Leicestershire Coal Field. HULL.

MEMOIRS

OF THE

GEOLOGICAL SURVEY

OF

GREAT BRITAIN

AND OF THE

MUSEUM OF PRACTICAL GEOLOGY.

THE GEOLOGY OF

THE LEICESTERSHIRE COAL-FIELD

AND OF THE

COUNTRY AROUND ASHBY-DE-LA-ZOUCH.

BY

EDWARD HULL, B.A., F.G.S.

PUBLISHED BY ORDER OF THE LORDS COMMISSIONERS OF HER MAJESTY'S TREASURY.

LONDON:
PRINTED FOR HER MAJESTY'S STATIONERY OFFICE.
PUBLISHED BY
LONGMAN, GREEN, LONGMAN, AND ROBERTS.

1860.

570.

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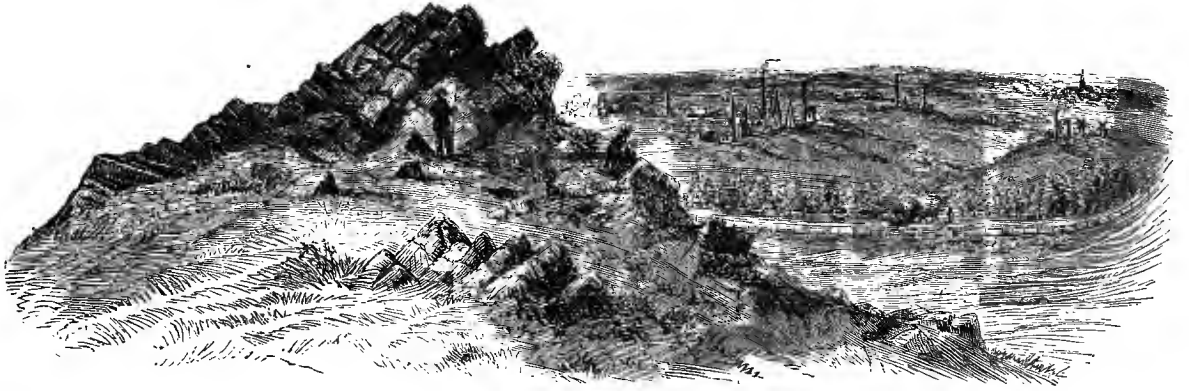

THE COLEORTON COAL-FIELD AS SEEN FROM THE PORPHYRITIC ROCKS OF PELDAR TOR.

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[2,246.—1,000.—10/60.]

PREFACE.

Before commencing the following observations, it is with pleasure I record the assistance received in carrying out the Geological Survey in the district of Ashby-de-la-Zouch. And first, my thanks are due to the Rev. W. H. Coleman, who for several years had been an accurate observer, and had tabulated a large amount of statistical information concerning the geology of the neighbourhood. Mr. Coleman, in the handsomest manner, placed the whole at my disposal, and also rendered me much personal assistance; and it is but due to my friend to state that he had mastered the geological structure of the greater portion of the area included in the following remarks, before the Government Surveyors commenced their labours.

I have also to record the readiness with which, in the great majority of cases, the proprietors or agents of the collieries allowed me to inspect the plans and sections, and, when necessary, visit the mines. Amongst these I may specially mention Mr. Woodhouse, of Overseal; Mr. Edward Green, of Charnwood Lodge; and Mr. John Browne, formerly assistant to Mr. Woodhouse. The services of many other gentlemen are acknowledged in the foot-notes in their proper places.

I have also had occasion frequently to refer to Mammatt's "Geological Facts," a work of which, considering the state of geological science at the time it was published (1834), it is impossible to speak too highly.

The following Maps and Sections of the Geological Survey illustrate the Leicestershire Coal-field, and are referred to in the following pages :—

Geological Maps, 63 N.W. and 71 S.W.—Price 2*s.* 6*d.* each.

Horizontal Sections, Sheets 46, 48, 49, 52.—Price 5*s.* each.

Sheet 46.—From the Trent, near Repton, to Bardon Hill, crossing the New Red Sandstone, the Coleorton coal-field by Whitwick and Swannington collieries, and the Carboniferous Limestone, near Ticknall.

Sheet 48.—From the Warwickshire coal-field across the Trias of Gopsall Park, by Heather Mill, Coalville, and Charnwood Forest to Wysall, near Loughborough.

Sheet 49, No. 2.—From the Warwickshire coal-field to Chellaston Hill, crossing the Moira coal-field by Donnisthorpe and Moira.

Sheet 52, No. 1.—From the Trent at Newton Solney to Swepstone, crossing the Moira coal-field by Newall, Gresley, Moira, and Measham Hall. No. 2, from west to east, by Linton, Ashby Woulds, Coleorton Common, Grace Dieu, and the northern edge of Charnwood Forest.

Vertical Sections, Sheets 19, 20.—Price 3*s.* 6*d.* each, plotted to a scale of 40 feet to 1 inch, (copperplate.)

Sheet 19, Coleorton District.—1. Bagworth colliery ; 2. Ibstock colliery ; 3 and 4. Snibston colliery ; 5. Whitwick colliery ; 6. Heather colliery ; 7. New Swadlincote colliery ; 8. Pegg's Green colliery ; 9. Coleorton colliery ; 10. Lount colliery ; 11. Heath End colliery ; 12. Boring at Rough Heath ; 13. Clay Pit, Woodville ; with an explanation of local mineral terms.

Sheet 20, Moira district.—1. Donnisthorpe colliery ; 2. New Oakthorpe colliery ; 3, 4, 5. Moira colliery ; 6. Woodville colliery ; 7. Granville colliery ; 8. Boring at Old Swadlincote colliery ; 9. Arthcote colliery ; 10. Whitehouse colliery ; 11. Gresley Common colliery ; 12. Gresley Wood colliery ; 13. New Stanton colliery.

CONTENTS.

THE GEOLOGY OF LEICESTERSHIRE.

CHAPTER I.

Physical Geography.

Before proceeding to describe the geological structure of the Ashby-de-la-Zouch coal-field and the surrounding districts, it will be necessary to give a rapid sketch of its chief physical features, these being, in effect, the result of the geological structure, modelled into form and feature by the agency of the sea when it formerly inundated the British Islands.

The Ashby-de-la-Zouch coal-field will form the more immediate subject of the following Memoir, but observations will also be extended over the area embraced by the Trent, the Soar, Charnwood Forest, and the confines of the districts occupied by the Keuper Marls of the New Red Sandstone.

Were a plane surface caused to extend over this area, and rest upon the higher portions, it would be found to touch these points of contact at nearly the same level as far as the confines of Charnwood Forest. The elevation of this plane would be about 450 feet above the sea, the intervening low grounds being scooped out in the form of basins and valleys. The higher grounds always present a flat tabulated appearance, which is particularly remarkable in the case of the high district extending from Pistern Hill to Smisby, and from Stanton Harold to Wilson. This is caused by the horizontality of the strata of which they are formed. In other cases such as those of the limestone hills of Breedon and Breedon Cloud, the flatness of the upper surface can only be accounted for on the supposition, that they have formed for a long time the bed of the ancient glacial sea; and it is remarkable how these masses of hard rock have formed barriers to the action of the sea on the district on their eastern sides during the elevation of the land; for while the ground to the westward is considerably lower, that to the eastward remains on a level with the upper surfaces of the Breedon Hills.

Above this comparatively level district, the hills of Charnwood Forest rise abruptly to a height of 200 or 300 feet, presenting in their rugged and sharp outlines a striking contrast to the scenery of the surrounding country, and endeavouring to assert their stratigraphical relationship to the Welsh highlands by similarity

of physical feature. The highest points of Charnwood Forest are the summits of Bardon and Beacon Hills, each of which reach an elevation of about 850 feet above the sea, and about 700 feet above the level of the Soar at Leicester.* From Bardon Hill a line of watershed extends along the ridge to the Derby road at Green Hill, thence through Coalville, Coleorton, Pistern Hill, Woodville, and along the Burton Road to Bretby. The lowest grounds are the alluvial plains of the Trent, Derwent, and Soar.

All rivers which flow through comparatively level regions form along their courses areas with level surfaces, bounded on one or both sides either by cliffs, steep banks, or gentle slopes, depending on the nature of the strata, and the resulting physical features of the districts. These flat, low-lying plains have a breadth generally proportional to the magnitude of the stream, and are liable to be flooded when the waters are much swollen. The banks which enclose the plains mark the limits beyond which the river never penetrates. The plains are overspread by the detritus of the strata composing the regions along the course of the river, which on being deposited in the river valleys is denominated "alluvium," and is composed of sands, clays, and gravels, amongst which are imbedded remains of the fauna and flora of the countries through which the rivers flow.

A large area of the northern portion of our district is overspread by alluvium, and towards the junction of the Trent with the Derwent, the breadth of their united alluvial surfaces is nearly four miles.

One remarkable feature presented by the plain of the Trent must not be left unnoticed. We occasionally find in the neighbourhood of this river two terraces, of different elevations, and of which that next the river is the lower. The higher terrace is about 20 feet above the lower; and as they are both alluvial surfaces, we may, perhaps, account for their existence on the supposition that the river formerly ran at a higher level than at present. In many localities the upper terrace has been subsequently swept away, and when this is the case the alluvial plain presents an uniformly level surface between its extreme limits.

Both terraces are well defined at Weston. The lower extends from the base of the picturesque cliffs which are washed by the Trent, along the north side of Donnington Park, across to the bank of the canal, from whence the higher terrace extends to the village of Weston.

They are also very marked in Elvaston Park. The dividing terrace traverses the park from east to west, the higher being about 12 feet above the lower.

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* Geology of Charnwood Forest, by J. B. Jukes, Esq., in the History of Charnwood Forest, by T. R. Porter, Esq.

CHAPTER II.

Geological Formations.

The district contains a large variety of formations, which, arranged in their order of super-imposition, are as follows:—

Post-pliocene, or Drift -		Sand and gravel, with boulders.
New Red Sandstone or Trias.	Keuper -	1. Red Marl, with gypsum and Upper Keuper Sandstone. 2. Lower Keuper Sandstone.
	Bunter -	Conglomerate Beds.
Permian Rocks -		Lower Permian Sandstone, Marls, and Breccia.
Carboniferous Rocks		Coal-measures. Millstone Grit. Upper Limestone Shale or Yoredale Rocks. Carboniferous Limestone.
Cambrian Rocks -		Slates, Breccias, Metamorphic Rocks, and Porphyries.
Trap Rocks - -		Granite, Syenite, Greenstone.

Cambrian Rocks of Charnwood Forest.

This isolated tract of slates, porphyries, and other igneous rocks partly owes its appearance at the surface to a large fault, by which they have been upheaved along the north-eastern side. It is completely surrounded by the uppermost Triassic strata, which wrap around the flanks of the ancient rocks and ramify far up into the valleys.

The rocks of this miniature mountain range form in their outline a striking contrast to the hills of more recent formations by which they are surrounded. These latter are for the most part tabulated, and planed off along their upper surfaces, as is strikingly exemplified even in the case of the hard limestone bosses of Breedon; but the rocks of Charnwood Forest form either knowls or serried ridges, which stand out in relief when viewed from the north-west.

In the absence of organic remains, these rocks have been referred by Professor Sedgwick and Mr. Jukes to the Cambrian period, amongst other reasons, from their resemblance to the rocks of this age in Wales. They have been described in detail by Mr. Jukes,* and the geological survey of the range has been executed by my colleague Mr. H. H. Howell.

The general structure of the Forest-rocks is that of an anticlinal, first pointed out by Professor Sedgwick, and shown on Mr. Howell's section across the forest.† This axis runs in a slightly curved line from Whitehorse Wood, through Iveshead Lodge, along the little valley called Longdale, to Holgate Lodge.

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* Geology of Charnwood Forest, appended to Mr. Porter's History of Charnwood Forest. To this work I must refer the reader for details.

† Horizontal Sections of the Geological Survey, Sheets 48 and 52.

Along the line itself the beds are nearly vertical, and from either side they dip to the south-west and north-east at high angles.

As it is beyond the object of this Memoir to enter largely into details regarding the districts beyond the limits of the Ashby coal-field, it will be sufficient to give a short description of the Forest-rocks along a line which crosses them transversely, and which presents nearly the whole series of beds in succession. This line is nearly in the direction of Mr. Howell's section, and stretches from New Cliff Plantation, south of Sheepshead to Peldar Tor, near Whitwick.

The quarry at Moorley Hill exposes to view a coarse-grained greyish slate, imperfectly cleaved and traversed by three systems of joints, recorded by Mr. Jukes.*

Joint A.	N. 24° E.	Perpendicular.
Joint B.	North	Ditto.
Joint C.	N. 80° W	Ditto.

The dip is north-east at 35°, and the cleavage at right angles to this. The anticlinal axis passes a few yards to the west of this quarry, where the beds are vertical, so that these are the lowest rocks brought to view along this line of section. Crossing the axis, we find the beds as far as Upper Black Brook, consisting of bluish purple and green slates, of a coarse character, alternating with fine grits, and dipping towards the south-west at angles varying from 35° (St. Ives' Head) to 55° (Black Brook). At this point the beds pass under red marls of the Keuper series.

A line of isolated crags, ranging south-east from Thringstone to Charley, marks the base of a series of bedded porphyries. These plutonic rocks are not eruptive, that is, injected *after* the deposition of the slates, but are of an age contemporaneous with the Cambrian rocks themselves, and like the great sheets of felspathic lava of North Wales, have been poured out on the bed of the ocean, and have assumed the stratified arrangement of the aqueous rocks with which they are associated. This bedded form may be clearly observed at Kite Hill, and at Peldar Tor. (*See* Frontispiece.)

At the base of the porphyry there occur some beds of slaty felspathic ash, which become more indurated upwards, and finally pass into the hard massive porphyry of which the rocks of the Hanging Stones, Kite Hill, High Cadman, and High Sharply are composed. The same series of rocks continue to Peldar Tor,† and rise in masses as rugged and bleak as any to be found on the highest summits of Wales or Cumberland.

These rocks consist generally of dark greenish felspar, with distinct crystals of pale felspar and sub-crystalline glassy quartz disseminated throughout. Sometimes the felspar crystals are of

* Geol. Charnwood Forest, p. 10.

† The "Tor," a pyramid of rocks above the road, is 660 feet high, according to Mr. Coleman's measurement with the aneroid; but north-east of this there are portions of the hill which reach a height of nearly 700 feet. The name "Pedlar Tor" of the Ordnance Map is incorrect.

large size, two inches in length. The dip is south-west generally, and the cleavage dip in the opposite direction north-east at about 80°. The strike of the beds and of the cleavage planes nearly coincide. Mr. Jukes remarks that bands of slate are intertangled with the porphyry, and much indurated. The porphyry itself is overlaid by beds of ashy slate, which are visible between Green Hill and Peldar Tor.

Bardon Hill.—In 1854–5 the component rocks of Bardon Hill were only visible near the summit, and there they assume the aspect of greenstone, apparently erupted through the slates.* In 1860 I visited the hill again, in company with Mr. Coleman. New quarries have been opened on the north side, in which the rock is finely exposed to view. At the entrance to the lower quarry felspathic ash with a slaty structure may be observed dipping under and passing upwards into felspar porphyry, which also exhibits a somewhat bedded aspect.

Ascending the hill, we reach a second quarry, and here it becomes evident the mass is similar to some varieties of bedded porphyry, which form the ridge above Whitwick. It consists of dark blue and green felspar, with crystals of hornblende, felspar, and quartz. There are also bands of epidote and veins of white quartz, in which small quantities of green carbonate of copper may be observed. It therefore seems not improbable that the rock of Bardon Hill belongs to the porphyritic series, but has been disconnected by a large fault ranging from north-east to south-west, the existence of which I had long since inferred on other grounds.

There are great variations in the rocks of Bardon Hill, and hand specimens might be obtained of nearly every gradation from ashy slate to syenite, through the varieties of felspar, porphyry, and greenstone.

A small boss of greenstone appears in some old quarries in a field north of Bardon station, but it is difficult to say whether it belongs to the period of Forest-rocks or to a later date.

The rocks of Stanton Field, Cliff Hill, Markfield Knowl, and Groby are of a different character. These masses are generally in the form of bosses or knowls, composed of crystalline syenite, in which the minerals, quartz, felspar, and hornblende are distinct, and combine to produce a rock of great durability and beauty.

CHAPTER III.

Carboniferous Limestone.

This formation reaches the surface in eight isolated areas, namely, Ticknall, Calke Park, Dimmingsdale, Breedon Hill, Breedon Cloud, Barrow Hill, Osgathorpe, and Grace Dieu.

At Breedon Hill and Breedon Cloud we are presented with beds lower down in the Limestone formation than those of the

* The survey of Charnwood Forest, as already stated, was executed by Mr. H. H. Howell, with the assistance of Prof. Ramsay.

remaining localities; at Ticknall, Calke, Dimmingsdale, and Grace Dieu the highest beds occur; and the strata of Barrow Hill and Osgathorpe are probably intermediate.

The strata of the two Breedon Hills are almost identical with each other in lithological character, as they also probably are in stratical position. They are composed of magnesian limestone or dolomite, exceedingly hard, brittle, full of cavities, and traversed by joints. The colour of the rock is generally yellowish-brown, but frequently tinged red by the presence of peroxide of iron, and the structure is frequently sub-crystalline. The beds of the two hills plunge at angles varying from 40° to 80° to the westward, the great amount of inclination being due to the proximity of the axis of disturbance which traverses Charnwood Forest, as also to a fault of later date, which passes along the eastern edge of the limestone between Wilson and Osgathorpe.

The stratification at Breedon Hill may be observed with greater precision at some distance, where the whole can be taken in at a glance; but care is to be exercised in discriminating between the beds and the joints, which are frequently very deceptive.

The stone is extensively quarried, threatening some years hence to make a considerable alteration in the original form of the hills. It is carried on tramways to the Leicester and Burton Railway and Canal. It is, however, unsuited for architectural purposes, being full of irregular cavities.

The fossils generally occur in casts, and in some specimens of *Spirifer* the internal spiral processes are beautifully preserved in calcareous spar.* The following list of fossils is furnished from the collection of Mr. A. H. Green, of Ashby, and by Mr. J. W. Salter, from the specimens obtained by the Fossil-Collector of the Geological Survey:—

Fossils from Carboniferous Limestone, Breedon.

Orthoceras giganteus	A shell.
Bellerophon opertus	Do.
Trochus	Cast.
Euomphalus Dionysii	Do.
E. tabulatus	Do.
Acroculia spirata	Do.
Macrocheilus	Do.
Spirifer duplicicosta	Do.
S. subconica	Do.
S. papilionacea	Do.
Cyrtina septosa†	Do.
Athyris (small species)	Do.
Syringopora geniculata (?)	
Zaphrentis cylindrica	

The small round knoll, which from its appearance has obtained the name of "Barrow Hill," is formed of limestone formerly

* Some of these are in the cabinet of M. Huish, Esq., of Castle Donnington.

† This is *Spirifer* of Phillips. It is almost like *Pentamerus* in the development of its large internal plates.—J. W. Salter.

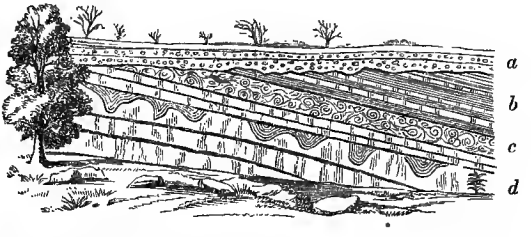
quarried. At Osgathorpe the limestone, which is very impure, is interstratified with shale, and full of joints. In one of the quarries the red marl is seen resting upon it, the base being a limestone-breccia, irregularly bedded and from 2 to 3 feet thick. On the opposite side of the western quarry the beds are probably broken off by the fault already alluded to.

