Thesis, University of London).
- RAMSBOTTOM, W.H.C., RHYS, G.H and SMITH, E. G.
 1962. Boreholes in the Carboniferous Rocks of the Ashover District
Derbyshire. Bull. Geol. Surv. Gr. Br., No. 19, pp. 75-168
- WARDLE, T. 1862 On the Geology of the neighbourhood of Leek.
(In John Sleigh's "Ancient History of Leek"). Leek.
(Reprinted separately in 1863 with the same pagination).
pp. 225-291, 4 plates.

Manuscript received 8th June, 1966