east of the l of "signal" on the Map), and the bottom of the cliff is in the division No. 5.

The dip lessens, and soon the beds are flat. There are springs at the foot of the cliff, thrown out by the marly bed in No. 5; and No. 4 ends off at the top of the cliff about half a mile southward of Holywell.

From Holywell there is a slight south-westerly dip, so that the lower beds again rise; and as the level of the ground falls north-eastward No. 5 ends off about a quarter of a mile before getting to the Martello Tower, and there is then nothing but the Chalk Marl (only 50 or 60 feet thick?) above the Upper Greensand. The former is hard at the bottom, and markedly bedded; the latter consists of green-grey and grey sandstone, coarsely bedded, with brown and green nodules in the top part, and is not very distinctly separated from the former.

Just beyond the Tower the Gault crops out: it is a light-grey sandy clay, calcareous at top, and drying hard; but only about six feet of it are shown.

On comparing this section with that of the Kentish cliffs, so well recorded by Mr. W. Phillips,¹ there seems to be a good deal of difference between the two chalk-coasts, as may be seen from the following Table, in which the divisions of the chalk in the two are correlated, as nearly as the evidence allows, though without certainty:—

<i>Kentish Coast.</i>		<i>Sussex Coast.</i>
Margate chalk, with few flints. ²		
Chalk, with many flints.	Chalk, with few organic remains...	1. Chalk, with flints.
	Chalk, with many organic remains (rough)	2. Chalk, with flints and nodular layers.
	Chalk, with few flints	? Absent.
Chalk, without flints.	Chalk with many organic remains (rough)	3. Chalk, without flints, but with nodular layers.
	Chalk, with few organic remains ...	4. Massive chalk, without flints.
	Absent, or included in the next below	5. Bedded chalk, without flints.
	Grey Chalk (or Chalk Marl)	6. Chalk Marl.

Possibly the highest division of the Kentish Chalk may be unrepresented in the Sussex section, and perhaps also the fifth division of the latter may be the equivalent of the upper part of the "Grey Chalk" of Mr. Phillips, which may include more than the "Chalk Marl."

III.—DENUDATION OF THE COALBROOK-DALE COAL-FIELD.

By DANIEL JONES, F.G.S.

(PLATE V.)

ALTHOUGH the Coalbrook-dale Coal-field has received a large share of the attention of geologists, the progress of mining operations reveals new facts from time to time, enabling us to explain away some of the difficulties which have beset earlier writers.

¹ Trans. Geol. Soc. ser. i. vol. v. p. 16.

² Not noticed by Phillips, as it does not occur on the coast he described. See Quart. Journ. Geol. Soc. vol. xxi. p. 395.

One of the principal features pointed out by Sir R. Murchison, Bart.,¹ and J. Prestwich, Esq., F.R.S.,² is the want of persistency in the strata and Coal-seams. In the references which I am about to make to the works of authors on this Coal-field, I am desirous of saying that I do not wish to recall opinions expressed some thirty or forty years since, with the object of showing that they were incorrect, but merely to lay before the reader the state of knowledge upon the subject previous to the true explanation of the nature of the Symon fault made by Mr. Marcus Scott,³ and by which alone I am able to offer the present interpretation of those difficulties which I have referred to.

When Mr. Prestwich gave his paper to the world in 1836, the true nature of the Symon fault had not been explained. It was to him, as to many others since he wrote, a very great puzzle, but now its explanation serves not only to elucidate the phenomena along the eastern boundary of the Coal-field, but also to account for the great difference between the strata of the northern and southern portions. It will be shown that the southern portion has been largely denuded, and subsequently laid over with Coal-measures of a younger age, and consequently that the Carboniferous deposits are not uniform or persistent. Thus the observation, "that from the care with which Mr. Anstice has had the sections of the pits at Madeley taken, they afford the most correct information of the number of strata and of the total thickness of the Coal-measures" in this Coal-field, is not supported. The details from which the following summaries have been deduced were in part supplied by that gentleman:—

	Depth.	No. of strata.
Madeley Meadow Pits	750 feet.	134 ⁴
„ Hills-lane	714 „	108

Now I would observe that the first of the older series of Coal-seams in the Meadow Pits is the Rider Coal (so called), which, however, is the same as the Double Coal of the other portions of the field; and I consider No. 67 of that section, described as "light rock full of pebbles, green, blue, and red hard," to be the point of division between the upper and lower, otherwise younger and older, series, or the line of abrasion of the older Coal-measures. If I am right, then there are only 65 strata which belong to the older Coal-measures in that section. The Hills-lane section shows no Big Flint Coal; and I consider No. 76, called "Bottom Coal Flint," is the first recognizable older stratum, and, consequently, there are only in that section 33 strata belonging to the lower Coal-measures. So that Madeley is not a locality in which the Coal-measures of the Coalbrook-dale Coal-field are at all well represented. We are given a

¹ Murchison's Silurian System, 1839, 4to. p. 86, etc.