At Grace Dieu the vertical walls of the old quarry afford an admirable opportunity for studying the stratification and mineral composition of the rocks in which they have been excavated. The higher beds are interstratified with shales, and are doubtless contemporaneous with those in similar positions in the Ticknall and Dimmingsdale sections. It is extremely doubtful, however, whether any great mass corresponding to the Breedon rocks actually exists beneath the Grace Dieu series. The proximity of the Charnwood Forest rocks, upon which the limestone rests, and around which it was deposited unconformably, renders such a supposition improbable.

The limestone of Grace Dieu varies from a pure bluish-grey carbonate of lime to a light yellow or brown dolomite, and in general it is highly argillaceous. In some places the beds are composed of spherical concretions, resembling conglomerate, while in others there occur cavities 2 or 3 feet wide and deep, filled with white, red, and blotched marl, now considerably indurated.

Sketch from Grace Dieu Quarry, South Side.

Fig. 1.



a Limestone breccia in a base of red sandy marl (Keuper).
b Interstratified limestones and shales.
c Bed of concretionary limestone.
d Massive limestone, with eroded cavities filled with marl.

The limestones and shales are surmounted by brecciated strata of Triassic age, which rest upon them unconformably, the former dipping to the northward at angles varying from 10° to 6°, while the breccia is horizontal. Fossils are very scarce at Grace Dieu and Osgathorpe.

The three limestone areas of Ticknall, Calke, and Dimmingsdale, are brought to the surface through the combined agency of a great fault and of a series of gentle rolls. They form the highest beds of the Carboniferous Limestone, and are surmounted by shales. The western extremities of the rolls or anticlinals terminate against the boundary fault of the coal-field, the downthrow of which is consequently on the west side. At Tick-

nall the throw of the fault is a minimum, and it increases in amount towards Whitwick, higher strata of the Coal-measures being brought down in succession against the older rocks in that direction. This will be evident from an inspection of the map where it will be seen that the coal-crops terminate successively against the fault from Dimmingsdale to Whitwick, while on the upcast side *the same* strata occur at both places.

The Ticknall limestone is surmounted by from 30 to 40 feet of blue, black, and purple shale, with occasional sandstones, containing beds of limestone towards the base. The upper beds of the limestone are also interstratified with shales, so that there is evidently a gradual passage from the calcareous to the argillaceous deposits.* The Ticknall limestone is generally very fossiliferous, some beds being composed principally of encrinital fragments and *Brachiopoda.*

List of Fossils from the Carboniferous Limestone, Ticknall.

CEPHALOPODA.

Bellerophon tenuifasciata.

BRACHIOPODA.

Spirifer linguifera.
S. glaber.
S. rotundata.
S. expansa.
S. rhomboidæa.
S. semicircularis.
S. bisulcata.
Producta scabricula.
P. depressa.
P. Martini.
P. resupinata.
P. gigantea.
P. antiquata.
P. hemisphærica.
Terebratula acuminata.

GASTEROPODA.

Euomphalus catillus.
E. carmatus.

ZOOPHYTA.

Cyathophillum basaltiforme?
Syringopora geniculata.
Calamopora tumida.
Retepora.

At Calke Park copper ore was formerly obtained in a quarry situated a few hundred yards west of the Hall.

At Ticknall and Dimmingsdale, the limestone is worked in caverns, and at the latter the rock is highly metalliferous. In one of the veins, the following minerals were obtained; copper pyrites, galena, calcareous spar, sparry iron-ore, blende, and bitumen. Mr. Bauerman, of the Geological Survey, called my attention to the curious fact, that most or all of the lodes in Dimmingsdale are formed of a quartzose conglomerate or breccia, and that the galena principally occurs in ribs at each side of walls of the lode, while crystals of the remaining minerals are formed in the druses of the veinstone. The ore is extracted in what is technically called "pipe-work," being followed by means of small horizontal galleries or pipes.†

* A very unusual instance of *current-bedding* is presented to view at the south side of the quarry east of the village. There we may see a series of interstratified limestones and shales, with a very regular dip to the eastward for a distance of about 50 yards, resting upon and surmounted by beds which are almost horizontal. Phenomena of this kind are common in sandstone and oolitic limestones, but, I believe, rather exceptional amongst strata of this formation.

† Geol. Charn. Forest, p. 16.

All the limestones are ultimately surmounted by shale, which is occasionally very thin, specially in Calke Park. The shale varies in colour from black to purple or red, the latter being principally characteristic of these beds at Ticknall. Some black shales were found in a deep drain, excavated in a field north of Worthington. They there gave origin to a spring at their junction with New Red Sandstone.

Along the borders of the shires of Derby and Stafford the Upper Limestone Shale attains a much greater development than in the localities in question, falling little short of 2,000 feet. Its thinning out in the direction of Charnwood Forest, taken in connexion with the debased character of the Grace Dieu Limestone, leads to the conclusion, long since arrived at by Mr. Jukes, that this lower portion of the Carboniferous series here approaches its original limits, formed of the ancient Cambrian Rocks, which were land during the earlier Carboniferous period.

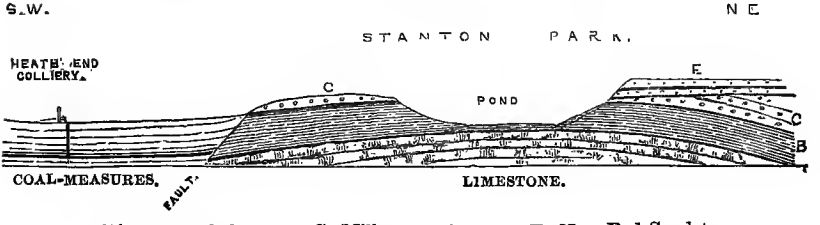
CHAPTER IV.

Millstone Grit.

Resting upon the Limestone shale, and forming the foundation for the Coal-measures, there occurs a series of grits, sandstones, and conglomerates, with shales, which, on account of the fitness of some of the beds for millstones, has been designated Millstone Grit. The grit forms the higher grounds around the limestone valleys of Ticknall, Calke, and Dimmingsdale, and produces an elevated ridge along the line of fault, rising on the upcast side above the western area occupied by Coal-measures, as is represented in the accompanying section (Fig. 2).

Fig. 2.

Section across Stanton Harold and Heath End.



B. Limestone shale. C. Millstone grit. E. New Red Sandstone.

The lower bed is generally a conglomerate, the pebbles being white or coloured quartz, sometimes three inches in diameter, ferruginous concretionary nodules, red jasper, and pieces of slate. The middle beds consist of coarse yellow, brown, or red grit, which yield large blocks either for millstones, troughs, or building purposes, at Stanton, Melbourne, and Repton Rocks. The mass of the stone is formed of siliceous particles, cemented by felspar, and

occasionally both these components assume a distinct form, and produce a rock such as might be supposed to have been derived from the detritus of granite. This is the appearance of the grit in a quarry at the north side of the village of Stanton. In a quarry in Calke Park, near the Melbourne Road, a remarkable conglomerate belonging to this formation may be seen, surmounted by more compact beds with plants, as *Sigillaria, Lepidodendron,* &c.

The highest beds of this formation are composed of fine-grained, thin-bedded grits, interstratified with shales, and presenting a variety of colouring from white to purple, through various shades of yellow and pink. These strata are well exposed in a quarry west of the village of Stanton-by-bridge. The dip is north-east, at 7°, and the ridge which the grit here produces marks a line of fault which can be traced to Repton Rocks, and having a downthrow on the west side, brings successively the New Red Sandstone, Permian, and Coal-measures, in contact with this formation.

North-west of Castle Donnington a section is opened in certain strata, which are probably referrible to the Millstone Grit. The section occurs in the lane leading to Cavendish Bridge. The strata consist of yellow, white, and blue shale, alternating with thin-bedded grits and rusty ironstone in bands or concretions. The dip is towards the south-east, and the beds are surmounted by the New Red Sandstone, which forms the banks of the alluvial plain in the neighbourhood. If these strata do not form a part of the Millstone Grit, they at least belong to the lower portion of the Coal-measures, and their appearance at the surface gives us a knowledge of the strata which underlie the New Red Sandstone in that neighbourhood. It renders it improbable that productive Coal-measures have set in between Donnington and Melbourne, and as there are at least 500 feet of unproductive measures resting on the Millstone Grit, it is improbable that coal-seams occur anywhere under the area occupied by the Trias included between Charnwood Forest on the south, the Trent on the north, the line joining the limestone areas on the west, and the Soar on the east.

At the north end of Thringstone, in the lane leading to the mill, Millstone Grit makes its appearance, rising from under newer deposits, which probably allow of its occupying a very limited superficial area. It consists of coarse purple grit, with quartz pebbles.

It was first observed by the Rev. W. H. Coleman, of Ashby, whose attention was attracted to the spot by numerous blocks of the grit built into the walls around. In a narrow lane to the west of this a section is exposed in different beds, consisting of thin-bedded grits and shales, with a westerly dip; these are probably above the former.

In many localities Coal-measure plants, generally silicified, are found in considerable quantities in this formation. This is particularly the case in the district between Cheadle and the Potteries in Staffordshire.

CHAPTER V.

Coal-measures.

We have now to enter upon the consideration of the next series of strata, as it occurs in our district, one which is economically the most important, as supplying our stores of mineral fuel and iron-ore.

The beds which combine to make up the Coal-measures are very variable in mineral character, and their nature can best be understood by reference to the pit sections.* They consist of various interstratifications of sandstones, clays, shales, and coal-seams. The sandstones are generally fine-grained, and of the colours of white, yellow, brown, and sometimes purple, and are known as "freestone," "poststone," and when in the state of a sandy ironstone, "cank." The clays are often in the state of "fire-clay," and are able to resist intense heat. These clays are used for making "fire-bricks" for furnaces, and "saggers," or pans for holding china-ware when undergoing the process of "baking" in the furnace. "Clunch," "clot," and "rammily earth," are names for the more common clays, and a very favourite term is "bind," which, perhaps, is rather synonymous with the word "shale," intended to denominate clay in a laminated state. There are also bituminous or black shales, and impure coal-seams termed "bat" and "sulphur," the latter term referring to seams impregnated with iron pyrites, which on burning give off sulphurous acid and sulphur fumes.

In the clays, seams or nodules of iron-ore, in the state of argillaceous carbonate of iron, frequently occur. The ore is called "clay ironstone," and is seldom found thicker than 5 inches for each layer; but in some measures the seams are frequently repeated, being separated from each other by beds of shale. In the Ashby coal-field, iron-stone is not at present either mined or smelted.

The coal-beds in particular districts are all known under distinct names, given them on account of their qualities, thickness, the name of the first discoverer, or from the caprice of the miners. Thus we have the "Main coal," always the principal seam of the district; the "Cannel coal," the "Four-foot coal," the "Jack Dennis" and "Dickey Gobbler" coals.

It will be observed on referring to the vertical sections that the coal-seams invariably rest on floors of clay, and wherever opportunities for observation have been afforded, it has been found that the clay-floor is penetrated by carbonized fibres trending downwards from the bottom of the coal. They are generally very thin, often mere threads, but are occasionally several inches in diameter. They are known to be rootlets of various plants.†

* *See* Vertical Sections of the Geol. Survey, Sheets 19, 20.

† *See* a series of carefully executed lithographs of the flora of the Moira coal-field in the late Mr. Mammatt's "Geological Facts."

Amongst the most remarkable is a rootlet called *Stigmaria ficoides*, formerly supposed to be an aquatic plant, but since shown by Mr. Binney, of Manchester, to be the root of *Sigillaria*. The persistency of these roots penetrating a bed of clay or earth below the coal has afforded us the means of arriving at more definite conclusions with reference to the origin of that mineral. *These clay-floors must have formed the soil on which the plants composing the coal had formerly grown.*

In the district of Ashby the coal-beds are generally evenly stratified, retaining their thickness with great persistency over extensive areas, and are seldom mixed with earthy or sandy matter.

The total thickness of measures known in the Leicestershire coal-field is at least 2,500 feet, and that part of the series containing the principal coal-beds is situated at about the centre. Towards the base, from 800 to 1,000 feet of unproductive measures occur, through which trials in search of coal have been made, hitherto unsuccessfully.

It is uncertain whether we have in this neighbourhood representatives of a series of beds which in other districts form the "Upper Coal-measures." In the coal-fields of Staffordshire, these measures attain a thickness of one thousand feet, and produce only thin worthless coal-beds.* Here, the highest measures are pierced by the pits of Moira and Gresley Common on one side of the coal-field, and on the other by the Whitwick and Bagworth shafts; but in none of these do we find the series of deep purple marls, with interstratified sandstones, which occur in the former localities. If these beds were ever deposited over this district, they have since been swept away; or perhaps they may be represented by certain local gritty sandstones, to be hereafter described, which present some slight evidences of unconformity to the measures on which they rest.†

The Ashby-de-la-Zouch coal-field may be divided into two portions,—that of Coleorton on the east, and of Moira on the west. It is difficult to identify the coal-seams in both these districts; and as they are separated from one another by an interval of lower unproductive measures, no opportunity is afforded of connecting them together by means of the outcrops of the coal-seams. The productive areas are situated at the western and eastern extremities. On the former side, the continuation of the coals is broken off by a great fault, passing through Woodville and Willesley, and throwing up on the east side lower measures; while on the latter there is a general dip to the eastward, and the coal-seams basset in succession as we cross the country from St. George's church to Coleorton Farm Town, where a great fault throws out all the coals below the Upper Lount seam.‡

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* *See* Hor. Sec., Geol. Survey, Sheet 55.

† *See* page 56.

‡ Mr. Coleman informs me that this fault was struck in coal-workings at "Parson's Meadow."

Lower Coal-measures.

The Pistern Hill Coal-seam.

These are two or three thin coal-seams worked by shafts sunk through the New Red Sandstone, which lies horizontally upon the summit of the hill. These coals have been proved to dip towards the south, and their outcrop may be traced by a series of old workings along the northern borders of South Wood; on approaching Heath End they are thrown down by a large fault, which brings in the Heath End coals. Beyond the outcrop of the Pistern Hill coals none have ever been proved, and a shaft sunk 557 feet at White Hollows failed to reach any seam of greater thickness than 20 inches; we may therefore place the Pistern Hill coals at the base of all the workable seams.

Coal was formerly worked in a gin-pit a little south of Smisby church, not many yards from the surface; a seam probably the same, but thinner, crops in the brickyard, east of the village, and it is to be supposed that this coal represents that of Pistern Hill. A coal-seam has been reached in the well of the Ashby work-house, which may be a continuation of the Smisby seam. The difficulty of tracing the Pistern Hill coals is insuperable owing to want of continuous workings, but the line now indicated in all probability approximates to their outcrop, and hence we have a geological horizon beyond which no coal-seams thicker than a few inches have ever been found.

Though the sections in the Moira and Coleorton districts cannot be identified, yet it is highly probable that the productive measures of each occupy the same general position in the series; in other words, that the representatives of the Coleorton coals are not *underneath* those of Moira. This is the opinion of Mr. Jukes, who even goes so far as to suggest that the Main coal in both districts is one and the same bed.* We might also attempt to identify the Heath End seams with the "Rafferee" and its associated "Four-foot" coal, and these latter with the "Stockings" and "Eureka" coals, and hence argue that below these last no useful seam exists. All such speculations, however, are exceedingly unsatisfactory, and would only tend to diminish that enterprise in exploring unknown regions of the strata, which in the case of the Eureka coal has been attended with so much success. From the depth of 50 feet † beneath this seam there lies buried a vast series of measures hitherto untouched by the boring rod, and though there are grounds for supposing that this series is composed of unproductive beds, yet it is to actual experiment we must look for any degree of certainty. This, however, cannot be said of the district lying to the eastward of the great Boothorpe fault. Any attempt in search of useful coal below the outcrop of the Pistern Hill, and Smisby coal, can only be attended with disappointment.

* Geol. Charn. Forest, p. 17.

† Messrs. Nadin reached a coal of 1 foot thick at a depth of 15 yards below the Eureka; and the same seam was found by Mr. Williamson at 22 yards from the Eureka in Lord Chesterfield's new pit near Bretby Park.

CHAPTER VI.

Coal-Seams.—Moira District.

Bottom or "Eureka Coal."—While Messrs. Robinson and Foreman were engaged in sinking a sump-shaft at the bottom of their Swadlincote pit, they proposed penetrating a few yards deeper than was necessary for their object into strata hitherto unexplored in that district, and the result was the discovery of a highly valuable coal-seam. Their example was soon followed by Messrs. Nadin at the New Stanton or Hawfield colliery. Having reached the necessary depth, they were dissappointed in not discovering the expected coal; but upon continuing to sink 15 yards further, they reached a thin seam one foot in thickness, with a roof of black shale ("Rattle Jack"), thus differing in several particulars from the "Eureka" of Messrs. Robinson and Foreman, the roof of which is "Stony bind" ten feet thick. It was evidently a lower seam than that they were in search of; and supposing it possible that the Eureka might have been cut out by a rock fault in the position of the shaft, they commenced to drive a horizontal heading at the proper depth, and at three yards from the shaft the first traces of the missing seam were discovered. From this point it gradually increased in thickness, till at eight yards from the shaft, it reached five feet, which is one foot more than at Swadlincote old colliery. (See Vertical Section, Sheet 20.)

This seam, however, had already been proved under Moira as far back as the year 1833, by means of a boring below the Main coal at Newfield pit. The section was kindly furnished by Mr. Woodhouse, for the details of which I refer to Sheet 20 of the vertical sections. In the boring, the following coal-seams were ascertained below the Main coal:—

	FT.	IN.
1. Toad Coal	3	6
2. Slate Coal (Little Woodfield)	3	8
3. Coal (Woodfield)	6	0
4. Coal (Stockings)	8	0
5. Coal (Eureka)	5	0
	26	2

The qualities of these seams are thus described, but from the evidence of a boring, such particulars must necessarily be imperfect:—

No. 3.	FT.	No. 4.	FT.
Top part dicey	2	Dicey	2
Mingy	2	Mingy	2
Rather dicey	1	Dicey	2
Soft	1	Soft	2

No. 5 is described as being "mingy and spiry." Above No. 3 there occurs a series of valuable ironstone-measures.

The absence of the *Eureka* coal in Hawfield colliery shaft is produced by a "rock fault" or "saddle." The coal has been swept away and its place filled in by drifted matter. Where it attains its full thickness its roof is formed of sandstone, remarkable for containing roots and stems of trees sometimes 15 feet long, lying horizontally and partially imbedded in the coal itself. These have evidently been drifted and spread over the coal-bed when in a pulpy state by the waters which deposited the sandy sediment now forming the roof.

At Swadlincote and Hawfield the roof of the Eureka coal is stony bind, or fine argillaceous sandstone. This would also be the case at Moira but for the intervention of a thin band of "dark bind" or clay four inches thick. At all these localities, however, the floor is composed of the usual underclay, either as "clunch," "rammily earth," or "fire-clay."

