
Chapter 24 Millstone Grit and Coal Measures

Introductory

Resting upon the highest beds of the Carboniferous Limestone is a well-defined sandstone, which may be called 'The Millstone Grit', and that is followed by a small but interesting tract of productive Coal Measures, which is, with the exception of that of Pembrokeshire, the most westerly coal-field in England and Wales.

None of these beds are reached in the section exposed along the eastern coast, for the Limestone there comes against the Berw faults. They are found only in the deep hollow of the Malldraeth Marsh, along which they extend for some seven miles and a half, the length of the coal-field itself being just six miles. Dipping off the rapidly thinning limestone, they plunge at angles of 20° to 30° against the Berw faults, and, thus let down far beneath the level of the platform of erosion, this little outlying basin of the Coal Measures has been preserved from destructive denudation (Figure 302).

The Millstone Grit is well exposed, but the Coal Measures lie almost entirely beneath the marine alluvium of the valley, beneath even glacial drifts that underlie that, not to speak of the Red Rocks that cover much of their outcrop; so that our knowledge of them is derived from shafts, borings, and other mining records. Where the succession is most complete, it appears to be as follows:

	Feet
COAL MEASURES	
Sandstone and shale, with coals and ironstones	1,105
MILLSTONE GRIT	
Sandstone, with thin shale, coal, and ironstone	402
	1,507

Details will be found in Chapter 35

There is some reason (p. 619) to suspect some degree of unconformity between this series and the Limestone, as well as within the Coal Measures.

The Millstone Grit

This is well seen on the Bodorgan shores, in the railway cutting east of the tunnels, at Fferam and Paradwys, with poorer exposures at Felin-bach and Tregarnedd, while a pebbly sandstone at the group of trees in front of Hirdrefaig House is probably an outlier. On the slopes below Hirdrefaig the lines are conjectural.

Petrology

The rock is remarkably uniform, and is a thick-bedded, rather coarse and rather soft sandstone, generally brown, but white where fresh ([E6063](#)) [SH 433 717]. Current-bedding is general, but pebbles very rare, except at Bodorgan, where there is a coarse conglomerate at the base. Fissile micaceous partings occur here and there, and even in the massive beds there is a distinct banding due to thin trains of dark matter. The quartz grains are in general well rounded, but occasionally show facets due to secondary growth. Large flakes of white mica are not uncommon, and there is a little feldspar, which is albite. Heavy minerals are rare, but iron-ores, rutile, and zircon occur. The rutile shows no sign of attrition, its prism and pyramid edges being straight and sharp.

By far the most interesting part of the rock, however, is its matrix ([E7457](#)) [SW 688 189], ([E10567](#)) [SH 425 710], ([E11397](#)) [SH 399 682]. The interspaces between the quartz are filled, not with the amorphous muddy matter usual in rocks of this kind; but with a snow-white, glistening, powdery substance that looks crystalline even under the hand lens, and is seen, under the microscope, to be composed of beautifully formed hexagonal plates. They are so thin that their optical reactions are feeble, but they have a refractive index near to the lower index of quartz, feeble bi-refringence, the

crystalline form and habit of *Kaolinite*, and are bi-axial. The mineral was identified by Dr. Flett and Mr. Dick. The plates are smaller than those from Pant-y-gaseg Mine (see p. 571), and the mode of occurrence is, of course, quite different from that. At Pant-y-gaseg it is found in a veinstone; here it is a true rock-forming mineral. The importance of kaolinite as a rock-forming mineral is probably considerable. Mr. Dick has drawn my attention to a case recorded in his paper of 1908, and writes me that he has since found it in other Carboniferous Sandstones. As it occurs, not in the form of pseudomorphs after felspar crystals or grains, but interstitially throughout the entire body of the rock, it would appear to be due to recrystallisation of a matrix of aluminous mud. No reason, however, can at present be given for so remarkable an alteration in a rock that cannot properly be called a metamorphic rock, which contains, it may be noted, fragments of albite that retain their optical characters. The kaolinite is abundant; it can hardly amount to less than a quarter of the whole bulk, perhaps even more than that.