The Eureka coal has lately been found at its outcrop along the Burton Road, near Bretby Park;* and a pit, the property of Lord Chesterfield, has been opened, which reaches the coal at 20 yards, though only about 50 yards from the outcrop. The section found in this shaft throws much light on a portion of the coal-field hitherto very obscure. At the mouth of the pit the *Stockings* coal reaches the surface, where it becomes mixed with a deposit of Boulder clay and sand, which forms a deep covering to the high grounds of the neighbourhood, and is cut through by the Burton Road near Brislingcote. The floor of the Eureka seam is fire-clay, and the roof stony bind, or argillaceous sandstone. Its thickness varies from 4 ft. 8 in. up to 5 feet, and it is of the usual good quality, though soft, being so near the basset. The strata here dip to the south-west, at 16 inches in the yard (24°), a high angle, but fully accounted for by the proximity of the great boundary fault which passes by Bretby Park gate. The inferior thin seam, found in Hawfield colliery, is also present here. Its thickness is only 16 inches, at 22 yards from the base of the Eureka† coal-seam.

The quality of this coal-seam (Eureka) is everywhere said to be excellent. It produces a bright flame with little ash, and possesses nearly throughout that structure of its parts known as "dicey," by which is understood that it breaks up into sub-cubical fragments resembling dice, of glossy, bituminous coal.

As this seam appears to extend to Moira, and doubtless much further south, and even to thicken out in that direction,‡ it will furnish a most valuable supply after the Main coal shall have been worked out.

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* A person of the name of Williamson, lately ground bailiff of the colliery, appears to have been the first to identify this coal as the Eureka at its outcrop, the smut having been previously taken for that of the Woodfield coal.

† My friend Mr. Coleman furnishes the following note:—"A still lower seam has been found in the well of the engine-house some 40 yards below the last 16-inch seam, and ¾ yard thick. The 'Anglesea coal' must be lower still. The 'Three-quarter' coal crops out half a mile to the north-east close up to the Great Fault."

‡ *See* Horizontal Section (Sheet 52), and *ante*, p. 22.

Stockings Coal.—This seam, the next in ascending order to the Eureka, produces a coal of impure and earthy nature, though occasionally reaching a thickness of nine feet. So inferior is its quality that the attempt to bring it into the market has been several times abandoned. This may have arisen from the abundant supply of fuel of a superior description, as the market value of most commodities is comparative. It was once got to some extent in the old pits near Brislingcote and at Gearies Lane, where the beds were found dipping rapidly from the boundary fault already alluded to.

The Stockings coal is mentioned as attaining a thickness of eight feet under Moira colliery, and in terms which would augur more favourably for its quality in that direction. It is quite possible it may improve towards the south and west, according to the manner of several other coal-seams, of which the "Over" and "Nether main" coals are well-known examples.

It has been suggested by my friend Mr. Coleman that the "Rafferee coal" on the upcast side of the great Boothorpe fault is identical with the Stockings coal on the other; and there are several points, with regard to thickness, quality, &c., favourable to the supposition. By means of this probable identity we can calculate the amount of throw or dislocation produced by the fault, which at Woodville would amount to about 1,100 feet! If these two coal-seams are not the same the throw must be much greater, as there is no other seam known on the downcast side of the fault to which the Rafferee coal can be referred.

Woodfield Coal.—The thickness of this seam averages 5 feet. The only place where it is mined at present is at Woodfield colliery near Newall, from which it derives its name. I have been favoured by Mr. N. Nadin with the section of the Newfield pit, which is sufficiently short to be inserted here.

Section at Woodfield Colliery.

	YDS.
Black earth	20
Nether coal	3
Rammily earth (under-clay)	35
Shale	4
Rammily earth (fire-clay)	34
Coal (Woodfield)	2
	98

This seam, which is of inferior quality, containing a rather large per-centage of ash, was once extensively worked all over the northern portion of the coal-field, between its own outcrop and that of the Nether (Main) coal. Many old banks are to be seen over this district, and it is probable that very little of the coal remains unexhausted.* The upper part of the seam, to a depth of 12 or 14 inches, is cannel.

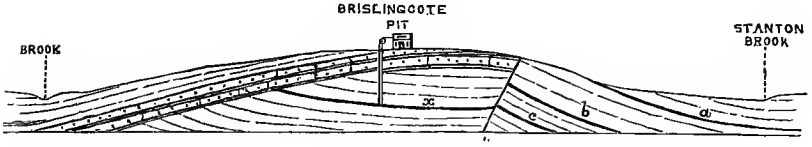
* For much general information concerning this district I am indebted to Messrs. N. and J. Nadin, of Stapenhill, as also to Mr. Robinson, of Swadlincote, and Mr. Bodeman, of White House, Newall.

A new pit has been opened between Brislingcote and the Burton road. The upper portion of the shaft passes through New Red Sandstone (Waterstones) to a depth of 13 yards, and the coal is reached at 50 yards. It is 5 feet thick, and it has been followed to its junction with the marls and sandstones of the "Red formation," which appear to rest upon or against it unconformably; and it is said that a bed of gypsum was found dovetailing with the coal-seam.

The boundary of the New Red Sandstone is a fault, proved farther south, at the village of Stanton. From these data the position of the beds in this neighbourhood would appear to be as represented in the annexed section.

SECTION THROUGH BRISLINGCOTE COAL-PIT.

Fig. 3.



N. R. SANDS. AND MARL. COAL-MEASURES. + Fault.

a. Woodfield coal. *b*. Stockings coal. *c*. Eureka coal.

x. Anglesea coal.

Scale—530 feet to 1 inch.

I was formerly of opinion that the *Woodfield Coal* of the north was the same as the *Slate coal* of the south of our district. Mr. Coleman, of Ashby, however, thinks differently, and holds that the "Toad" coal of Measham and Oakthorpe is identical with the "Little Woodfield" seam of Newall, and that the "Slate coal" of the south passes into black shale, or thins out northwards. In the former case the lowest seam pierced in the Moira boring would be lower than the Eureka, in the latter it would be identical with it. The determination of the point is interesting and important, as involving the known existence or the contrary of a considerable bed of coal; at present, I do not think we have sufficient data for arriving at a conclusion.*

The Slate Coal has been worked to some extent around Oakthorpe and Measham. It is described as a good burning coal, and, consequently, undeserving of its disparaging name. It varies from 3 feet 8 inches to 4 feet thick.

The following table is intended to represent the number and thickness of the coal-beds at the northern and southern part of the district, under the supposition that the "Little Woodfield"

* The northern outcrop of the Woodfield coal has been traced on the map from information derived from Mr. N. Nadin, and from several old miners of the neighbourhood. It is 12 yards below Thorntree Farm. The outcrop is also known between the old collieries near Brislingcote, and the New Eureka coal-pit, by the side of the Burton road. It had also been found in a field west of Brislingcote Farm, and farther south, near Newall Park.

and "Toad" coals are identical, and reckoning from the base of the main seam.

Newall.			Moira.		
Name of Seam, &c.	Feet.		Name of Seam, &c.	Feet.	
	From	To		From	To
Nether Main coal	5	9	Nether Main coal	3½	7
Various measures	40	50	Various measures	31 7	–
Little Woodfield coal	3¾	4	Toad coal	3 6	–
Various measures	135	145	Various measures Slate coal 3 8 Various measures	148	–
Woodfield coal	5	6	Coal	6	–
Various measures	48	71	Various measures	29½	–
Stockings coal	5¼	9	Coal	8	–
Various measures	60	75	Various measures	45	–
Eureka coal	4	5	Coal	5	–
Various measures	43½	–	Various measures	6	–

As the Slate coal bassets both at the north and south sides of the coal-field, and as there is also reason to conclude that the strata along the western boundary dip towards the centre, we obtain an idea of the general form of the coal-field. It is evidently not a true basin, but a basin smashed in two by the great Boothorpe fault. Various other fractures also traverse the basin, and destroy all symmetry of outline.

The Slate seam is the lowest hitherto worked in the district of Measham, and whatever be the extent of area of the Main coal in that direction, that of the Slate seam must be greater; and in conjunction with the underlying Woodfield, Stockings, and Eureka seams, will form a most valuable repository of mineral fuel for future consumption.

Mr. Coleman considers that at Stanton colliery this seam is represented by a bed of bituminous claystone 4 feet thick, and probably in some measure an ironstone. The surfaces of the laminæ are spotted with light-brown impressions of shells of the genus Anthracosia (*Unio*), and of a small crustacean called *Cypris* or *Cythere*, of a species hitherto unknown.* These produce an appearance which may have given rise to the name of the bed, which, indeed, is very like a celebrated bed of ironstone in the Pottery district of Staffordshire.

Little Woodfield Coal.—The outcrop of this seam is exposed to view in a brick-yard close to the side of the lane leading from Newall to Bretby Park Lodge. As a coal it is of little value, and I am not aware that it is or has been worked for consumption.

Toad Coal.—The position of this seam from Moira southwards is from 30 to 50 feet below the Nether Main coal, and it is from 3 to 4 feet thick.

* Discovered by Henry Green, Esq., of Ashby-de-la-Zouch.

Main Coal.—This seam, as its name implies, is the most important in the district, and is worked in all the collieries from its northern basset to Oakthorpe. It has lately been reached in the New Willesley Basin colliery. In all the northern portion of the coal-field it consists of two beds, the "Over" and "Nether," separated by strata which gradually thin out southwards, thus throwing the two seams into one. Both parts, however, are capable of being distinguished, and are known as "Over" and "Nether" throughout the whole extent of the coal-field.

At the Old Stanton collieries the measures which separate the Over and Nether seams attain their maximum thickness of 60 feet, as will be seen by the following section.

SECTION AT STANTON OLD COLLIERY.

Name of Stratum.	Feet.	Feet.
New Red Conglomerate -	45	45
Coal-measures - - -	33	78
Over coal	6	84
Various measures	60	144
Nether coal - -	6	150

At New Stanton colliery the intervening measures are only 15 inches thick; at White House colliery, 2 feet; at Gresley Wood colliery, 9 inches; and from Moira colliery southward the Over and Nether coals form one undivided bed, averaging 14 feet in thickness.

The floor of the Nether coal is uniformly a stratum of clay, or fire-clay, which led Mr. Mammatt to infer "that an immense flat "was originally covered with the substance of this fire-clay "many feet thick, and that upon this flat there took place a uni-"form growth of ..... vegetation." *

The thickness of the Over and Nether seams is very nearly equal, ranging from 5 feet to 7 feet each; but it is a remarkable fact, that while in the southern half of the coal-field, from Moira to Measham, the *Over* coal is superior in quality to the *Nether;* the reverse is the case in the neighbourhood of Newall, towards their northern bassets. The consequence is, that different parts of the Main coal are got in each district; while at Church Gresley colliery, situated in the centre of the area, where both the *Over* and *Nether* seams are of medium quality, the whole thickness of 15 feet is extracted.

That any portion of this valuable coal-bed should be neglected is much to be regretted. But, as I am informed by Mr. Woodhouse, there is at Moira colliery a difference in the market value of the "over" and "nether" portions of two shillings and upwards per ton. This depreciation amounts to an actual pro-

* "Geological Facts," p. 74. Mr. Mammatt proceeds to speculate concerning the alternations of coal and fire-clay, in a manner which, however ingenious, appears incompatible with the views stated in the above extract.

hibition. Those portions of the Main coal now left exposed to the atmosphere will certainly deteriorate, and cannot at a future period be got as economically or with as much safety as at the present time. At Church Gresley Colliery the whole thickness of the Main coal is extracted, and it is to be hoped that this plan will be pursued more extensively for the future. To those interested in the subject I would earnestly recommend the perusal of the valuable observations of Mr. Warington Smyth on the plans adopted in the South Staffordshire coal-field for getting the whole thickness of the 10-yard coal;* a work of much greater difficulty than would be necessary in the Ashby coal-field.†

The Main coal has been divided into a series of subdivisions, known to the miners, and named according to texture, purity, and fracture. Mr. Mammatt asserts them to be constant over the area included between "the southern and western bassetings of "the Main coal to a depth of 1,000 feet on its northern side," that is, as far north as Gresley Wood and Swadlincote.‡

DIVISIONS OF THE MAIN COAL.§

No.	Name.	Explanation.	Feet.	In.
1	Roof coal	Spires, dark slaty structure	0	11
2	Stone coal	Spire and dice mixed	1	7
3	Dicey	Breaking into cubes or parallelopipeds	0	5
4	Grisley	Small cubes, with pyrites	0	5
5	Spires	As No. 1	0	11
6	Dicey	As No. 3	0	7
7	Hard Seam	As No. 1, but more compact	0	1½
8	Dicey	As No. 3	0	4½
9	Slating	As No. 7	0	1
10	Holing	As No. 3, but not so compact	1	0
11	Scalps	Dice, with two seams of spires	0	6
12	Grounds	Dice, with spires mixed, very stout	0	11
13	Undergrounds	As No. 1	0	4
14	Roof coal	Dice	2	2
15	Hard Seam	Spires, compact	0	1
16	Soft Seam	Dice	0	4
17	Hard Brown	Spires, compact	1	0
18	Hard mixed	Spires (and dice?), compact	0	6
19	Holing	Dice, tender	1	2
20	Jods	Spires	1	0
		Total	14	5

The roof of the Main coal is generally a thin bed of fire-clay called "tow," upon which there rests a coal-seam, the "Second Rider coal," from 6 inches to 4 feet in thickness. In the case of the Bath pit (Moira) the tow is absent, and the Rider, here 4

* Records of the School of Mines, vol. i. part 2, p. 339. Longman.

† Mr. Woodhouse informs me that the Nether coal is left at Moira colliery in such a state as to be capable of being raised, should the price of coal authorize it.

‡ These subdivisions must be considerably modified by the changes in the thickness of the Main coal, amounting to 4 feet.

§ "Smut" is the soft black carbonaceous matter into which a bed of coal decomposes at the outcrop.

feet thick, rests immediately on the Main coal, producing a solid bed nearly 18 feet in thickness.

The *Over* coal has been almost exhausted under Measham Field, from Oakthorpe eastward nearly to Gallows Lane, as also northward and eastward of Donnisthorpe. The Nether coal remains, for the most part, undisturbed, though considered by no means of inferior quality.

At Oakthorpe the Main coal bassets,* but is thrown in again by an east and west fault, which crosses the country on the south side of the village. The smut may be seen in a garden close to the turnpike on the Measham and Moira road; and the cellar of the Gate Inn at Oakthorpe is said to be excavated in the Main coal. I was unable to verify this statement personally, as the landlord informed me that the coal was covered up. Near both these places the *Slate* coal was worked by means of pits which did not pass through the Main coal, which places it beyond doubt that the coal-crops in question are those of the Main coal.†

About 80 years since Oakthorpe Hill was on fire all along the basset, and the combustion continued for several weeks, defying all attempts to extinguish it.

The depth of the Main coal over Measham field varied from 20 to 25 yards, and the beds were found nearly horizontal, the dip being slightly towards the south and west. There was formerly a pit to the Main coal at 25 yards, between the farm and the river Mease, about 200 yards from the Swepstone Road, on the side opposite Measham Hall. The coal was worked as far south as the brook and there left. According to Mr. Mammatt, the Main coal bassets at or near this point. This statement is confirmed by recent borings, though the actual exposure of the coal is concealed under Permian Breccia.

There is also a probable southern basset, but for the supposition that there is a western basset in this neighbourhood there is no evidence whatever; on the contrary, all the evidence goes to prove that the Main coal *deepens* in those directions. It is true this seam reaches the surface at Oakthorpe, but it is thrown in again by a fault of considerable magnitude, of the existence of which Mr. Mammatt does not appear to have been aware. On the downthrow side of this fault there was a boring made not many months since, when it was found that the 4-foot coal was 50 yards deep. Now the 4-foot coal is about 60 yards above the Main coal, and hence south-west of Oakthorpe the main coal ought to be 110 yards deep. As far as the evidence goes the Main coal may spread for miles west and south-west of Measham.

As the boring to which I have alluded is of great interest, and as there appears to be no doubt about its accuracy, I give the details. The position was on the west side of the lane leading

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* From Mammatt's "Geological Facts."

† Most of my information about the old workings in this neighbourhood was derived from an intelligent old miner, Samuel Dennis, *alias* Cornet. (Sam. Dennis died in 1857, aged 85 years.)

from Oakthorpe village into the Burton road, and about 150 yards south of the canal.

MR. PIDDOCK'S BORING, OAKTHORPE.*

Name of Stratum.	Feet.	In.	Name of Stratum.	Feet.	In.
Soil - -	2	0	Brought forward -	84	6
Sandy clay	4	0	Fire-clay -	1	6
Brown rock	3	0	Grey rocky shale - -	34	0
Rocky shale	3	0	Mixed shale and coal	2	0
Brown rock	2	0	2 coal -	0	9
Yellow rock	5	0	Dark shale and coal - -	1	3
Dark shale -	1	0	Grey rocky shale	2	0
Grey rock	6	0	Blue shale - -	7	0
Blue shale -	19	0	3 { Coal / Parting / Coal } Little or Four-foot coal. -	3	1
Dark rocky shale -	35	0		0	5
Grey rock -	2	0		2	10
Dark shale -	0	6	Dark fire-clay -	2	6
1 Coal -	2	0	Rocky shale - - -	1	6
Carried forward -	84	6	Total - -	143	4

Though the parting near the centre of the coal (No. 3) in the above section appears to identify it with the *Little* or *Four-foot* coal, and though some of the measures above, as "mixed shale and coal" are very similar to those of Mr. Mammatt's section, yet it is to be regretted that the boring was not continued down to the Main coal, or at least to the intervening bed of Cannel, so as to leave no room for doubt as regards the existence of the Main coal underneath this portion of the country.

The northern bassetings of the Over and Nether coals was traced on the map from the following data:—

The *Nether* is 4 yards deep in the well of Newall Park; it was also obtained along with the basset of the Little Woodfield coal, south of Hills Close Farm, in an open work. The Over coal-crop is seen in the lane-cutting south-west of Thorntree,† and the Nether in a clay-pit near Woodfield colliery. Its basset north of Newall, where it forms with the Over coal a solid seam with a small parting of shale, is known to the miners.‡ East of the Moira main fault there is no basset for any of the coals below the *Little coal*, those lower down being broken off by the *Boothorpe fault* before arriving at the surface.

The following is the mode of excavating the Main coal adopted in the Hastings and Grey pit, Moira:§—

Scarcely one-half of the Main coal is got, the portion worked being 6 feet in the *Over-coal*, leaving a roof one foot thick, and a

* The Section was kindly procured for me by the Rev. W. H. Coleman, of Ashby-de-la-Zouch.

† "Thorntree" in the Ordnance Map is an error for "Rowan Tree," *i.e.* Mountain Ash.

‡ These details I obtained principally from Messrs. Nadin and a miner, Francis Dent, of Newall.

§ For these particulars I am indebted to John Brown, Esq., who kindly accompanied me over the Hastings and Grey colliery; and to the details in the "Geological Facts."

floor of the *Nether* seam, which is said to be a good coal, though inferior to the upper part.

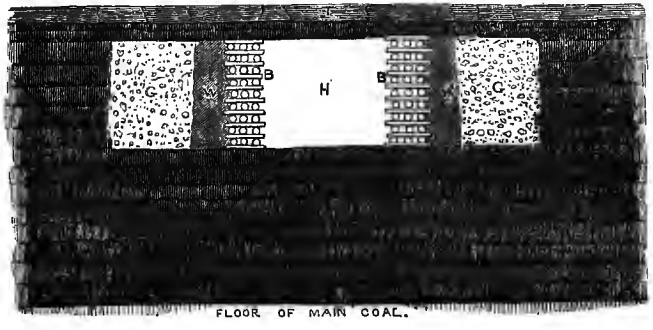
At about the centre of the portion worked there occurs a soft seam, 8 inches in thickness. This is "holed" or excavated as far as a man can, with effect, use a mandril or pick, that is about 3 feet. When about 20 feet has been holed wedges are inserted in the roof, about a foot underneath the "tow." The wedges, which are long and thin, are driven up by hammers with long shanks. The mass is thus detached and cleared away, then the wedges are inserted at the floor, and the lower part of the coal is forced upwards, by the same process and with the same results.

Only large blocks are sent up the shaft, and were the refuse and small slack allowed to remain exposed to the air of the mine, spontaneous combustion would ensue. To prevent so dangerous an occurrence the following means are employed :—

When the blocks of coal have been carried away, and the refuse swept out of the workings or "gobbins," two walls or "brettices" are formed, by laying crossways several tiers of oak stems, 3 feet long by 6 inches thick, and reaching from the floor to the roof. The walls are carried forward with the proper interval for a passage between, generally 6 feet. Inside each brettice a wall of plastic clay called "wax," brought down from the surface, is formed progressively with the brettice, and is firmly squeezed under the roof, so as to render the gobbin air-tight. The gobbin is then filled in with the refuse slack, and the brettice and clay wall are carried onwards as the excavations proceed; this part of the work being accomplished by men specially appointed to the task in the evening. This mode of working the coal produces a waste of (including the roof) one-third of the portion of the Main coal which is excavated, and thus of the entire seam only about one-fourth is made use of. The following diagram is intended to represent a cross section of a heading newly completed in the Hastings and Grey colliery, Moira.

SECTION THROUGH MAIN COAL.

Fig. 4.



T Tow, or clay roof of Main coal. H Open passage. B Brettice wall.
W Wax, or clay wall. G Gobbins, or waste filled with refuse slack.

In some places the roof settles considerably, and the pressure becomes so great that the balks of timber are crushed to nearly half their former thickness. This pressure is often occasioned, Mr. Brown informed me, more from the presence of faults than from the weight of the superincumbent strata.

It has been already observed that in the northern portion of the Moira coal-field, the Main coal is divided by the intercalation of various measures, attaining at Stanton colliery a thickness of 60 feet. In order to account for these phenomena, we may suppose that after the growth of vegetation, probably in the form of peat, which now constitutes the lower half or nether seam, a slight subsidence of the country occurred, the amount of which was greatest in a north-west direction, and causing the submersion of a portion of the area to a depth greater than 10 fathoms. Over the mass of vegetable matter under water, sands and clays were tranquilly deposited to the upper surface of the water, and a new growth of vegetation commenced, now composing the *over* seam of the Main coal.

Cannel Coal.—The next seam above the Main coal of which any use has been made is one which though thin is very constant, both in mineral character and thickness throughout the whole extent of the coal-field, from its northern to its southern bassetings. It is No. 354 of Mr. Mammatt's pit sections. Its average thickness is 3 feet, though it sometimes reaches 4 feet. The greater portion is cannel, which always forms the upper side, the lower being common coal of variable thickness. I have never heard of its having been got, except by one miner on a small scale many years back, who by some means or other, became a losing party by the transaction.

Little or Four-foot Coal.—This is the most important seam above the Main coal; it varies in thickness from 4 to 5½ feet. The roof is strong bind, with an occasional parting of tow or clay, while the floor is clunch.

In the section of the Rawdon pit there occurs a parting of fireclay 1 foot thick, near the bottom of the seam, which in the Hastings and Grey pit section is replaced by black bass. It is No. 335 of Mr. Mammatt's sections, who gives the following subdivisions of the seam.

	FT.	IN.
1. Dicey coal, with a seam of spire one inch -	1	8
2. Hard spire coal - - - -	1	9
3. Soft dicey coal - - - -	0	5
4. Soft fire-clay - - - -	0	5
5. Soft dicey coal - - - -	0	6
Total - -	4	9

The basset of the Little coal was found in laying the foundations of the bridge of the Burton road, near Stanton. It occurs 10 yards below Hawfield Farm, and crops out along the southern side of Newall, till it terminates against the main fault. It also

occurs close to the surface, between the Potteries and Spring Wood, south of Bretby Park, being proved in the old pits in that neighbourhood.* The southern basset was laid down on the map from information on the spot,† and from Mr. Mammatt's horizontal sections.

In the New Willesley Basin pit, near Oakthorpe, the Little coal was found to be 39 yards from the surface. It is 4 feet thick, without any parting near the base, and the roof is "strong blue rock."‡

Block Coal, otherwise known as "*Jack Dennis*" or "*Watson*," around Swadlincote.—This is No. 271 of Mr. Mammatt's sections, and is a seam varying in thickness from 3½ to 4 feet. It invariably occupies a position underneath a thick stratum of bind containing several seams of ironstone. The northern outcrop may be viewed in the cutting of the tramway leading from Gresley Wood colliery to the main line of railway, where it strikes against a small fault. It is also exposed to view in a clay pit north of Mr. Bodeman's new colliery, Swadlincote; on the Moira side of the coal-field Dennis coal bassets north of the New Willesley Basin pit, as it has not been touched in the shaft. On the west side of the Moira main fault it is cut off at "the stone wall fault." My friend Mr. Coleman informs me that it was formerly worked to a small extent at Sale's Spring pit.

As far as I am aware, this seam has not been got to any extent. It is generally of a friable and jointed nature, and in the sinkings is usually found charged with water.

Dickey Gobbler, so called from the miner by whom it was first worked. It occurs at the mouth of the pit at White House, Newall, and within a few feet of that of Gresley Wood colliery. It is No. 222 of Mr. Mammatt's sections, and ranges in thickness from 3 to 4½ feet. Bands of ironstone are common in the clays which overlie the Dickey Gobbler. The coal is of medium quality, resting on a floor of strong clay, with ironstone nodules.

Ell Coal.—This is the highest seam which has been worked in the Moira coal-field. Its thickness, as its name implies, is generally a yard and a quarter. It has been extensively got under Gresley Common, and to some extent on the east side of Ashley Woulds. A new pit has been sunk on Gresley Common, south from the "Church pit," a section of which has been forwarded to me by Mr. Coleman, from Mr. Healy. The object was to work the Ell coal, which was found to be 4 feet thick at a depth of 82 feet from the surface. In the shaft of the Grenville colliery its depth is 72

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* These particulars I learned from an intelligent miner, Francis Dent, of Newall.

† Furnished by Samuel Dennis, *alias* Cornet, of Measham.

‡ The section was kindly given me by Mr. Whithead, bailiff. Since writing the above this colliery has passed into the hands of the Marquis of Hastings (1860). On reaching the Main and Little coals the inflow of water from the old workings was so great as to necessitate the erection of the largest Cornish engine in this district. The diameter of the cylinder is 84 inches, and it was manufactured at the works of the Burton-on-Trent Iron Foundry.

feet, with a thickness of 3 feet 11 inches, with three beds of potter's clay, at the following depths from the surface:—

	Depth.	Thickness.
No. 1 -	35 ft. -	4 ft. (grey).
No. 2 -	65 „ -	8 „ (grey and black).
No. 3 -	66 „ -	4 „ (grey and good).*

It bassets in the wood, north of the Granville colliery and westward of Woodville, till it is broken off against a fault having a downthrow on the south. Three yards above the Ell coal there occurs a valuable bed of fire-clay, well adapted for making saggers. This clay is worked by means of gin pits on Gresley Common, and in open works south-west of Woodville.†

In a series of borings, in a position about 500 yards south of Woodville, and on the west or downcast side of the Great Boothorpe fault, which were undertaken by Mr. Joyce for the purpose of proving the depth of the Ell coal, and for a copy of which I am indebted to Mr. Coleman, the smut of a coal 8 feet thick, heretofore unknown, was ascertained, close to the surface, and in a position about 85 feet above the Ell coal. This is all that is at present known about this seam, which appears to be the highest of which we have any knowledge.

Besides the coal-seams here particularized, there are several others of minor importance, the history and statistics of which are unknown, and of the value of which little account is taken, owing to the present abundant supply now obtained principally from the Main coal. They are kept in reserve for future use; and their value will be augmented in proportion as the supply from other sources fails.

Rafferee Coal, Woodville.

On the upcast side of the great Boothorpe fault there occur around Woodville two coal-seams, separated by about 8 or 10 yards of measures, and chiefly valuable for the potter's clay with which they are associated. The uppermost of these seams is called "Rafferee coal," and is chiefly remarkable for the inconstancy of its character. In some places it attains a thickness of 10 feet, and at a short distance is not more than 2 or 3 feet thick; this will be seen by the following sections, at a distance of little more than a quarter of a mile from each other.

Messrs. Hough and Grey's Pit.	YDS.	FT.	*Waterloo Pit.*	YDS.	FT.
Measures - - -	19	0	- -	14	0
Rafferee coal - -	0	9	- - -	0	3
Measures with pot-clay	8	0	- - -	11	0
Coal - - - -	0	3	- - -	0	4
Clay - - - -	–		Pot-clay -	0	2

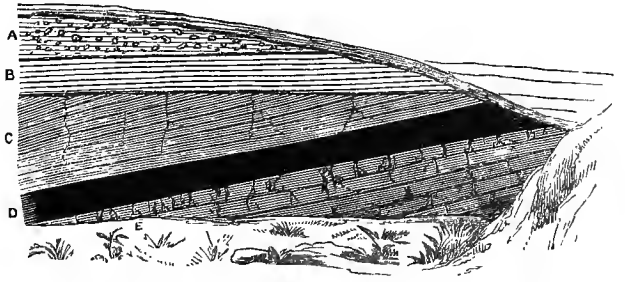
* *See* Vertical Section, Sheet 19, Granville colliery.

† "Saggers" are pans used in pottery works, in which are placed the finer kinds of ware when placed in the "ovens" to be "baked."

The basset of these coals occurs near the east end of the village, but they are repeated again by a fault passing through the Waterloo pit, and a few yards east of Butt House, and the two sections given above are on opposite sides of the fault. At Blockfordby the outcrop of the 4-foot coal is exposed in an open work

Outcrop of the Four-foot Coal at Blockfordby.

Fig. 5.



A Loose breccia in matrix of marl.
B Purple marl forming base of New Red Sandstone.
C Sandy shale. D Coal 3 feet thick.
E Pot-clay, with rootlets stretching from the coal.

in a field north of the village. The bed forms a little basin, or rather basin with a portion of the side flattened out. The basset of the Rafferee was proved some years since in a deep trench at the west end of the village near the brook; the smut was 9 feet thick.* Further south than this there are no data for tracing the crop of the Rafferee coal; but a higher bed, or at least an apparently higher bed, makes its appearance in this neighbourhood. It was formerly worked by the landlord of the "Blue Bell," Blackfordby, in a shallow pit close to the Boothorpe road; its thickness was described to be 3½ feet, the coal good in quality, and the beds dipping rapidly to the west. After a few tons had been got the works were drowned out. If all these particulars are correct, this coal could not be the seam underneath the Rafferee, as the latter did not appear in the shaft. I conclude, therefore, that it is a higher seam, and probably continuous with the coal formerly worked at Sweet Hill Oak. At these pits the coal was 30 or 40 yards deep, and 4½ feet thick. The pits were worked by a blind collier some forty years ago.† The outcrop of a coal-seam (probably the same seam) was laid bare in the railway cutting south of Sweet Hill Oak; it is there 4 feet thick, and was excavated and burnt during the formation of the line. The section is now almost entirely concealed.

It is not improbable that the Rafferee coal is the same as the "Stockings" seam of Moira. Both are of inferior quality; both rest on clay from 2 to 3 feet in thickness; and in both cases a bed

* On the authority of John Orme, of Woodville, a native of Blackfordby.
† From information obtained from John Orme, of Woodville, and Samuel Dennis, alias Cornet, of Measham.

of good coal of nearly equal thickness is found underneath, at depths by no means very dissimilar. In order to render the comparison more obvious, the two following sections are placed in juxtaposition:—

SWADLINCOTE SECTION.

	FT.	IN.
Woodfield coal - -	5	0
Measures - - -	48	0
Stockings coal - -	5	2
Clunch - - -	3	0
Measures - - -	61	0
Eureka coal - -	4	0
Clunch - - -	5	0

WOODVILLE SECTION.

	FT.	IN.
Probable coal seam -	4	6
Measures (more than)	42	0
Rafferee coal - from 9 to 3	0	
Clay and		
Measures - - -	33	0
Coal -	4	0
Pot-clay - -	2	0

It will be admitted that, making due allowance for changes consequent on the interval, more than a mile between the two sections, there is a strong similarity; and should it ultimately prove to be the case that the Rafferee is the Stockings coal, and the underlying 4-foot coal the Eureka seam, it will be sufficient to deter from attempts to reach a good coal below the Eureka, as it will in that case form the lowest bed of the productive Coal-measures.* This event will also throw light on the magnitude of the Boothorpe fault. The Ell and Rafferee seams are at about the same depth from the surface on each side of this fault at Woodville; and on the supposition of the "Rafferee" being identical with the Stockings, the amount of throw at the south side of Woodville will be equal to the depth of the Stockings below the Ell coal nearly, *i.e.*, 800 feet.

CHAPTER VII.

COLEORTON DISTRICT.

LEAVING Moira, and commencing our course to the eastward towards Coleorton, we make a diagonal section of the coal-producing district, with which it will be well to become acquainted, in order to the proper understanding of the relationship subsisting between its eastern and western portions. After crossing the "120 yard" fault, which traverses the strata not far from the east side of the village of Moira, we arrive at the Hastings and Grey pits, where the Main coal is worked at a depth of about 120 yards deeper than in the Bath pit, on the shallow side of the fault. Here the beds are almost horizontal, being at the centre of the trough formed by the strata between the northern and southern bassetings. Continuing our course along the railway, we find, on passing under the bridge of the Willesley Road, the strata rising rapidly to the eastward, first at angles of about 10°, but increasing in amount

*Except, perhaps, the "Anglesea seam," which Mr. Coleman considers as below the "Eureka."

till, at a distance of 200 yards from the bridge, they stand in a vertical position, and are broken and dislocated in a very remarkable manner. We have, in fact, arrived at the position of the great Boothorpe fault, by far the greatest dislocation on this side of the Ashby coal-field; and in crossing we pass at once from a thick series of coal-producing measures into another almost unproductive, and far down in the coal formation. As we proceed eastward the beds, with two or three coal crops, are found still rising to the east, but at angles which lessen as we recede from the Boothorpe fault. This westerly dip is constant till we have passed half a mile beyond Ashby-de-la-Zouch, where we arrive at the axis of the "*Ashby Anticlinal*," east of which the beds roll over and dip towards the east; and as we proceed towards Coleorton we pass in succession the outcrop of a series of coal-seams, which, though representing generally those of the Moira district, are not strictly comparable.

The New Red Sandstone overspreads the southern half of the Coleorton coal-field, and the upper portion of the Whitwick, Snibston, Ibstock, and Bagworth shafts pass through the red marls and white sandstones of this formation. The strata incline at a very small angle to the south-east; and underneath, the Coal-measures preserve a steady dip to the eastward at angles from 4° to 6°, and consequently the coal-seams rise and basset against the under surface of the newer and unconformable beds of the New Red Sandstone. The *direction* of the dip at the northern extremity of the Coleorton field changes by a quarter of a circle, and the coal-crops form a series of concentric curves, which are abruptly terminated towards the east by the great fault which forms the boundary line of the coal-field.

As the Coal-measures approach the position of the boundary fault, they are found to rise very rapidly, so as to become almost vertical in the space of a few hundred feet; this produces a synclinal, the axis of which passes at a short distance east of Peggs Green colliery, through the new Swannington shaft, and a quarter of a mile east of Whitwick colliery. In company with the son of Mr. W. Stenson, jun., I explored a heading which had been driven in a direction 20° north of east, to a distance of nearly half a mile from the shaft of Whitwick colliery.* Upon reaching the position of the synclinal axis, we commenced ascending along the floor of the coal, at first gradually but at a rapidly increasing inclination, till the heading finally passed into a nearly vertical shaft, which had been driven upwards with much difficulty at an angle of about 80°; we measured the interval between the shaft and the place where the coal-seam was horizontal, and found the distance only 60 yards. East of the new Swannington shaft the rise of the strata is even more rapid, and its effect is to render the coals unworkable east of the pit; the dip is north-east, at 3 inches in the yard, but at 80 yards east of the shaft the coal commences to rise into a vertical position almost

* *See* Horizontal Section, Sheet 48.

instantaneously.* At about 100 yards from the pit the beds are probably vertical, between which and the boundary fault there is room for 600 feet of strata, so that were a deep cutting to be opened, we would probably find all the beds, as far as the base of the Lount coals, rising vertically to the surface in succession.

With the exception of the main or boundary fault of the Coleorton coal-field, and another which branches from it at Heath End, there are no dislocations of importance in this district. The absence of *faults*, properly so called, is however, fully counterbalanced by those irregularities in the stratification known as "*rock-faults*;"† to these I shall refer hereafter, proceeding at once to the consideration of the principal seams of coal, commencing with the lowest.

Heath End Coals.—These constitute, as far as has been hitherto determined, the lowest workable seams of the Coleorton coal-field. Their outcrop occurs at the entrance to Dimmingsdale, and the seams are broken off against the boundary fault to the north-east of the Heath End pits on the one side, and by a large branch fault, which ranges along the west side of Rough Heath, on the other.

The following is a section of the coal-seams which were worked at Heath End colliery.‡

HEATH END SECTION.

	FT.	IN.
1. Bind (shale)	10	0
2. Stone	4	0
3. Bind	2	0 ?
4. Coal	4	0
5. Stony bind	1	0
6. Coal { Coal, 2 feet / Cannel, 7 feet }	9	0

In some places the 4-feet coal rests immediately upon the thick coal, so as to form a solid seam 13 feet in thickness. The outcrop is now visible (1860), but though the cannel is somewhat anthracitic so near the surface, there is reason to infer that its quality improves on the deep, and should this prove to be the case, it will form a seam of great value under the Coleorton district. At Heath End the dip is southward, and it is terminated both to the east and west, by large upcast faults. The probable depth of the Heath End coals below the Coleorton main seam is shown in Horizontal Section No. 1, Sheet 46.

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*For these particulars I am indebted to Mr. Houldsworth, manager of the New Swannington colliery.

† Miners, and those who ought to be better acquainted with the subject are constantly confounding the two kinds of phenomena here referred to. The distinction is essential. *Faults* are breaks in the strata, accompanied by a vertical displacement; *rock-faults* are banks of sand or clay which replace in a coal-seam parts previously carried away.

‡ This section was kindly furnished by the Rev. W. H. Coleman.

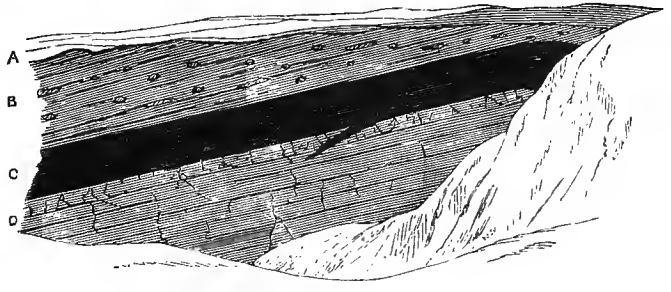
Lount Coals.—Roaster (No. 1).*—This is a thin seam, averaging only 2 feet in thickness, but of excellent quality. It has been got to a small extent at Lount. The position of the outcrop of this and the higher seams I obtained from the information of an intelligent miner, who had worked in all the pits, which are numerous between Lount colliery and Lount wood. I was informed by Mr. Houldsworth, of Swannington colliery, that the "Roaster" was found in the cellar of Stanton Hall. The late Earl Ferrers had caused a coal to be laid open alongside the lane leading from Lount to Stanton Hall, in a position one hundred yards north of the brook. The dip was found to be north, and a few yards further towards *the deep* of the coal, a pit was sunk for the purpose of proving its quality, when it was found that the seam had disappeared, hence there would appear to be a roll-over of the beds, accompanied by a fault; and this coal may be the Roaster described as being under Stanton Hall.