A grey shale, about 30 feet thick, is seen on the railway and at Bodorgan, and in it, at Bodorgan, is a thin siderite-ironstone ([E10566](#)) [SH 389 672]. The percentage of iron in pure theoretical siderite (FeCO_3) is 48.20, and a thin ironstone pierced by an adjacent boring (Chapter 35), which may be the same bed, yielded 40 per cent. 'iron'. There is also a seam of coal in the formation.

Nature of the Base

Except a few small pebbles at Tregarnedd, nothing occurs to break the uniformity of the sandstone until Bodorgan is reached, where there are two coast sections of great importance. On the shore south-east of Bodorgan house, the usual brown or yellow sandstone is underlain in a low cliff by five or six feet of strong conglomerate, with pebbles as much as a foot long. These are of local members of the Mona Complex, chiefly Gwna Green-schist and schistose grit, with quartzite, venous quartz, and jasper. Those of the schist are thin and broad, as they are in the Ordovician conglomerates. At the cliff's foot this conglomerate rests directly on similar schists, with calcareous and basic bands, which form the foreshore, dipping at high angles. Tongues of the conglomerate also extend out from the cliff on to the foreshore, and even where the schists are practically bare, large boulders of them still rest on, and adhere, to, the old Sub-Carboniferous surface.

A little north-east of this, and due east of Bodorgan house, is an inlier, faulted on its western side, - of the same schists. But on its eastern side a still more remarkable unconformable junction is exposed in the sea-cliff (Figure 303) about 10 feet high. Conglomerates and pebbly sandstones rest upon a ledge and against a small crag of nearly vertical schists.

There is no fault, the conglomerate adheres to the vertical junction without the least crushing, and the upper beds pass unbroken over the brow of this ancient cliff. In one place the old cliff undercut, overhanging as much as four inches, and pebbly sandstone can be seen still remaining in its little sheltered crannies. In fact, we are able to see here a ledge or shelf of the old Carboniferous coast line, just like the ledges of our Pleistocene and modern beaches. The pebbles are chiefly of local schist and schistose grit, with some, in the higher beds, of jasper. Close to the base they are very angular, and reach two feet in length. Above these basal beds come some red pebbly sandstones, then brown and grey-sandstones of the usual type, containing casts of *Sigillaria* three or four inches in diameter. In these are tawny-coloured shales, with pebbles, and some hard fine sandstone of the well-known 'Gannister' type; at the top of the group being the grey shale alluded to, and about six inches of the ironstone, rather nodular, and full of septarially arranged veins of calcite.

That these conglomerates are really at the base of the Millstone Grit, and not at that of the Carboniferous Limestone, is clear from an inspection of the map. The limestone dies out by overlap half-a-mile to the north, and on both sides of the inlier the conglomerates pass at once under typical kaolinite sandstones, those on the eastern side being the bottom beds of the main mass of the Malldraeth Shore section, and containing *Sigillaria*.

Palaeontology

What now is the true horizon of this Millstone Grit? Well, about 200 feet above its base there occurs the lowest coal in the district, known as the Glantraeth coal. It is from two to three feet thick, and was worked in a series of 11 pits along the western shore of the marsh, from the railway as far as Pen-crug-bach. Ramsay places this coal in the middle of the deposit, saying that it is probable that about 200 feet of sandstone above it belong to the 'Millstone Grit', his reason

presumably being that the same type of sandstone continues upwards for that distance.

Now a number of old spoil-banks remain about the sites of these old shafts, and from nine of them, in the year 1902, the following fossils, preserved in black and bluish grey shale,. were collected.<ref>The fossil-lists in this cliapter are founded on 394 specimens collected by the present writer, and on plants lent by Mr. Prichard. The plants were named by Dr. Kidston, the molluscs by Dr. Wheelton Hind, and the fish by Mr. E. T. Newton.</ref> [E.G. 235–349]:

Stigmaria ficoides (*Sternb.*)

Plant fragments

Lingula mytiloides *J. Sow.*

Posidoniella laevis (*Brown*)

Posidoniella sp.