Nether Coal (No. 2).—This seam is 70 yards deep at Lount pits, and its thickness 4½ feet.

Middle Coal (No. 3).—This seam at Lount is 4½ feet thick, and the same at Lount Wood and Coleorton Moor. Its outcrop is exposed to view in an open work at the east side of the Ashby and Nottingham road, near Lount Wood, where it is laid open for the potters' clay, on which it rests. This clay is full of rootlets (*Stigmaria ficoides*), which run downwards from the bottom of the coal.

Outcrop of the Middle Lount Coal, near Lount Wood.

Fig. 6.



A. Yellow Drift clay.
B Blue shale, with ironstone nodules, 7 feet.
C Middle Lount coal, 4 feet 6 inches.
D Grey under-clay, with *Stigmaria* rootlets, &c.

This seam together with the Nether, and to a small extent the Roaster, has been almost worked out over this district, near the outcrop. Old pits and banks are numerous over and around Lount and Smoile Woods.

* The numbers after each coal refer to the Vertical Sections of the Geological Survey, Sheet 19.

The Middle coal is generally divided by a band of ironstone about a foot from the top, and the upper part is occasionally cannel.

Second Lount Coal (No. 4) is 3 feet thick and of medium quality.

The *Upper Lount* or *Smoile Coal* (No. 5) is 3 feet thick at Lount, and nearly 4 feet at Coleorton Moor; this, together with the Middle and Nether seams is, I understand an inferior coal, and at present in but little request.

The basset of the Lount seams preserves, in all probability, a continuous course southward to the west side of the village of Heather, but is concealed beneath the New Red Sandstone. Near this village there were formerly some coal-pits, and four seams of coal were pierced through, which presented the following section:—

SECTION OF HEATHER PIT.*

No.	Name of Stratum.	Feet.	In.	Feet.	In.
1	Blue bind, &c.	36	0	36	0
2	Sandstone	13	0	49	0
3	Blue bind	39	0	78	0
4	Coal	6	6	84	6
5	Blue bind	3	0	87	6
6	Coal	6	0	93	6
7	Rocky bind and clunch	42	0	135	6
8	Coal	4	0	139	6
9	Blue bind	8	0	147	6
10	Coal 3 ft. 9 in.				
11	Shales 2 „ 3 „ } Main coal of Ibstock	10	9	158	3
12	Coal 4 „ 9 „				
13	Fire-clay	3	0	161	3
14	Rocky blue bind	117	0	278	3

It is probable that Nos. 4, 6, 8, represent the Lount Upper, Second, and Middle coals, in which case No. 10 would represent the Nether, and No. 12 the Roaster, or Nos. 10 and 12 conjointly may represent the Nether coal of Lount, and the Roaster be absent. At Heather colliery, Nos. 4, 6, and 8 were found to be of very inferior qualities, whilst Nos. 10 and 12 were good. These two last seams are considered to unite farther to the eastward, and form the bottom coal of Ibstock and Bagworth, 8½ feet in thickness. I am informed by Mr. Price that the measures at Heather form a synclinal trough, and that the higher coal beds basset both east and west of Heather colliery. The lower seams were (I understand) worked westward to this basset under the New Red Sandstone, but it is improbable that they crop in the opposite direction. The following section probably represents very closely the position of the strata; it is drawn through Heather and Ibstock collieries. The strata have been proved un-

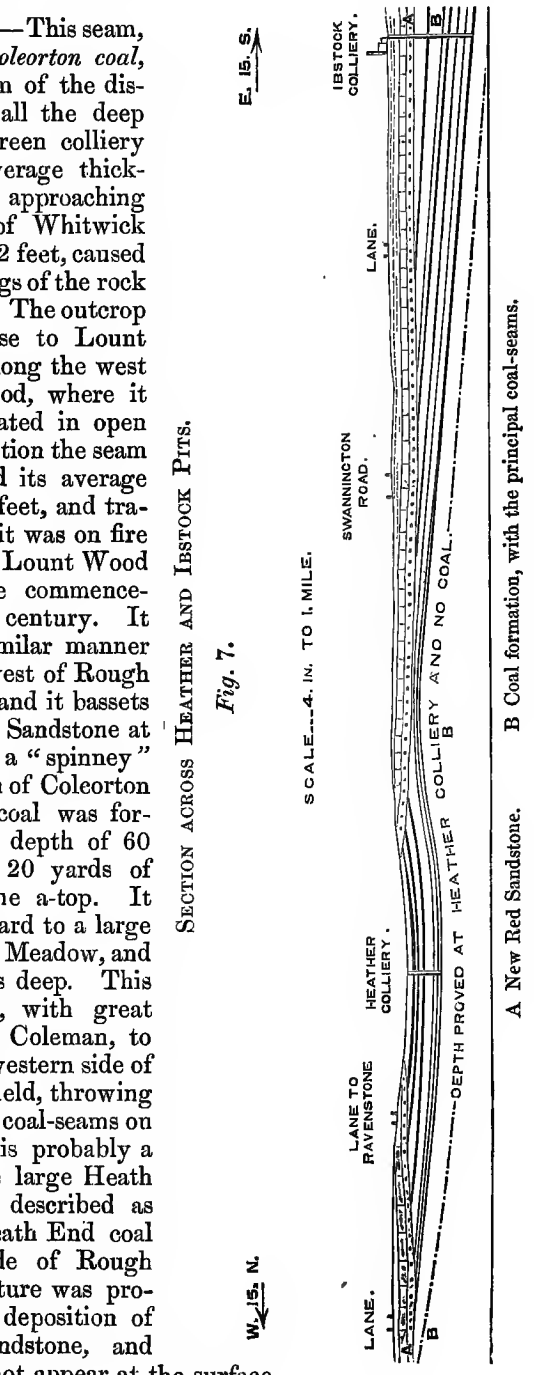
* Furnished by the Rev. W. H. Coleman of Ashby.

productive 117 feet below Heather colliery. (*See* Horizontal Section, Sheet 48.)

Main Coal (No.7).—This seam, also known as the *Coleorton coal*, is the principal seam of the district, and is got in all the deep pits, from Pegg's Green colliery southwards. Its average thickness is 6 feet, but on approaching a *rock-fault* south of Whitwick colliery, it reaches 12 feet, caused principally by partings of the rock dovetailing with it. The outcrop of this seam is close to Lount toll-gate, and runs along the west side of Smoile Wood, where it was formerly excavated in open works. In this direction the seam was found to exceed its average thickness by 2 or 3 feet, and tradition records that it was on fire along the outcrop at Lount Wood as far back as the commencement of the 15th century. It was also got in a similar manner along the hill-side west of Rough Park, and I understand it bassets under the New Red Sandstone at Coleorton Hall. In a "spinney" on the hill-top south of Coleorton rectory, the Main coal was formerly worked at a depth of 60 yards, with about 20 yards of New Red Sandstone a-top. It was followed westward to a large fault under Parson's Meadow, and was there 36 yards deep. This fault is considered, with great probability, by Mr. Coleman, to range all along the western side of the Coleorton coal-field, throwing out all the valuable coal-seams on the west side. It is probably a continuation of the large Heath End fault already described as terminating the Heath End coal along the west side of Rough Heath. This fracture was produced prior to the deposition of the New Red Sandstone, and consequently does not appear at the surface.

Fig. 7.

SECTION ACROSS HEATHER AND IBSTOCK PITS.



There is a similarity between the measures which accompany the two seams in the Ibstock and New Snibston sections, as well as in the thickness of the coal-seams themselves, due allowance being made for changes in thickness, consequent on the interval between them.

Section at New Snibston Pit.	ft.	in.	Section at Ibstock Pit.	ft.	in.
1. Strong blue bind	10	0	Stony bind	9	4
2. Grey metal stone	37	5	White sandstone	8	4
3. Blue bind 4. Black stone	0	9	Strong Stony bind	8	6
5. Main coal	5	0	Coal (top coal worked)	5	0
6. Fire-clay	4	6	Clunch	3	0

To my friend Mr. Coleman I am indebted for a copy of a very interesting boring made on the land of L. Fosbrooke, Esq., in 1830. The spot is between a pond and two cottages half a mile north of Hugglescote. It only reached as far downwards as the seam called Rattle Jack, which is about 33 yards above the Main coal. The measures correspond very closely with those in No. 2 pit, Snibston colliery, and the following are the coal-seams passed through :—

	Thickness. ft.	in.	Depth. ft.	in.
1. Stone Smut coal	3	4	254	9
2. Swannington coal	4	3	280	4
3. Soft or Three-quarter coal	0	8	325	6
4. Slate-coal Rider	1	1	363	5
5. Slate coal	5	11	387	11
6. Yard coal	1	11	433	11
7. Rattle Jack coal	3	3	465	9

There is evidently a large area of useful Coal-measures overspread by the New Red Sandstone as yet undisturbed, and extending from a line joining Coleorton to Heather, and eastward to the boundary fault of the coal-field, which will afford an almost unlimited supply after the Main coal, has been exhausted. To the southward a similar area extends from the western basset of the Heather coals (which will probably continue to Market Bosworth), eastward to the confines of Charnwood Forest. West of this little coal is to be expected until we arrive at the deep side of the Boothorpe fault, which probably continues its course for several miles in a S.S.E. direction from Willesley, throwing up productive Coal-measures on the west side.

From the basset between Lount colliery and Coleorton Hall, and eastward to the north side of Pegg's Green colliery, the Main coal is said to be exhausted; and, indeed, the numerous old pits and banks which abound over this area bear witness to the fact. Over this tract there is probably not an acre of undisturbed ground. The easterly dip of the strata must, therefore, cause the accumulation of water in these old mines in the direction of

Pegg's Green, and the greatest precautions are found necessary in order to prevent the flooding of the present mines by the bursting of these reservoirs. At Pegg's Green colliery, before a heading is driven in the direction of these old collieries, a boring rod of 12 feet in length is inserted through the Main coal in a horizontal direction, in order to prove the solidity of the seam to that distance. On one of many occasions the old mines were tapped, and upon the withdrawal of the boring rod the water gushed forth with great impetuosity; a plug was immediately inserted in the orifice, and it required the strength of two men to hold it in, while a third with a sledge hammer drove it home. As the hydrostatic pressure is proportional to the depth alone, there must evidently be a large accumulation of water for a considerable distance in the direction of the basset in order to produce a depth proportional to the pressure indicated upon this occasion.

The following section showing the quality of the Main coal throughout its thickness was furnished by Mr. Houldsworth, of Swannington New Colliery.

MAIN COAL, COLEORTON.

	FT.	IN.
1. Bright coarse coal	0	9
2. Fine grained	1	0
3. Very bright	0	2
4. Coarse bright	0	9
5. Bronzed spire	0	1¼
6. Coarse bright	0	4
7. Spire	0	1
8. Close-grained bench	1	7
9. Top spire	0	1¼
10. Tod	0	9
11. Bottom spire	0	1
12. Dice	0	3½
13. Floor coal	1	6
Total	7	6

The Main coal is overlaid by several feet of strong argillaceous sandstone, which at Pegg's Green, Coleorton Moor, and Whitwick collieries rests directly on the coal, while at Snibston and New Swannington collieries a stratum of bind from 2 to 5 feet thick intervenes. The value of a solid and hard roof is great, as otherwise 12 inches or so of the coal-seam must be allowed to remain a-top; but sometimes the sandstone roof is found to soften and give away after long exposure to the air; and where interlaced with partings of coal is liable to break off unexpectedly.

Sulphurous Coal (No. 8).—This is a thick seam, with partings of shale, but unfortunately so charged with "sulphur" (iron pyrites) as to be almost valueless, and from the quantity of sulphuous acid produced during combustion is called the "stinking coal."

Rattle Jack Coal (No. 9).—From 2½ feet to 3 feet thick.

Yard Coal (No. 10).—From 2½ feet to 3 feet thick.

Slate Coal (No. 11).—This seam, as its name implies, is of inferior quality, and like "the 4-foot coal" of Moira, which it is possible it may represent, is generally parted near the base by a thin stratum of shale, from 3 inches to 3 feet thick. Its average thickness is from 4½ to 5 feet. It was formerly got to a considerable extent around Coleorton, and is probably well nigh exhausted. A thin seam, "the Slate Coal Rider," generally accompanies the Slate coal, separated by from 8 to 12 yards of measures, and is more valuable as indicating the position of the seam, than on account of its intrinsic worth.

The following Table shows the composition of the Slate coal at Swannington.*

SLATE COAL.

	FT.	IN.
1. Average quality coal	1	6
2. Black stone	0	8
3. Fire-clay (uncertain)	2	6
4. Coal	2	5
5. Blue bind	0	2
6. Coal	1	6
Total	8	9

The outcrop occurs alongside the brook, which runs by the east side of The Paddock, where some sixty years ago the coal was extracted in an open work.†

Soft Coal (No. 13).—Also known as "the Three-quarter Coal," is a thin seam varying from 1 to 2½ feet thick.

Swannington Coal (No. 14).—This seam, I am informed, is of good quality, and in olden time was extensively worked. In sinking the shafts of the Coleorton and Swannington new collieries, it was found to have been worked out, as the "gobbins" alone remained. The outcrop may be viewed at the junction of the incline, with the main tramway at Orton Quarter Mars. The thickness of the seam varies from 2¼ feet to upwards of 4½ feet.

Stone Smut (No. 15), and *Stone Smut Rider* (No. 16).—These are average coals, and were formerly got at Whitwick colliery before the existence of the Main coal was ascertained. The Stone Smut Rider averages 3½ feet; the Stone Smut 4½ feet; and between the two there is an interval of 45 feet of measures.

In sinking the New Swannington shaft these two seams, together with the *Swannington*, were found to have been exhausted. From the number of old pits north of Swannington, it is probable that these seams have been entirely worked out over the district. Mr. Houldsworth pointed out to me no fewer than thirteen old banks, within sight of the engine-house of the New Swannington colliery.

The basset of the Stone Smut occurs at the north side of the

* Furnished by Mr. W. Walker, jun., Coleorton.

† According to the account of an old collier, Grandsir, of Coleorton.

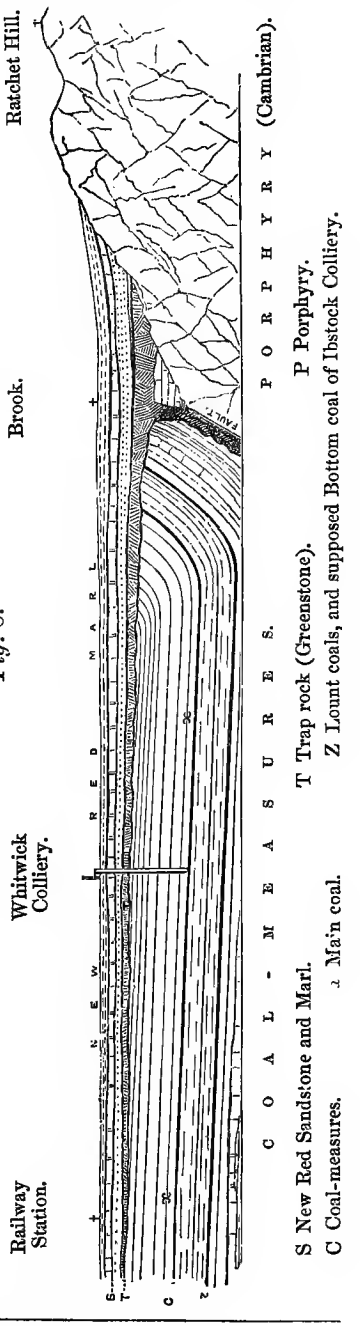
tunnel close by the California pit. The *Stone Smut Rider* bassets at the south side of the tunnel, is close to the mouth of the shaft of the New Coleorton colliery, and was cut through in the tunnel at its northern outcrop, where its thickness was found to be 3½ feet.

One-foot Coal.—This is a seam which occurs near the mouth of the shaft at New Swannington colliery, and its basset was marked out for me by Mr. Houldsworth. As the strata are thrown up very suddenly, east of the pit mouth, this and probably a few of the lower seams do not come in actual contact with the Coleorton boundary fault.

The *One-foot seam*, together with several higher, but thin coals were found in the Whitwick and old Snibston shafts; and, consequently, the beds through which they pass are the highest with which we are acquainted in the country. It is not improbable that we have now reached a position in the coal formation at or near the top of the productive series, and are now on the confines of the upper unproductive Coal-measures, which, though attaining a thickness of from 600 to 1,000 feet in Staffordshire, are not represented in the Ashby-de-la-Zouch coal-field, having either been swept away by the waters of an ancient sea, or covered over by the New Red Sandstone in a district further south than has been explored by the boring rod of the miners.*

Fig. 8.

Ideal Section through the East Shaft of Whitwick Colliery.



S New Red Sandstone and Marl. T Trap rock (Greenstone). P Porphyry.
C Coal-measures. Z Lount coals, and supposed Bottom coal of Ibstock Colliery.

* For full details of the coal series at the collieries of the Coleorton district, see Vertical Section, Sheet 19.

TABLE showing the Thickness of the Coal-seams which are supposed to represent each other in the under-mentioned Collieries.

(This Table is constructed on the supposition that the Coals of Bagworth and Coleorton are continuous, which is very uncertain.)

No.	Bagworth Colliery.	Ft.	In.	Heather Colliery.	Ft.	In.	Ibstock Colliery.	Ft.	In.	Snibston Colliery.	Ft.	In.	New Coleorton Colliery.	Ft.	In.	Willis Bailey's Colliery.	Ft.	In.
1	Coal	1	4	- - -	-	-	- - -	-	-	Stone smut	4	9	- - -	5	1	- - -	4	9
2	Coal 4 0 / Bat 0 9 / Coal 1 7	5	7	- - -	-	-	- - -	-	-	Swannington	3	7	- - -	2	3	- - -	4	6
3	Coal	7	0	- - -	-	-	- - -	-	-	Soft	1	1	Three-quarter	2	3	- - -	0	0?
4	Coal 5 0 / Bat 0 6 / Coal 4 6	9	6	- - -	-	-	- - -	-	-	Slate rider	2	2	- - -	0	9	- - -	1	0
5	Coal	1	6	- - -	-	-	- - -	-	-	Slate	4	8	- - -	4	6	- - -	5	0
6	Coal 2 3 / Bat 0 2 / Coal 1 8	3	11	- - -	-	-	- - -	-	-	Coal	2	10	Coal 2 3 / Bind 1 6 / Coal 0 8	2	11			
7	Coal	2	10	- - -	-	-	- - -	-	-	Coal	3	7	- - -	1	4			
8	Coal 1 2 / Cannel 1 6 / Clunch 0 5 / Coal 0 6	3	2	- - -	-	-	Coal	1	0	- - -	2	0	Coal 0 2½ / Shale 3 8 / Coal 3 0	3	2	Uncertain.		
9	Coal 2 3½ / Clunch 0 8½ / Coal 2 2½	4	6	- - -	-	-	Coal	4	0	Coarse	2	10	Sulphurous	3	6			
10	Coal (worked)	5	0	- - -	-	-	(Worked)	5	0	Main	5	0	- - -	6	6	- - -	6	0
11	- - -			- - -			Coal	3	0									
12	Coal	2	0	- - -	-	-	- - -	2	9									
13	Coal	4	6	- - -	6	6	- - -	5	5	- - -	3	5				Lount, Upper	3	9
14	Coal 3 3 / Fire-clay 8 6 / Coal 3 1	6	4	- - -	6	6	Coal 2 10 / Shed 0 1 / Coal 4 6	7	4				Not proved			Lount, Second	3	0
15	Coal	3	7	- - -	4	0	- - -	2	6½	Not proved						Lount, Middle	4	6
16	Coal	8	3	Coal 3 9 / Shale 2 3 / Coal 4 9	8	6	- - -	8	6							Lount, Nether	4	6
	Total thickness of coal	69	0	- - -	25	6	- - -	39	6	- - -	35	11	- - -	32	3			

CHAPTER VIII.

FAULTS.—MOIRA COAL-FIELD.

THERE are few physical phenomena to be met with in a coal-field calculated to excite greater interest in our minds than the lines of dislocation, or *faults*, which traverse it, often in great numbers, and the effect of which is to produce vertical displacements in its strata. On crossing a fault we often pass at a step from a district, it may be, rich in mineral produce to one utterly barren; or we leave behind an area of country where some valuable coal-seam lies within easy distance of the surface, and enter upon another where the same bed of coal has been plunged to a greater depth by several hundred feet, and where the difficulties and expense of obtaining it are greatly increased.

There are four principal faults producing important changes in the structure of the Ashby coal-field. Their general direction lies N.N.W.; this is parallel to the axis of elevation of the Charnwood Forest rocks, and proves a connexion between the forces which produced these phenomena. The faults to which we allude are the "Main" or "100 yard fault" of Moira; the Boothorpe fault, the Heath End fault, and the "Main" or Coleorton boundary fault. We now proceed to trace the first of these from its northern to its southern termination.

Moira Main Fault.—This line of fracture traverses the coal-field from the south side of Decoy Wood to Oakthorpe, in a direction of N. 20° W. The downcast is on the east side, and amounts to 120 yards at Newall, 100 yards at Moira, and 80 yards near Oakthorpe. Its position has been proved at the lodge, Bretby Park, from the smashed and tilted character of the strata in that locality.* The fault was also proved at the old collieries on the hill side north of Newall, the Block coal having been worked at one side on a level, with the Woodfield on the other.† It has likewise been struck in the shafts of White House collieries,‡ and was found in the excavations for the railway at Swadlincote station. Its position was ascertained in some old pits at the north side of Swadlincote village as far as Gresley Common,§ where it splits into two arms, one of which extends to Castle Gresley, and the other southward along the Wooden Box branch line of railway,‖ crossing the main line near the east end of the tunnel, and the sum of the downthrows being nearly equal to the throw of the main line of fracture. It is not probable that the line of the fault is continuous with either of these arms for any great distance in a southerly direction from their point of junction. At the east side of Ashby Woulds there is a line of unproved ground, along which

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* According to Mr. Nadin, of New Stanton colliery.

† From information obtained from Francis Dent, of Newall.

‡ According to Mr. Bodeman, who led me to understand that the fault splits into two portions for some yards.

§ From plans in Mr. Woodhouse's office.

‖ Ibid.

I suppose the fault to run till it reaches the eastern end of the reservoir, where it has again been proved by actual experiment. From this it extends along the east side of the Hartshorn Road, coal having been worked on its downcast side,* and it was again proved near William Hough's farm, west of Moira village.† Farther south than this the extension of the Main fault appears involved in mystery. Of the old workings no records have been kept, and the fault, which at Moira collieries is a great reality, suddenly becomes a matter of considerable uncertainty. I believe, however, that by the help of information obtained from Samuel Dennis, of Measham, an intelligent old miner, well acquainted with all the old coal-pits of the neighbourhood, I have succeeded in tracing the main fault for some distance farther south. It appears that many years ago the Main coal was got in collieries between Willesley and Oakthorpe. There were two pits alongside the lane joining these villages, one on the site of Mr. Merriman's house, another within a quarter of a mile of Willesley Park. Both of the shafts were exactly the same depth, so that the lane is parallel to the line of strike or level, the dip being north. Another pit, however, was sunk to the Main coal much nearer the Moira Road, and not far from Oakthorpe, on *the same line of level as the former*, and the depth was found to be 20 yards. It is therefore evident that a fault 80 yards downthrow on the east passes between Merriman's house and the Moira Road, which, as it is in the direct line, is doubtless a continuation of the main fault. Much farther south than this it probably does not extend, as there is a cross fault extending from Oakthorpe to Gallowslane, against which it appears finally to terminate.

The branch faults are numerous, though generally of small amount. The following is a brief account of them, derived either from information of coal-miners or from plans of workings:—

A fault crosses by Woodfield colliery with a downthrow of 16 yards on the north. The fault which runs under Newall Church and the other in a parallel line through Hawfield farm were marked out by Messrs. Nadin, who described the Main coal as having been worked along their faces. Another, a knowledge of which I derived from the same source, passes due east through the shaft of the New Stanton colliery, having a downthrow of 16 yards on the south. The position of the Church Gresley faults have been proved in the colliery, and were marked out for me by Mr. Walters, the bailiff, and Mr. Nadin informed me that in the Old Stanton collieries the Main coal was worked westward to a fault which is doubtless that marked on the map, and which passing N.N.W. through Overseal, brings the Red Marl down on the west side against lower beds of the New Red Sandstone.

From the Hastings and Grey pit (Moira) a heading was driven

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* From plans in Mr. Woodhouse's office.

† From the account of Mr. Hugh, landlord of the Moira Inn, who asserts that the Block coal is thrown near the surface of the west side.

due south for one-third of a mile, crossing several minor faults with "up-throws" on the south side. Two small faults pass between the two shafts, which it is not possible to represent on the ordnance map.* At Willesley old pits, two faults were struck, of which there are no particulars preserved. Mr. Green, of Charnwood Lodge, thinks that there is a fault with a down-throw of 100 yards running due east and west across the south side of Moira. This, I think, is a point of much uncertainty. The Main coal has been worked as far west as the lane leading south from the toll-gate, east side of Overseal, and no fault was struck. Half-a-mile further to the north the same coal was worked up to a fault which was traced for a distance of 80 yards, its direction is N.N.E., but the amount and side of the downthrow are not known. A fault, ranging from the east end of the reservoir to the railway, is marked in the plans in Mr. Woodhouse's office, but there are no details concerning the throw. There are also two small faults west of the Bath pit, the directions of which were marked out by the bailiff.

Mr. Woodhouse informs me that the boundary of the New Red Sandstone at Gresley railway station is a fault which has lately been struck in a heading driven from Moira colliery.

Stone Wall.—This fault traverses Donnisthorpe Field in a direction E.N.E., with a downcast of 100 yards on the north side. It was proved on both sides in the old mines of Donnisthorpe Field, and is marked in Mr. Mammatt's section (C to D), where it crosses the canal embankment south of Moira. In that locality the throw is from 120 to 140 yards. It probably terminates on the east side against the *Main Fault* of Moira, and is lost under the New Red Sandstone in the opposite direction.†

Oakthorpe Fault.—By this name I mean to designate a line of dislocation, of the existence of which as proved by actual experiment, I can find no record, but of which there is not the less certainty, if the information received from several sources concerning the depth of the Main coal in the old pits is to be relied upon.† The fault appears to range east and west, passing a few hundred yards south of the village of Oakthorpe, where, as has been already stated, the Main coal crops out, and where there have been pits into the *Slate* coal which did not pass through the *Main* seam. On the south side of the fault the Main coal is thrown in again, and at the south-west side of Oakthorpe the downthrow must be about 110 yards.‡ The following section, drawn nearly along the Moira Road from the turnpike gate east of Oakthorpe to the Measham and Ashby Road, will explain the nature of the evidence by which the position and amount of this fault has been determined.

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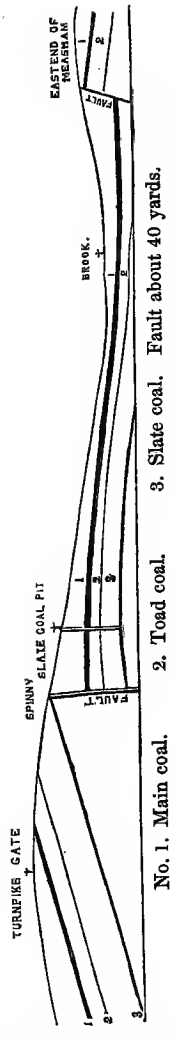
* From information afforded by John Brown, Esq.

† For the information concerning the old pits and faults in this neighbourhood, I am chiefly indebted to Samuel Dennis, *alias* Cornet, of Measham.

‡ *See* p. 29.



SECTION ACROSS THE OAKTHORPE FAULT.

Fig. 9.

In the *Slate coal* pit marked in the section the Main coal was passed through at a depth of 15 yards from the surface. The "Over" coal, or upper part of the Main seam, was found to have been wrought out, and only the "gobbins" remained; but near the shaft a fine pillar of the Over seam was found standing as a support to the roof, and was speedily demolished by the miners.

I was informed by an old miner at Measham, that a fault runs along the north side of the village having a down-throw on the north side of 25 yards; Dennis, however, had no knowledge of it, but as the Main coal is very near the surface under that part of the village, its existence is not improbable.

*Boothorpe Fault.**—This line of dislocation, though unknown to the miners, and consequently not distinguished by a title, has produced the most important changes in the position of the Coal-measures and the mineral value of the western and central areas of the Ashby coal-field. It forms a boundary wall between a district of vast mineral value on the west, and one of an opposite character on the east.

The first evidence we get of the existence of this fault is the disturbed nature of the beds in the old pits south of the potteries near Bretby Park. I was fortunate enough to fall in with Francis Dent, of Newall, who had formerly worked in all the old collieries of the district, and in the accuracy of whose statements I place the utmost confidence. From him I learned that a fault had actually been struck close to the turnpike road near Spring Wood. It cut out the coal, and he considered it as passing under the potteries and joining the *Main* fault near Bretby Park Lodge. He also affirmed that the coal-seams were found pitching at high angles as they approached the position of the fault, and that it was the general opinion of all the old miners that some great dislocation existed along the line already indicated.

From the information afforded by Mr. Ely, ground bailiff of the Granville colliery, I was enabled to trace approximately its

* I have adopted this name from the Rev. W. H. Coleman, who had made himself acquainted with its position previous to my arrival in the country.

position in the neighbourhood of Round Wood. Mr. Ely also marked out a small branch fault which gradually dies out 200 yards south-east of the Granville shaft. From the plans I obtained the position of a cross fault striking from White House colliery to the north end of Midway House; the downcast is on on the south side, but the amount is unknown. At Woodville the measures have been proved unproductive to a depth of at least 200 yards*, above which there are two or three coal-seams, accompanied by potters' clay, the whole of which are unknown in the Moira coal-field on the deep side of the fault, unless, as has been surmised, they represent the Woodfield, Stockings, and Eureka coals. These seams, one of which is called the Rafferee coal, have already been described,† and the position of the Boothorpe fault can be fixed upon with considerable accuracy south of Woodville, as there is the Ell coal on the deep side, and the Rafferee coal on the shallow side of the fault.

The fault passes close along the east side of the village of Boothorpe, producing a probable, though uncertain, dislocation in the New Red Sandstone. At Sweet Hill Oak, its position must be close to the old pits, in which, some 60 years ago, the Rafferee or one of its associated coal-beds was worked. It thence continues its course, crossing the Burton railway at the Willesley cutting, at a position 180 yards east of the bridge of Willesley lane. Here, during the excavations the beds were found to be tremendously smashed; and though covered over at present, I was enabled to observe a small section a few yards west of the fault where the shales were lying at an inclination of 35°. The dip gradually lessens as we recede from the Boothorpe fault, and at the entrance to the cutting on the Ashby side, the dip is only from 8° to 10°. Further south we find no sections, and the fault becomes lost under the New Red Sandstone, which it does not appear to affect, having, in fact, been produced at a period antecedent to the deposition of that formation. I shall presently endeavour to explain why, though this is the case, these faults in some places appear to form its boundary lines.

The Boothorpe fault appears to pass close under Willesley Church, and a little east of Gallows Lane turnpike; the Main coal having formerly been won within a short distance of this position, and also along the west side of Willesley Park. The strata were found to rise rapidly to the east, the strike having changed by a quarter of a circle from its normal direction, which is due east and west. These phenomena are all to be accounted for by the proximity of the Boothorpe fault.‡ To trace this line of dislocation farther south is necessarily impossible, the country being overspread by the New Red Sandstone; but it is probable that it continues its course for several miles in the same general

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* *See* page 66. † *See* pages 35–6.

‡ *See* Mammatt's "Geol. Facts," the information in which was corroborated by Cornet, of Measham, who had formerly worked in these old pits.

direction, throwing out all the productive measures along the east or upcast side; and the proximity of this fault will explain the reason for the basset (under the New Red Sandstone) of the Main coal in Swepstone Brook, as the fault appears uniformly to have produced in the Coal-measures a rapid inclination to *the westward*, all along its course.

Heath End Fault.—For a knowledge of the existence of this fault I am indebted to Mr. Coleman. Commencing at the north, it appears to branch out of the boundary fault, at the edge of Calke Park. It has been proved to throw out the Heath End Cannel coal, near the west side of Rough Heath, and its proximity is indicated by a strong spring of water, which rises from a bore-hole about 150 feet from the surface, along the side of the road. It is remarkable that three weeks after this spring commenced to flow the well of Ashby workhouse dried up. In the brook at the south end of Rough Heath the strata are much disturbed, and the fault probably continues southward by the west side of Lount Wood, and was again struck in the workings of the Main coal at Parson's Meadow, Coleorton. Its further extension southward under the New Red Sandstone is no doubt considerable. It thus appears that the Coleorton coal-field lies between two large faults, which throw out the coal-beds both on the east and west sides.

CHAPTER IX.

Coleorton Boundary Fault.

It is no uncommon circumstance to find the coal-producing districts of our country walled in, as it were, by faults. The Shropshire coal-field is bounded on its east and west sides by walls of Permian and New Red Sandstone; and the South Staffordshire coal-field is similarly circumstanced. But while in these instances the areas of the Coal-formation have been vertically elevated to a level with the newer formations, the Ashby coal-field has been limited along its eastern side by a process the reverse of this. Here the coal-field has either been caused to sink, or the older formations been upheaved from below, and the line which marks the juxtaposition of the two series of strata is known as the *Main or Boundary Fault.*

This line of dislocation commences at Ticknall, and traverses the country in a straight line in a south-easterly direction to the eastern extremity of Bardon Hill. The amount of throw is a minimum at Ticknall, where the Mountain Limestone Shale on the one side is brought up against the Millstone Grit on the other, and becomes a maximum east of Whitwick Colliery, where the Millstone Grit and Charnwood Forest rocks are brought up against strata about 2,200 feet above these formations. This is consequently the amount of throw here, and this amount diminishes in proportion as we proceed towards Ticknall, as will be evident

from the manner in which the coal-crops are broken off in succession against the fault.

The following calculation gives us the downthrow at Whitwick colliery, where it is nearly a maximum:—

	FEET.
Depth from the base of New Red Sandstone to the Main coal - - - - -	700
„ from the Main coal to the Nether Lount coals -	220
„ from the Nether Lount to the Heath End coals (approximately) - - - -	350
„ from the Heath End coals to base of Coal-measures (approximately) - - -	900
„ Upper beds of Millstone Grit - - -	40
Total - -	2,210

As the throw of the fault increases towards the south-east to a position as far *at least* as Whitwick colliery, we must either suppose that the beds commence to rise towards the south as they approach Bardon Hill, so as to regain their original position; or else that they are broken off by a cross fracture striking the main fault at right angles. The former supposition cannot be entertained for a moment, as in this case it would be necessary to suppose that the lowest beds have stretched themselves to a length equal to the difference between the curve which they would form and its chord, since there are no cross faults between Ticknall and Whitwick sufficient to equalize these lengths. We are, therefore, driven to the conclusion that there is a cross fault in some position south of Whitwick colliery; and the north side of Bardon Hill, standing out in a direction perpendicular to the ridge of the Forest rocks, in all probability marks the line of this cross fault. The downthrow would of course be along the north side, and would equal that of the main fault at their point of junction, while it might rapidly lessen in amount in a westerly direction. This indeed would appear to be the case, since we find no evidence of the proximity of a fault at Ibstock colliery, the strata there being found to lie very regularly, with a gentle inclination to the eastward. (See Horizontal Sections, Sheets 46 and 48.)

CHAPTER X.

Rock-faults, Coleorton.

With the exception of the Coleorton Boundary fault, the supposed cross fault of Bardon Hill, and another striking out from the Boundary fault, through Rough Heath, there do not appear to be any faults of importance affecting the measures of the Coleorton coal-field. The absence of these "troubles" is, however, in some degree compensated for by the presence of other sources of annoyance to the miner, namely "*Rock-faults*,"—phenomena which, though in their very nature different from faults

such as those we have been considering, are often confounded with them, not only by the uneducated colliers, but even by those from whose position a higher amount of knowledge might have been expected. A rock-fault may be described as a bank of sandstone, stony bind, or clunch, which replaces a bed of coal, and may either fill up a hollow previously formed in the coal-seam, or become interlaced with it by a series of wedge-shaped branches. In the former case the bank will be found to come downwards from the roof, in the latter, to rise from the floor; having in the one case been produced *after* the formation of the coal-seam, in the other *during* its formation, both being carried forward, *pari passu*, as the courses of masonry in a wall.

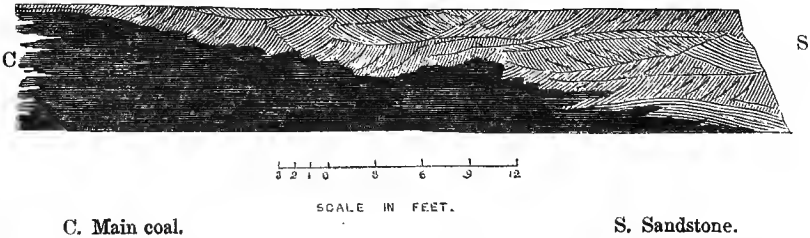
The principal rock-faults or banks occur at Pegs Green and Whitwick collieries. In the former a bank of argillaceous sandstone, in one place 80 yards in width, replaces or "eats out" the Main coal, the one passing into the other by means of a series of interlacings.

At Whitwick and Snibston the phenomena presented by the rock-banks are of a highly interesting character, and tend to throw much light on the physical conditions under which the *Main coal* has been formed in that neighbourhood.

There appear to be at least three banks of sandstone, two close to the pits and the third in the direction of Bardon Hill, all of which are probably connected together. The principal mass has a due north and south direction, and the coal has been worked on both sides for some distance, a heading having been driven through in a position where the width was found to be 400 yards. There is also another bank stretching nearly east and west, which will in all probability be found to be a branch from the former. Its width is about 32 yards.

The floor of the Main coal is under-clay, and it is remarkable that while this floor remains perfectly even and regular, all the interruptions caused by the rock which replaces the coal have acted *downwards*, apparently after the formation of the latter. This will be apparent upon viewing the annexed diagram taken on the spot.

SECTION OF THE ROCK-FAULT IN THE MAIN COAL, COLEORTON.
Fig. 10.