Pterinopecten papyraceus (*J. de C. Sow.*)

Dimorphoceras gilbertsoni? (*Phill.*)

Gastrioceras listeri (*Martin*)

Gastrioceras coronatum? (*Foord & Crick*)

Glyphioceras?

Goniatites

Acanthodes sp.

Fish-spine and fragments

Posidoniella laevis and *Pterinopecten papyraceus* are quite abundant, and Dr. Hind remarks that the manner' in which *P. papyraceus* occurs, and its accompanying fauna, indicate the horizon of the 'Bullion Mine ' of Lancashire. It is clear therefore that the Glantraeth coal and its shale are on the 'Bullion Mine' horizon, that they carry with them the 400 feet of massive sandstone in the midst of which they lie, and that therefore this sandstone must be regarded not as a separate subdivision, but as an integral part' of the lower zone of the Coal Measures.

The Coal Measures

Petrology

Only one, insignificant, exposure is known; by the riverside below Nant, where a few feet of white sandstone can be seen. Almost the whole of the outcrop is beneath the marine alluvium of the great marsh. On the old spoil-banks from Nant to Berw, and at Morfa-mawr, a good deal of material remains. Most of the sandstone brought up was evidently used for building; it seems to have been light grey or white, and rather fine. Smooth black shale is plentiful, with some that is micaceous and grey. Blocks of coal are also there, well-bedded, smooth, and lustrous.

From the shaft and boring-records it is evident that the formation consists for the most part of grey and white sandstone, black and grey shale. Red and yellow sandstone do not appear to occur in large quantity. Underclays, fire-clays, and oil-shales are recorded, one of the latter being given as 27 feet thick. Ironstones are rather frequent, usually an inch or two in thickness, and seldom, apparently, exceeding six inches. The coals vary from mere films to six feet, a 7-foot 6-inch seam being split by two partings. Some is described as cannel. Seams of 'Glo pux', coal in 'lumps', are mentioned, one of them being nine feet thick. Thirteen coals, possibly fifteen, are known. The various types appear usually to be in rather

rapid alternations, but some thick beds of grey sandstone and dark shale are described.

The following boring record is reproduced here, as it appears to convey a picture of the general character -of the formation. It is at a spot 1,000 yards east of Pen-y-bont, between the main line of railway and the sea. A summary is given first, and then the detail of the Coal Measures, which are probably about the middle part of the series. The measurements are in depth, not thickness.

	Feet	Inches
Drift and Alluvium	110	0
Red Measures (horizontal)	339	6
Coal Measures (dipping first at 8°, and then at 15°)	317	6
	767	0

Detail of the Coal Measures.

	Feet	Inches
Brown Shale	7	6
Black Shale	4	0
Dark Shale	3	0
Jet Black Shale	5	0
Black Shale, bands of cannel	8	9
Underclay	0	9
Light Shale	4	6
Black Shale (6 inches), Underclay (1 foot 0 inches)	1	6
Light Shale	8	6
Sandstone	2	0
Light Shale	8	8
Ironstone band	1	2
Light Shale	11	2
Ditto with Ironstone bands	4	0
Light Shale	6	0
Dark Shale	5	0
Black Shales with 2 thin bands of Ironstone	18	6
Soft Clay Shale	1	0
Dark Shale	4	0
White Sandstone (1 foot 6 inches), Black Shale (2 feet 0 inches)	3	6
White Sandstone	3	0
Greyish Sandstone	8	6
Dark Shale	.3	0
Grey Sandstone	4	6
Dark Shale	41	0
Light Shale	5	0
Shale and Sandstone	12	0
Grey Sandstone	22	0
Dark and Black Shales	10	6
Grey Sandstone'	16	6
Dark Shales.	14	0
Grey Sandstone	7	0
Dark Shales	17	6

Light Shales	16	6
Dark Shales	3	0
Black Shale (3 inches), Underclay (1 foot 6 inches)	1	9
White Sandstone	3	0
Grey Sandstone	5	4
Black Shales	4	5
Very Black Shales	5	6
Coal	2	3
Underclay	2	9
White Sandstone		Base not seen

Palaeontology

Fossils have now been obtained from two principal horizons, viz. (in 1902) from the old spoil-banks of Morfa-mawr in the middle of the marsh; and from those of the old mines near Holland Arms that range north-east and south-west for about a mile and a half.