C. Main coal. S. Sandstone.

In one place in the Whitwick mine, the Main coal is parted near the top by a bed of white rock containing nodules of ironstone, and the upper seam becomes united to the lower by the

gradual thinning out of the intervening strata, while finally, at a distance of 12 yards from the place where both attain their greatest thickness, the sandstone of the roof descends with a gradual slope down to the very floor of the Main coal. Mr. Stenson, jun., who kindly accompanied me through the mines told me that the rock has been found not only to cut out the coal-bed, but even to furrow out some inches of the clay which forms the floor.

Another *rock-fault* has been discovered in the direction of Bardon Hill, which, from the statements I have received, would appear to differ from those we have hitherto been considering in being *contemporaneous* in its formation instead of subsequent to the production of the coal-bed. It was reached in a heading driven south from Whitwick colliery at a distance of 1,200 yards, and the excavations were continued 110 yards into the rock without passing through. The coal was got for about 1,000 yards along the north side. The seam was found to widen into a total thickness of 12 feet on approaching the rock, caused in a great measure by lenticular partings of stony bind stretching into it from the bank to greater or less distances.

An attempt was made to reach this rock-fault by a heading driven from pit No. 1 of the Snibston colliery, but after gaining a point distant 15 chains from the Ashby road without discovering the rock, the heading was discontinued. From the fact that the Main coal on approaching this rock-bank is caused to widen into nearly twice its usual depth by partings stretching out from the main mass of rock, we should be led to infer that both the bank of rock and the coal-seam were in process of formation at the same period of time; but the case is different with regard to the rock faults in the neighbourhood of the Whitwick pits, the formation of which has probably taken place in somewhat the following manner:—

The Main coal may have been a vegetable mass about 60 feet thick, growing under the atmosphere at a slight elevation above the sea or estuary. Towards the end of the period, when it had attained its full thickness, the country began to subside, and was finally submerged. It is not to be supposed that this submergence was perfectly equal all over the area occupied by the coal-growth; and it is quite possible to conceive that furrows may have been produced over various portions, and channels scooped out in several directions. This formation of channels in the mass was followed by the deposition of a light-coloured sandy clay, which, after filling up the channels, was spread over the whole, and now forms the roof of the coal-seam.

These suppositions are borne out by the mineral character and other phenomena which characterize the rock in question. No separation occurs between the rock which takes the place of the coal and that which forms the roof. Both have evidently been derived from the same source, and have been deposited continuously. The mineral character varies from a sandy claystone, or hard "stony bind," to a fine-grained sandstone, occasionally highly micaceous. *False-bedding* is very prevalent, especially in

the portions which form the banks, and when occurring in the sandstone of the roof cause it to disintegrate rapidly and to break off in slabs. False-bedding is usually attributed to the action of currents, which in this case may have been produced by a river or the ebb and flow of the tides through the channels.

CHAPTER XI.

Upper Coal-measures.

In several localities on the western side of the coal-field there occur beds of sandstone, which, with respect to quality and position, appear to be in some measure distinct from those sandstones which are found in pit sections interstratified with the coal-seams and their accompanying measures. Mr. Coleman, of Ashby, has for some time regarded them as *Upper Coal-measures unconformable to the strata on which they rest;* and it must be allowed that, although the evidence is not conclusive, or rather is insufficient, still the balance seems to incline on the side of his hypothesis.

The locality where these sandstones can be best viewed is at the ballast-pit near the Moira railway station. At first sight the rock appears to resemble Millstone Grit, but its position forbids the possibility of its being so, as it occurs on the downthrow side of the Boothorpe fault. The beds consist of coarse fissile grit, of various shades between red, purple, and grey. They are traversed by veins of sandy hæmatite, and have occasionally thin partings of shale. The bedding is very obscure, but is probably nearly horizontal. The same rock is again shown in a quarry north of the railway, and still further north at the village of Boothorpe, where it is bounded on the east by a fault bringing it in contact with the New Red Sandstone. This fault, which is a branch from the great Boothorpe dislocation, in all probability forms the boundary line along the east of the more southern sandstones near the railway.

The evidence that this coarse grit is unconformable is this—that it has not been passed through in the shafts of the Hastings and Grey colliery, which ought to be the case if the strata were conformable, the dip being westward; and that it appears to be horizontal in the immediate neighbourhood of strata highly inclined.

Half a mile north-west of Newall there rises a very prominent hill, partly covered by a wood, and formed (judging from the blocks of stone scattered over it) of coarse grit, resembling Millstone Grit more than any sandstone to be met with in the coal-field. When engaged in tracing the coal-crops, I was much perplexed to account for the position of this grit; and my guide, Francis Dent, could throw no light on the subject. Its position appears to be above the Woodfield coal, and yet it does not extend to any considerable distance along with that and the overlying

coal-seams. As there is no section, we are deprived of the advantage of knowing the dip; but, judging from the features of the surface, the sandstone would appear to be an outlier, resting horizontally on the Coal-measures, and as the latter have an inclination of several degrees towards the south and south-east, there would necessarily be an unconformity. Taking all the evidence into consideration, I am inclined to consider the grit in this locality as a portion of the Moira and Boothorpe rock; and if so, we must suppose that at a certain period, towards the close of the carboniferous epoch, a general disturbance, followed by denudation, affected this portion of the Coal-measures, after which the deposition of these grits ensued. A later period of denudation has only left a few detached fragments of this formerly extended bed of sandstone; but, like the fragments of an old ruin, they are sufficient for indicating the area which it once overspread.

At a period during which, we feel assured, many minor oscillations of the land and sea-bed occurred, it was by no means improbable that successive strata of the Coal-formation should have been rendered unconformable; and of the fact we have illustrations in the coal-fields of South Wales and the continent. The occurrence of these phenomena in other districts adds to their probability in the Ashby coal-field; but additional evidence will be necessary before we can determine with certainty this highly interesting question.

Another interesting feature with regard to the Moira grit is the occurrence therein of fragments of *Sternbergia*, a fossil of the Coal-measures, demonstrated by Professor Williamson to be the cast of the pith of a tree allied to an Auracarian pine. Two very fine specimens, measuring 10 and 12 inches in diameter, were found in this locality, and are now in the Museum of Practical Geology.*

CHAPTER XII.

Permian Formation.

It is by no means certain whether any representatives of the Permian formation occur in the district under consideration. If, indeed, certain beds, which shall presently be described, are of Permian age, they are but meagre traces of a formation which, along the borders of the Staffordshire, Shropshire, and Lancashire coal-fields, reaches a thickness occasionally exceeding 1,000 feet.

There are, however, certain facts, which seem to favour the supposition that the beds to which we refer may be marginal outliers of the Permian formation. They appear to rest unconformably on the Coal-measures, as they repose on beds of the latter belonging to different geological horizons. They are unknown in pit sections, and have never been found interstratified with Coal-measures. It is therefore evident that they do not form part of

* Presented by the Marquis of Hastings through the Earl Howe.

the Coal-formation, but are of more recent origin. Again, with reference to the New Red Sandstone, they underlie the quartzose conglomerates of that formation, which, *in this part* of the country, form its base; and what is still more remarkable, these supposed Permian beds are found where the quartzose conglomerates are absent, and where they are, consequently, overlaid directly by higher beds of the New Red Sandstone; from which it would appear that they are connected neither with the New Red Sandstone nor Coal-measures, but are independent of both. These phenomena will be observed on referring to the maps, on which all the subdivisions of the New Red Sandstone have been traced. Lastly, with reference to mineral character, which, as evidence, is of much value, these doubtful beds bear a strong resemblance to Permian strata in other parts of England.

A small district composed of red-coloured strata extends from the village of Ingleby to the Knowl Hills near Foremark Park. A line of cliffs formed of the light-coloured sandstone and conglomerate of the New Red formation, rises above the alluvial plain of the Trent, and at Ingleby red marls, streaked with bands of white, may be seen cropping out from underneath these sandstone cliffs. We can trace these marls for some distance eastward, but at Knowl Hills, some beds of sandstone, differing considerably in mineral characters from those of the Trias, are found to intervene between these latter and the red marls. It would, therefore, appear that between this locality and Ingleby the New Red Sandstone had overlapped unconformably the red sandstones which form the Knowl Hills; from which circumstance, taken in conjunction with their lithological character, it is probable that the latter are of Permian date.

The rocks of the Knowl Hills consist of fine-grained red and brown sandstones, regularly bedded, containing no pebbles, and occasionally parted by seams of marl; in nearly all of which respects they differ from the sandstone of the Trias, which overlies them. Some coarser beds occur at the north-east side of the hill, where they may be seen cropping out along the bank; but the best section is exposed to view alongside the brook, which takes its rise at the springs, called the Seven Spouts, where they burst out at the junction of the sandstone and underlying marls.

As far as lithological character is of value in determining the date and relationship of widely separated strata, it is certainly in favour of the supposition that these interstratified marls and sandstones are of Permian origin. But the whole series of beds here is comparatively unimportant, the sandstones attaining from 20 to 25 feet, and the marls from 25 to 30 feet in thickness.

The following are additional localities where these supposed Permian strata occur.

In a lane leading up the hill from Hartshorn Grange a small section is exposed in beds consisting of loose breccia in a marly base, and resting on red marl, the thickness of the whole being 20 feet. In the brook north of Glover's Mill red marls may be observed resting on Coal-measures, and lower down the brook red

and grey sandstone occasionally crops out along the bank. Not much faith is to be put in the Permian age of these beds.

Half a mile from Woodville, on the Burton road, there is a brickyard, in which the following succession of strata is open to view:—

1st. Yellow sandstone, with quartz pebbles.
2nd. Yellowish-brown sandstones and shales.
3rd. Red marl, streaked with yellowish bands.
4th. Loose breccia of small pebbles in a marly base.
5th. Red marl streaked with yellowish bands.
Total thickness 14 feet.

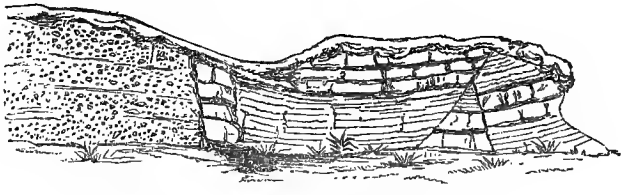
No. 1. is undoubtedly towards the base of the New Red Conglomerate. The underlying beds are of less certain date. From their similarity of appearance to Upper Coal-measure strata in the North Staffordshire coal-field, I was at first induced to include them in Coal-measures, but upon a subsequent examination in company with Mr. Coleman and Professor Ramsay, it was unanimously agreed that they were of newer date, though whether of Permian or Triassic was allowed to be uncertain.

Along the Burton road, between Castle Gresley and Cadley Hill, similar marls and breccias occur at the base of the New Red Sandstone, of very trifling thickness. They appear again at Overseal, having been proved to a depth of at least 20 feet in a well.

At the village of Linton an excellent opportunity of observing these breccias is afforded.* They are here thrown to the surface by means of two faults, which strike each other at right angles. One of these is exposed to view in a lane near the village from which the subjoined sketch has been taken. The other is inferred, as we find in some old quarries east of the village the Waterstones and Red Marls of the New Red Sandstone dipping against the breccias. The small area occupied by the breccia offers a most advantageous position for a coal-shaft, as, for all we know to the contrary, the Main coal might be here reached at a very moderate depth.

Fig. 11.

Section in Lane at Linton.



Loose breccia (Permian ?) — Brown Sandstone and Marl. (New Red Sandstone.)

The breccia is composed of a mass of loose pebbles, angular or otherwise, of the following rocks:— Light-green and indurated

* The difference between conglomerate and breccia is, that in the former case the pebbles of which it is composed are rounded, in the latter angular, or nearly so.

slate,* grits of various colours and textures, dark brown and purple sandstones, often micaceous, chert, felspar, trap (?), and quartz. The whole occasionally becomes a fine gravel of a deep purple or ferruginous red colour, but some of the pebbles are as much as 4 to 5 inches diameter.

At Oakthorpe and Measham apparently the same breccia again occurs, but in a consolidated state. At the former place the canal has been excavated through the rock for about 300 yards, and the blocks built into the parapet wall; and at the latter a section is opened in a quarry at the north side of the village. In both these cases the components of the breccia are of a nature similar to those which form the unconsolidated breccias of Linton.

Loose marly breccia has been proved to extend under Measham field in the old coal-pits, and known to the miners under the name of "Fox gravel." According to Mr. Dennis it was found from 12 to 14 yards thick, but this is probably an exaggeration.

Packington stands on unconsolidated breccia, composed principally of slate. This stratum is overlaid by the Waterstones of the New Red Sandstone, which appear to be unconnected with the breccia, the latter being rapidly overlapped by the beds of the Triassic formation. This apparent unconformity, taken in connexion with the mineral character of the breccia, induces us to conclude that it is of Permian date.

In the railway cutting nearest Ashby station, on the west side, a fault occurs throwing in a few feet of red measures, of which it is uncertain whether they are to be considered as Permian or Trias. The section shows 2 or 3 feet of thin-bedded red and purple sandstone, sometimes speckled, resting on red and purple marl. The whole is surmounted by the Waterstones of the Trias. Mr. Coleman tells me that when the line was made he found small nodules of hæmatite in the marl. This would seem to connect the marl with that which forms the base of the Waterstones in the neighbourhood; and as far as lithological character is concerned, we can only say, that if these beds occurred in a Permian district, they would do very well for Permian, or if in a New Red Sandstone district, they would answer equally well for New Red Sandstone. It has been considered as the safer course to include the whole as New Red Sandstone in the Geological Map.

CHAPTER XIII.

The New Red Sandstone or Trias.

Bunter Sandstone.

Of the three subdivisions into which the Bunter Sandstone of England may be divided where the series is complete, only one is present along the edges of the Ashby coal-field.†

* Mr. Coleman does not consider these slates as identical in appearance with any of the slate rocks of Charnwood Forest.

† For further information on this subject, *see* Report of the British Association for the Advancement of Science for 1854, pages 86, 87.

The quartzose conglomerates appear in force chiefly along the western limits of the Ashby coal-field. They occupy considerable areas from Donnisthorpe to Overseal, and westward; also from the northern boundary of the coal-field to Repton and Ingleby. Judging from the heights of some of the hills in this neighbourhood, the subdivision must attain a thickness of nearly 200 feet. The best sections occur at Repton, where there are several quarries in conglomerate formed almost exclusively of quartzose pebbles. Along the cliffs extending from Foremark Park to Ingleby the beds consist of hard white and yellow sandstone, containing scattered pebbles of quartz, chert, &c. In these beds the "Anchor Church" is excavated, being, in fact, a series of small caves connected by passages hewn out of the rock. It is said that this excavation, the entrance to which is guarded by the deep waters of the Trent, was formerly the resort of bandits, and used for purposes rather different from those which its name implies.

Sections in the conglomerates are also exposed to view at the Seven Spouts, where seven copious springs gush forth at the junction of these strata with the Permian beneath; at Repton Mill and along the valley, extending from Repton to Glover's Mill; at the potteries north of Newall, in a lane, south of which they form two small outliers. They again appear at Boothorpe, where they are probably thrown in by faults, or at least by one fault, as the Coal-measure grits form higher ground.

On the western side of the coal-field the beds of this subdivision form a narrow band resting regularly on the Coal-measures along their eastern boundary, but terminated on the opposite side by a line of fault, the downthrow of which is on the west, and which consequently throws in the Red Marls and Waterstones on that side. The fault is no where actually visible. There is a good section at Gresley station.

Quarries have been opened along the bank of a branch of the Mease north of Netherseal; and at the village itself the rock is everywhere exposed, consisting of coarse yellow sandstone with quartz pebbles, which is immediately overlaid along the outskirts by the marls and brown sandstones of the Keuper series. The conglomerates, which are again visible at Acresford, form the high ground on which Donnisthorpe stands, and extend thence to Measham, where they are overlapped by the Waterstones, and are seen no more to the eastward.

That the conglomerates should end off along a line drawn from Ingleby to Measham, eastward of which they do not again occur, is a fact sufficiently remarkable, and may be accounted for in two ways, either that they are unconformable to the Red Marl and Lower Keuper Sandstone, or that there has been a difference of level in the original sea-bed along this line.

The Waterstones or Lower Keuper Sandstone subdivision is to be considered as more connected with the Keuper Marl by which it is surmounted, than with the Bunter Sandstone beneath. With the Red Marl it is intimately associated, passing upwards into it, often very gradually, and containing in itself numerous

beds of marl. In the neighbourhood of the Ashby coal-field the base of the subdivision is generally marl, upon which rests a bed of breccia or conglomerate, and thus presenting a section very similar to that in the border counties, where the subdivision attains its greatest development.

At Castle Donnington there are numerous sections in these beds, and the base is formed of a thick stratum of red marl, surmounted by yellowish pebbly sandstone, upon which rests about 80 feet of yellow and brown regularly stratified sandstones of fine grain, and containing partings of marl. At the north end of the town the basement-beds form a cliff overlooking the alluvial plain of the Trent; and some Carboniferous strata may be observed cropping out at the base of the cliff, proving the entire absence of the conglomerate subdivision in this neighbourhood. Between the town and Hemington the beds are broken off by a fault, which throws down the Red Marl and Keuper Sandstone against the base of the Waterstones and Carboniferous strata.

Along the north side of Donnington Park the Waterstones form a highly picturesque bank, at the base of which flows the Trent. The upper part of the bank is formed of the Keuper Marl, with a thin bed of sandstone running along the edge of the ridge. A quarry of excellent freestone has been opened near the gardens.

On the opposite side of the river, at Weston Cliff, the sandstones of this formation are extensively quarried and present many of the littoral phenomena so characteristic of these beds. These consist of sun-cracks, gutters, rain-drops (?), and ripple-marks; and my friend, Mr. Huish, of Castle Donnington, has found footprints of *Labyrinthodon*. The section presents a face of 20 feet, and the beds consist of white, grey, and brown sandstones, with marly interstratifications. None of the sandstones are of the best quality, being soft, and traversed by joints often filled by black oxide of manganese.

In the neighbourhood of Repton, the best section occurs in the lane leading to Loscoe Farm. Their super-position on the conglomerate beds is visible; they are here faulted against the latter by a north and south fault. Numerous sections occur between Repton and Burton, which do not require special notice, as the strata are very similar. The general dip of the country is towards the north-west; the higher portions are capped by the marls, which are here very full of thin blue and white sandstones, known as "skerry" by the natives.

At Brislingcote the Lower Keuper Sandstone is thrown against the Coal-measures by a fault, and there also appears to be an overlap or thinning out of the conglomerates, as the coal has been worked up against the Waterstones.* The position of this fault is well shown on the Burton road north of Stanton, where there is a quarry of white sandstone, with the base of the Keuper Marl on one side and the pebble beds forming higher ground at the other.

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* *See* page 25 and woodcut section.

The Red Marl, with Upper Keuper Sandstone.—These beds will not require any lengthened description, as they present but little variety, and are similar in character to their contemporaries over other parts of England. They consist of red shaly marl, with numerous thin courses of more sandy shales, of grey or blue colours. These beds become very sandy towards the base, often rendering it doubtful whether they are to be considered sandstones or marls, and gradually pass into the Lower Keuper Sandstone.

At a distance of from 100 to 150 feet from the base a bed of Upper Keuper Sandstone, associated with grey and bluish shales, generally occurs. At Kegworth this stratum is very well shown in a brickyard south of the town; it there consists of fine-grained white argillaceous sandstone, 1 foot thick, and interstratified with the usual bluish fissile beds already mentioned. Its position there is not more than 40 feet above the top of the Waterstones, the beds of which bear considerable resemblance to it. These beds are frequently ripple-marked, and contain pseudomorphous salt-crystals, first noticed and described by the late Mr. Strickland, in the Keuper Sandstone of Gloucestershire.* A little Crustacean, *Estherea minuta*, characterises these strata, but I have not been able to find any traces of it north of the Ashby coal-field, though I have had frequent opportunities of observing these beds around Derby and Nottingham.

Such is the general character of the Upper Keuper Sandstone, which will apply in almost every locality. It forms the tops of the high grounds extending from Kegworth to Melbourn, and by the combined influence of denudation and an anticlinal, it reaches the surface at the village of Diseworth, where it is more than usually thick. It occurs at Hemington, on the downthrow side of the Donnington fault, and caps the highest portion of Melbourn Parks and Brand Hills.

A considerable outlier of the Waterstones, with a small tract of Red Marl in the centre rests on the Coal-measures, and extends nearly from Ashby to Ticknall. It is completely isolated, and it is remarkable that, while the conglomerate beds, to the depth of at least 150 feet, are found at a short distance to the westward, they are altogether absent in this locality.†

These beds have been pierced for coal at Pistern Hill, but in general they rest upon an unproductive portion of the Coal-measures.

This outlier is generally bounded by a picturesque, though not very lofty escarpment, especially in the direction of Ticknall. The beds are everywhere horizontal, and consequently the surface of the area is tabulated.

Several good sections may be observed in the road-cuttings, as at Smisby, Blockfordby, Hartshorn, and Pistern Hill. The base is generally red shale or clay, on which there rests a series of interstratified brown and yellow sandstones and red shales, from

* Chloride of sodium, Quarterly Journal of the Geological Society, vol. ix., p. 5.

† *See* page 61.

80 to 100 feet thick. In the centre occurs a small outlier of Red Marl, which may be noticed resting on the sandstones in the section at Smisby. The Marl is on a lower level than the ridge along the outskirts of the outlier, which is composed of sandstone, and it may therefore be supposed that the outlier forms a gently inclined basin, the beds having assumed a slight dip from all sides towards the centre.

Another, and smaller outlier of the same beds, occurs at the west side of Ashby. The western boundary is a fault, which is exposed to view in the railway. The base is here also a bed of red clay, containing nodules of earthy hæmatite.

At Chellaston this formation yields a valuable and thick bed of gypsum, which is extensively worked, and in the associated clays Mr. Rupert Jones has discovered numerous species of *Foraminifera* and plates of *Echinodermata*.

CHAPTER XIV.

Trap Rocks.

Before proceeding to describe the trap rock of Whitwick and Snibston, it may be useful to remark that the term "whinstone" is frequently made use of in pit-sections in a non-geological sense. In such cases it may be understood to mean some kind of hard sandstone of a dark colour. In this sense, I presume, the term is used with reference to a stratum intermediate between the *Stone Smut* and *Stone Smut Rider* in No. 2 Snibston pit section, as also in that of Pegg's Green colliery, where a bed of "whinstone" 1 foot thick is mentioned.

A mass of rock, of the igneous origin of which there can be no question, is pierced through in the shafts of the Whitwick and Snibston collieries. It is remarkable that this mass of trap, the only one occurring over any part of the Ashby coal-field, should occur in its exceptional form, that is as a *bed* and not as a *dyke*. Its presence was first proved in sinking the first shaft of the Snibston colliery, under the direction of Mr. Stephenson, the engineer of the Britannia Tubular Bridge,* and when struck must have caused much perplexity, as it was supposed by many that the Forest-rocks had been reached, and that consequently there was no coal. However, Mr. Stephenson persevered (though, all things considered, the experiment appeared sufficiently hazardous,) and having passed through no less than 60 feet of whinstone, got down into Coal-measures, and finally reached the Main coal.

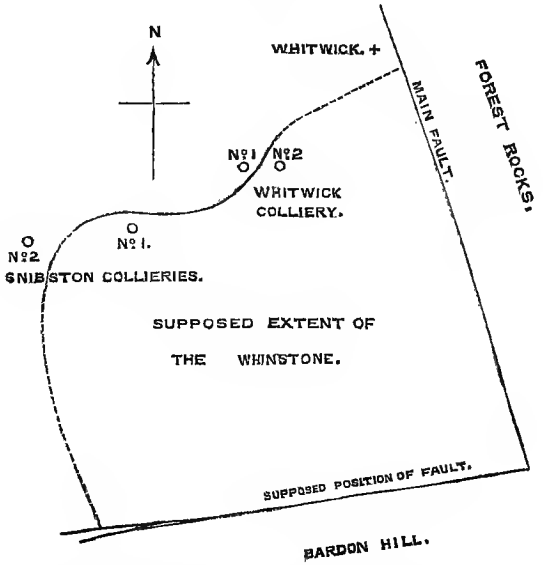
The position of this bed of trap appears to be at the base of the New Red Sandstone,† and its northern boundary can be traced for some distance with considerable accuracy. In the Snibston

* *See* Murchison's Silurian System, Appendix D. 1, p. 729.

† *See* Horizontal Sections, sheets 46 and 48, and Vertical Sections, Sheet 19; also the ideal Section through Whitwick colliery, p. 45.

Section No. 1, the rock is 22 feet thick, while in No. 2 it does not occur. In Section No. 1 of Whitwick Colliery it is absent, and is 60 feet thick in No. 2. Hence the boundary must be between these shafts respectively, and very abrupt in the latter case. From the smaller thickness of the whinstone in the Snibston than in the Whitwick pits, we may conclude that it thins out towards the south-west. On the south it probably extends to Bardon Hill, and on the east to the Main fault, while on the west it has not extended as far as Ibstock colliery. On these data the accompanying plan has been drawn, representing the extension of the bed of Whinstone in every direction.

Fig. 12.



The shafts of the Whitwick and Snibston collieries being cased with brick, the rock cannot now be examined *in situ*, but specimens are preserved in a wall at Whitwick colliery. It appears to be a greenstone, in which the hornblende predominates over the felspar. The former component occurs in crystals of a dark green colour, and the latter, of a paler tint, is transfused amongst the crystals of hornblende. The whole rock is of a dark green colour, often approaching hornblendic rock in appearance, and is entirely distinct in mineral character, as it is in age, from the porphyries of Charnwood Forest. Mr. Stenson informed me that in the Whitwick shaft it was found resting on a seam of coal, which it had turned into cinders, while the New Red Sandstone, which overlaid it, was unaltered.

From these data it would appear that the Greenstone has been ejected at a period intermediate between the upheaval and denudation of the Coal-formation, and the deposition of the New Red Sandstone; nor can its origin be connected in point of time with

the outflow of the porphyritic rocks of Charnwood Forest, these being of a date as ancient as that of the slates with which they are associated.*

A boss of greenstone shows itself in an old quarry north of Bardon station. This rock is rather different from that just described, as the felspar has a pinkish tint. Whether it forms part of the Greenstone of Whitwick or of the porphyry of Bardon Hill cannot be ascertained.

CHAPTER XV.

Abortive Borings and Sinkings for Coal.

The following are some of the localities where unsuccessful experiments in search of coal have been made, and which it may be of use to chronicle:—

1. White Hollows, near Ticknall. Shaft sunk to the depth of 557 feet, through low unproductive measures. Five seams were found, the thickest being only 1 ft. 10 in.†
2. Warren Pool, near Stanton Harold. Boring 180 feet in depth, about forty years ago. The locality is on the upcast side of the boundary fault of the coal-field.
3. Between Breedon and Springwood Farm; in the hollow close to the road. In this case a shaft was sunk; depth unknown. The sides are said to have been sandy, and to have fallen in. The strata in this position are below the coal-beds.
4. Prestop Park, near Ashby. Two borings, 1850–1. No. 1, depth 288 feet, in which three beds of smut were pierced through, the thickest of which was but 6 inches. No. 2, depth 378, four coals found, the thickest being only 13 inches; the localities are in low unproductive measures.
5. Smisby. Position, a quarter of a mile south of Old Park. In the year 1855. Depth 395 feet. In measures below workable seams of coal.
6. Woodville. In a position now occupied by the pottery works at the north side of the village. Depth 200 yards. The upper half, 100 yards, was proved by a shaft; the lower, by a boring. This experiment was carried forward in a position on the upcast side of the great Boothorpe fault, and below the outcrop of the Rafferee and its accompanying coals. It is, however, of much value, as proving that these coal-seams are the lowest of any value which are to be found on the shallow side of the Boothorpe fault.

* Geology of Charnwood Forest, p. 21.

† The Section is in the possession of the Rev. W. H. Coleman.

CHAPTER XVI.

Salt Water in the Main Coal of Moira.

One of the most remarkable phenomena of the district is the occurrence of brine in the Moira Main coal. It is present in greatest quantity in the Bath pit, on the shallow side of the Hundred-yard fault, at a depth of 593 feet, and trickles from the Main coal whilst it is being excavated. The salt water appears to be confined exclusively to the Main coal, and to the shallow side of the Main fault, as there is no water in the Hastings and Grey colliery at a greater depth than 200 yards. These saline waters were analized by Dr. Ure, at the request of the late Mr. Mammatt, who furnishes us with the results in his "Geological Facts."

One imperial gallon contains—

	GRAINS.
Bromides of potassium and magnesium	8·0
Chloride of calcium	851·2
Chloride of magnesium	16·0
Iron—as a proto-chloride	trace
Chloride of sodium	3700·5
Total	4575·7

It is evident that the Main coal is not itself the source whence is primarily derived the saline water; it appears only to be a channel or temporary resorvoir for the fluid, for otherwise it ought to occur as plentifully on the deep as on the shallow side of the Main fault. Mr. Edward Green called my attention to the fact that brine rises to the surface in a field situated on Coal-measures north of Donnisthorpe, and was formerly much resorted to by the inhabitants for medicinal purposes; and he suggested that the brine might find its way along the faults into the Main coal, filling the joints and fissures, and being retained by the clay of the floor. The supposition is supported by the fact, that both localities are at the same side of the fault, and also that the brine at Donnisthorpe is at a much higher level than in the Bath pit, so that if there existed a channel by which to percolate down to the Main coal, the brine would take that course. This theory appears to me more ingenious than probable; but having no better to offer in its place, I leave it to the judgment of the reader to adopt or reject.

The waters of the Bath pit are used at the Moira and Ashby baths, and are considered highly beneficial in scorbutic and rheumatic affections.

CHAPTER XVII.

Post-Pliocene or Drift.

The most recent formation in this part of Leicestershire is the Post-pliocene, or Drift. This consists of a series of sands, gravels,

and clays. Mr. Coleman considers that it belongs to three periods, or at any rate has had three sources, part having come from the north, part from the east, and the most recent from the Forest of Charnwood. The first of these contains granitic fragments, the second chalk and chalk-flints, and the last is composed of the slates, porphyries, and trap rocks of the Forest west of Coleorton. Channels have been scooped out in the district occupied by the Keuper, and filled in with gravel belonging to the Drift period. These channels are of considerable size, upwards of 10 yards in depth, and are very well shown in the railway cuttings. Their direction is north and south nearly, and the strata on both sides are not disturbed.

CHAPTER XVIII.

General Conclusions.

We have now passed in review a series of rocks belonging to four great systems, viz. :— the Cambrian, the Carboniferous, the Permian, and the Triassic. Let us now examine briefly some of the changes which have accompanied their formation, and the relationship which they hold with reference to one another.

The ancient slates and porphyries of Charnwood Forest must formerly have arisen, either as an island or sunken reef, from the bed of the sea in which the Lower Carboniferous rocks were deposited. We are not to forget that these hills were, in all probability, of much greater horizontal extent and *actual* elevation than at present. They form the foundation for the Carboniferous rocks for miles beyond their present superficial area, and the subsequent denudations or marine actions to which they have been exposed have doubtless lessened their former altitude.

The highest beds of the Mountain Limestone appear to have been deposited around the flanks of these rocks to a height of about 200 feet below their *present* summits, and as deposition progressed, the whole mass of these Cambrian rocks must have become entirely concealed by the Coal-measures. At the close of the Carboniferous period, the present rugged district of Charnwood Forest presented a comparatively level sea-bottom of Coal-measures, the slates and porphyries being buried at a depth of 3,000 feet below their present position.

At the close of this period subterranean disturbances came into action on a grand scale, not only in our district, but over Europe. It was then that the Charnwood Forest rocks were upheaved, along a line of fracture now forming the boundary-fault of the coal-field, the line of elevation, which is parallel to this fault, passing some distance eastward, and producing an anticlinal axis through the centre of the ancient slate rocks. At this period, also, were produced the Boothorpe and Moira Main faults, together with the majority of those which traverse the coal-field.

During or shortly after these disturbances, which were causing great irregularities in the bed of the sea, this last-named agent

was not inactive in the production of effects directly antagonistic. Like the two moral forces of human society, the one tending to disproportionate, the other to equalize the relationship between man and man, the plutonic and aqueous agencies were here opposed to each other. As is the case in society, the result was a compromise. The leveling forces, indeed, swept away incalculable masses from the higher eminences, but minor inequalities remained. The old slates and porphyries still preserved their time-honoured pre-eminence above the newer Carboniferous rocks, thus illustrating the geological paradox that the oldest and lowest strata compose the loftiest elevations.

The deposition of the Permian rocks now ensued, of which only a few traces occur in our district. It is quite possible, however, that Permian beds, together with portions of the Coal-measures, may have been swept away before the commencement of the formation of the Trias. However this may have been, there can be no question but that a new series of disturbances, accompanied by denudation, ensued, terminating the Permian, and introducing the Triassic periods. This is proved by the fact that throughout England the beds of the Permian and of the New Red Sandstone are unconformable.

At the commencement of the deposition of the Triassic group the surface of the rocks, whether above or under the sea, appears to have been very irregular. The mountainous districts of our island were partially unsubmerged, together with many minor eminences of central England, amongst which we may probably include the limestone hills of Breedon, and the slates and porphyries of Charnwood Forest. But what is most remarkable is this, that these physical conditions had been in existence for a considerable, perhaps a very long period, before any deposition of strata of Triassic age had commenced in *the central districts.* As has already been remarked, the lowest subdivisions of the New Red Sandstone are only sparingly represented in Leicestershire. At the commencement of the Keuper period shallow sea and intertidal conditions prevailed, until the Red Marl began to be deposited over a deepening sea-bed.

The glacial epoch has left its monuments in the large blocks of travelled boulders which lie scattered around the borders of the Leicestershire coal-field, and the skirts of Charnwood forest. To the same eventful geologic period are referable the ever varying sheets of sand, clay and gravel, which rest indiscriminately on all the older formations. They tell us of a time when the ocean overspread the plains of Britain, in which fleets of icebergs sailed southwards, carrying freights of rock, stones and mud from the northern islands which remained unsubmerged, and as they melted scattering these materials over the ocean's bed.

GLOSSARY

OF

TERMS USED IN THIS MEMOIR.

Basset - -	Synonymous with "outcrop." The end of the coal or other stratum, where it reaches the surface.
Bass or Bat -	Dark bituminous shale, approaching earthy coal.
Cank -	Hard, nodular, siliceous ironstone.
Clot or Clod-Bind	Clays in various states.
Clunch - -	Clay or fire-clay, often under a coal-seam.
Dice - -	The layers in a coal-seam, of a glossy, bituminous nature, breaking into cubical pieces or "dice."
Floor - -	The bottom of a coal-seam, where it is in contact with its under-clay.
Freestone -	Generally white, fine-grained sandstone, suitable for building purposes.
Gobbins - -	The hollow portions of a coal-mine adjoining the headings from which coal has been extracted.
Mingy - -	Soft or brittle.
"On the Deep"	The direction towards which a stratum dips.
"On the Crop"	The converse of the above expression.
Outcrop or Crop	*See* "Basset."
Saggers - -	Earthen pans, into which china-ware is placed for "baking" in the furnace.
Skerry - -	Evidently of Celtic origin (*carrig*, a rock, Hybernicè), a name applied in Derbyshire to the thin layers of sandstone interstratified with the red marls of the Keuper series.
Slack - -	Small refuse coal.
Slum -	Soft clay or fire-clay.
Smut -	Black carbonaceous matter, into which a coal-seam decomposes at its out-crop.
Spire-Spiry -	The bands of slaty carbonaceous matter which alternate with the bituminous layers in a coal-seam.
Sulphur - -	In coal-districts used for iron-pyrites as it occurs in coal, &c.
Tow - - -	Soft fireclay occurring on the roof of the Main coal of Moira.
Whinstone -	Properly basalt; but sometimes incorrectly used in mining records for very hard sandstone or chert.

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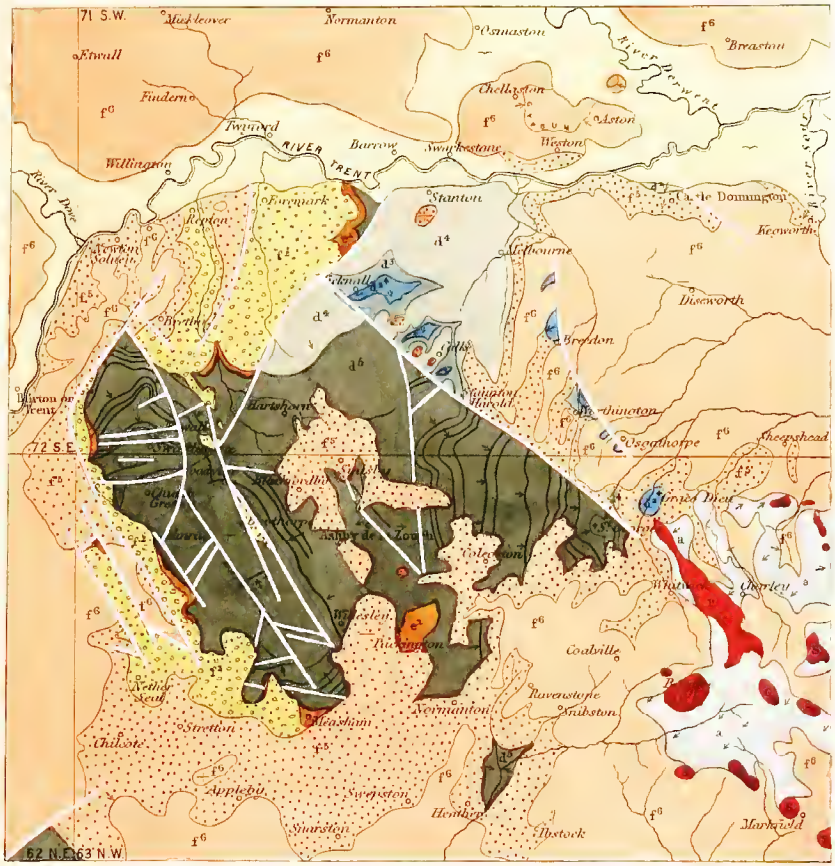
of the

LEICESTERSHIRE COAL-FIELD

by Edward Hull, B.A., F.G.S.



Alluvium

Red Marls

Waterstones
Lower Keuper Sandstone

Conglomerate
Bunter

Keuper

New Red Sandstone.

Permian Rocks.

Coal-measures

Millstone Grit.

Limestone Shale.

Carboniferous Limestone.

Cambrian Rocks.

Porphyry
(of Cambrian Age.)

Greenstone & Syenite.

Coal Crops.

Lines of Fault

Dip of Strata
Horizontal

Chains 20 0 20 40 1 2 3 4 5 6 7 8 9 10 Miles

Scale of 1 Inch to 4 Miles.

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