Only a few plants were obtained from the spoil-banks, but a collection made about the year 1861 by the late Mr. Henry Webster from the Berw mines, and now in the possession of Mr. Thomas Prichard, of Llwydiarth Esgob, has, through his kindness, been examined by Dr. Kidston.

At Morfa-mawr the following forms were found [E.G. 155–234]:

Lepidodendron lycopodioides (*Sternb.*)

Carbonicola nucularis? *Hind*

Carbonicola obtusa? *Hind*

Carbonicola robusta (*J. de C. Sow.*)

Carbonicola sp. [cf. *turgida* Brown]

Acanthodes sp.

Megalichthys sp. [scales.]

Palaeoniscus sp.

Rhizodopsis?

Carbonicola robusta is present in abundance, and some of the shells are very thick. Dr. Hind therefore refers the beds mined at this place to an horizon about that of the Arley Mine group. He adds: 'The somewhat doubtful specimen of *C. turgida* points to a rather higher horizon, that of the Moss Coal of North Staffordshire, and the crushed forms referred to *C. obtusa* and *C. nucularis* to an intermediate horizon, the latter being found in North Staffordshire only at the horizon of the Hard Mine coal, although I have noted it above the Mountain Mine of Wigan'. With regard to these points it may be remarked that there is now no means of ascertaining from what levels in the workings the respective fossils came, so that it is quite possible that the subsidiary horizons suggested may really exist just above the main Arley Mine horizon about which there can be now no doubt.

These beds of Morfa-mawr must be approximately 800 feet above the top of the Millstone Grit, and as they are considerably below the beds worked at Berw, they are in a general way about the middle of the series. Little is known about the beds below and above them, for some distance, but near the north-east end of the coal-field the following few forms were found at two small spoil-banks which may lie from beds not far from the same horizon W.N.W. of Nant at

south end of Hirdrefaig South Lane; and footbridges adjacent [E.G. 1–10], plant fragments, lamellibranch fragments, and *Coelacanthas*?

We now come to the beds worked at Holland Arms and Berw. Seven spoil-banks between the sixteenth milepost on the main road and the 'f' of 'Esgeifiog' have yielded the following [E.G. 16–54, 350–394]:

Sphenopteris sp.

Calamites?

Calamocladus sp.

Acanthodes sp. [spines]

Coelacanthus elegans? *Newt.*

Coelacanthus lepturus? *Ag.*

Coelacanthus [spines and scales]

Cryphiolepis?

Elonichthys? [scale]

Palaeoniscid scales and fragments

Rhizodopsis sp. [scales]

Strepsodus? [scales]

which are likely to have come from the lower part of the series that has been worked at Berw. So also may some Palaeoniscid scales [E.G. 11–15] obtained on a spoil-bank at the west end of the Berw pools.

The plants collected from the Berw mines ('Colliery Disused' and (Figure 343)) by the late Mr. Webster 'are certainly from the highest horizon that has yet been explored in this coal-field, though no record has been found of the precise band or bands from which they were obtained.

Dr. Kidston's list, founded on Mr. Prichard's collection of 53 specimens, is as follows:

Alethopteris decurrens (*Artis*)

Alethopteris devreuxi (*Brongn.*)

Mariopteris muricata (*Schloth.*)

Mariopteris *forma* nervosa *L. & H*

Neuropteris flexuosa *Sternb.*

Neuropteris impar (*Weiss.*)

Neuropteris scheuchzeri *Hoffm.*

Neuropteris sp.

Sphenopteris latifolia *Brongn.*

Sphenopteris obtusiloba Brongn.

Calamites ramosus Artis

Calamites suckowi Brongn.

Calamites sp.

Calamocladus charaeformis (Sternb.)

Calamocladus equisetiformis (Sehloth.)

Annularia radiata Brongn.

Sphenophyllum cuneifolium Sierra).

Sphenophyllum sp. [cone]

Lepidodendron lycopodioides Sternb.

Lepidophloios acerosus (L. d H.)

Lepidophloios laricinus Sternb.

Lepidophyllum intermedium (L. & H.)

Lepidostrobus sp.

Sigillaria mammillaris Brongn.

Sigillaria tessellata Brown.

Stigmaria ficoides Brongn.

Pinnularia columnaris (Artis)

The Berw beds are therefore referred by him to the Westphalian division of the series; and he adds that they may be correlated with the coal-bearing beds of Denbighshire and Flintshire. Whether any still higher zones exist in this coal-field can only be settled by exploration. They may, however, have been removed by denudation before the deposition of the overlying Red Measures.

Summary and correlation

Summing up what is at present known concerning the Upper Carboniferous rocks of Anglesey, they may be described as a series of variable sandstones and shales, with 14 known seams of coal, the whole reaching a thickness of about 1,500 feet. There is a Millstone Grit about 400 feet thick, much kaolinised, and this, overlapping the highest beds of the Limestone towards the west, comes to rest directly upon the ancient floor of the Mona Complex, where it develops a very coarse local conglomerate that is, in places, banked up against a shelf of the ancient coast-line.

Fossils, consisting of brachiopods, marine and fresh water molluscs, fish, and plants, have been obtained from three principal horizons, and justify a subdivision as follows:

3. Berw beds.

2. Morfa-mawr beds.

1. Millstone Grit.

Of these (1) corresponds to the Bullion Mine, and (2) to the Arley Mine group of Dr. Hind, while (3) are referred to the Westphalian division of Dr. Kidston. Correlating and comparing them according to the several nomenclatures now in use, they can, it would seem, be tabulated as follows:

COMPLETE COAL MEASURE SERIES			ANGLESEY
Upper Coal Measures	Radstockian Series	—	—
Transition Series	Staffordian Series	—	—
Middle Coal Measures	Westphalian Series	—	Berw beds
Lower Coal Measures with Millstone Grit	Lanarkian Series	Arley Mine beds/Bullion Mine beds	Morfa-wawr beds/Millstone Grit

From the fossil-lists, and from this table, it is therefore. evident that in this little broken outlying basin occurs the alternation of marine and plant-bearing beds that are now recognised over most of southern Britain, with. definite fossil zones, and that the series therein preserved represents the lower two-thirds of the complete succession of the British Coal Measures<ref>Local details of the Coal Measures will be found in Chapter 35.</ref>.



(Figure 302) section across the Anglesey coalfield from Lledwigan to Berw. Scale eight inches = one mile. M = Penmynydd Schists, Mona Complex MS = Tyfry Beds Mona Complex d2■ = Carboniferous Limestone. dp = Posidonomya Cherts. d4 = Millstone Grit d5 = Coal Measures. 1, 2, 3, 4, 5, 6, 7 = Coal Seams. d6 = Red Measures.

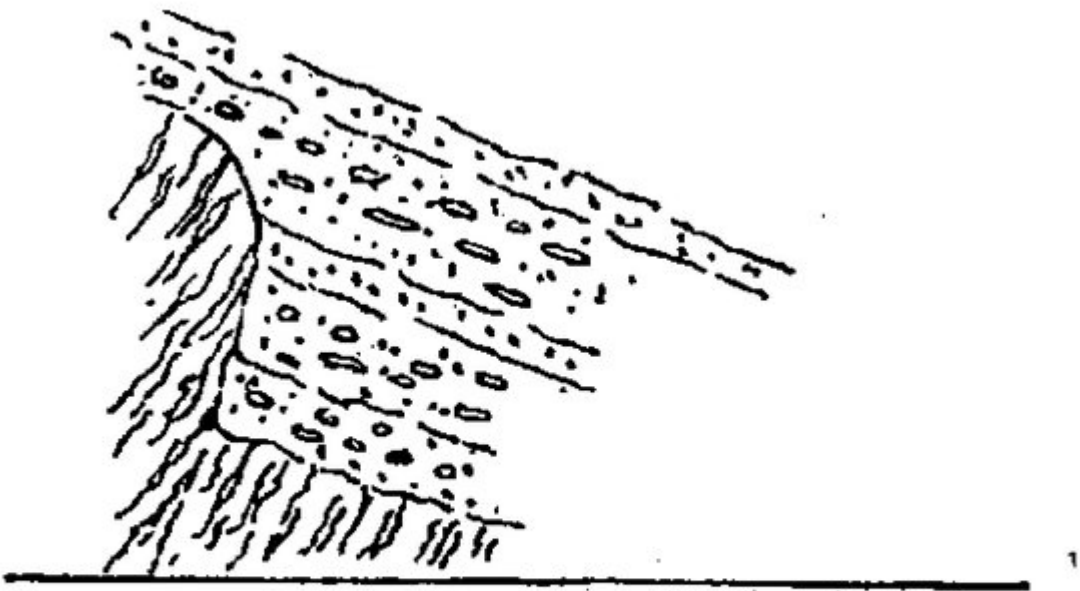


FIG. 303.—BASE OF MILLSTONE GRIT AT BODORGAN.

(Figure 303) Base of Millsone Grit at Bodorgan. Height of old cliff about 10 feet.

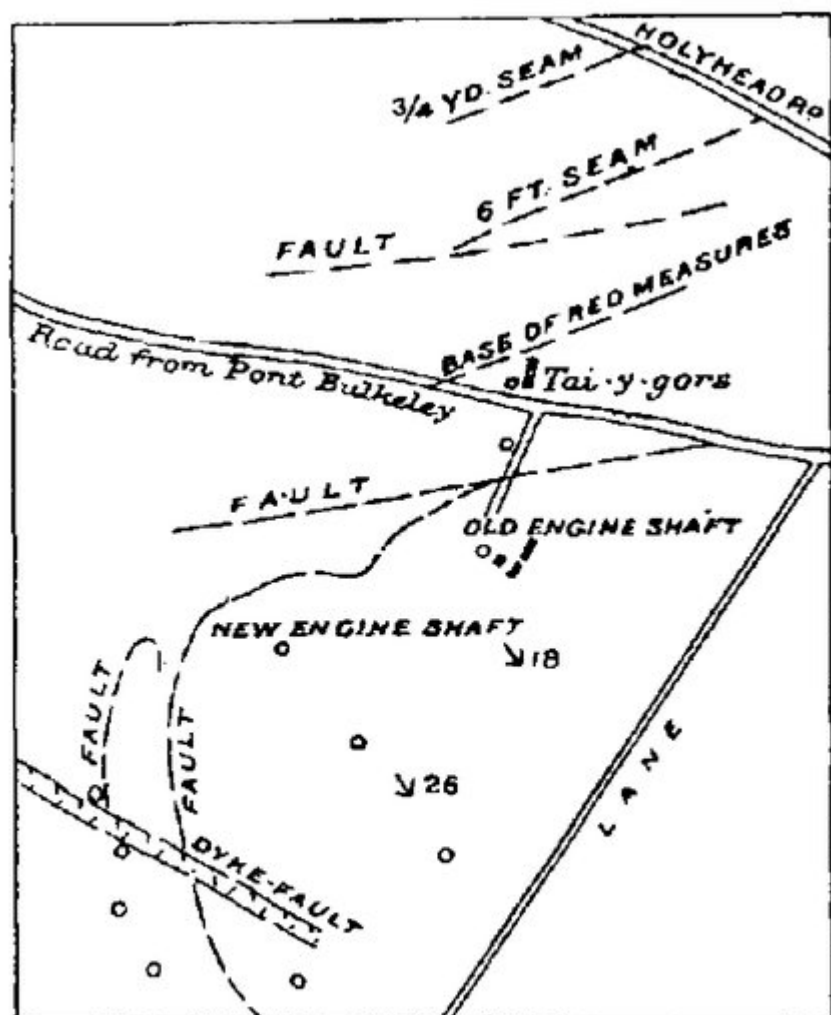


FIG. 343.

THE COAL MEASURES AT BERW.

(Figure 343) The Coal Measures at Berw. Scale: four inches = one mile.