² Prestwich, Trans. Geol. Soc. London, 1840, 2nd ser. vol. v. p. 413.

³ Quart. Journ. Geol. Society, 1861, vol. xvii. p. 457.

⁴ Prestwich on the Geology of Coalbrook-dale, Geol. Trans., vol. v.

table showing the number of strata passed through and their total thickness as follows :—

	Depth.	No. of strata.
Lightmoor.....	460 feet.	46
Dawley	450 "	58
Malinslee	560 "	51
Wombridge	540 "	70
New Hadley.....	440 "	57
Donington Wood	560 "	60

To which is added the following note—"The minuter sub-divisions in these sections not being generally given as they are at Madeley, will account for the disproportion between the thickness and number of the strata, and in one stratum at one pit may be included several of an adjoining pit." This may be the case; but I would observe that in the sections given a much larger proportion of older Coal-measures are met with than at Madeley, which measures generally have strata of greater thickness than the upper series. The Fungous Coal is the highest of the older Coal-seams in the district, and the Chance Pennystone the highest workable ironstone of the older strata. From the surface to the Chance Pennystone at New Hadley is 109 feet, about 80 feet of which is alluvium, and described as "wild red ground." At Hills-lane I consider that the whole of the strata from the Chance Pennystone to the Penny-measures proper have been removed by denudation, and the space has been since filled up with Coal-measure of the younger age, which consists of much thinner strata, and this accounts for the much greater number of strata in the southern portion. The geological horizon for these younger Coal-measures is of course above the Chance Pennystone. The persistency of the Clod Coal is remarked upon: this is due to the fact that being low in the series it escaped to a greater extent the denudation which overtook the higher strata. "If it were not for the Pennystone, Clod Coal, Best Coal, and one or two more beds, which serve as landmarks throughout the whole Coal-field," says Mr. Prestwich, "it would be difficult to recognize the connexion between the Donington district and the Malinslee, or between the Malinslee and the Madeley or the Broseley. The difference between the Amies and Donington sections is still more striking, and placed side by side they appear totally distinct." This is not surprising, seeing that at Amies only 79 feet of older Coal-measures exist, instead of about 384 feet, as at Donington. "It is singular to observe the great and rapid variations in the importance and lithological character of the larger portion of the strata composing these Coal-measures. One stratum will gradually disappear, whilst a thin one will rapidly acquire a thickness of several feet, and will again frequently wedge out." "The Chance Pennystone, which is 8 feet thick at Wombridge, is unknown at Malinslee." By reference to the map it will be seen that it has been denuded from the Malinslee district.

Mr. Prestwich points to the phenomena of the Symon fault in the neighbourhood of Malinslee, but it remained for Mr. Scott to point out that it was caused by the denudation of the older Coal-measures.

The same author was astonished to find that a Limestone (*Spirorbis* Limestone) was in the southern portion of the Coalfield only 170 feet above the base of the Coal-measures, and suggests as an explanation that about Broseley the formation was apparently littoral, and says, "the connexion of the strata between this locality and those where marine remains¹ occur is not clearly ascertained," for he had not been able distinctly to detect the band of limestone on the north side of the Severn. He further says, "Nevertheless, by tracing the prolongation of the bed by means of a few of the associated strata, its equivalents in other parts of the Coal-field may be approximated to. Accordingly, at New Hadley and Wombridge, the place which the freshwater stratum would hold, may be somewhere about that occupied by the marine deposit of Chance Pennystone." Now, connecting this with the observation about littoral deposits, I suppose he meant that a change of character, from freshwater to strictly marine, took place in the stratum as it passed from the shore, where rivers may have flowed in, to the deep sea, where only marine animals could exist. The *Spirorbis* Limestone is now known to be of marine origin; and, again, its geological position would be many yards above the Chance Pennystone. At Hemans Pit this Limestone is 105 feet above the Pennystone, whereas at Lodgewood we have Chance Pennystone 283 feet above the Main Pennystone, the *Spirorbis* Limestone holding a still higher position than the Chance Pennystone. If Mr. Prestwich could rewrite his most valuable paper—the text-book of all students of the geology of that district—with such corrections and additions as the evidence gleaned since he wrote would make desirable, it would confer a great benefit upon those who take his paper of 1836 as their guide. Indeed, it is the standard work on the subject, and should be corrected and brought down to the present time.

At page 435 a table is given of the thickness of Coal contained in the ground, and showing the number of beds into which it is divided, with this remark—"In these localities the productive Coal-measures are fully developed, and consequently the difference of total thickness does not arise from the cropping out at one place of beds which exist at another." Now it is this view which I hope in this paper to controvert, for I maintain that the upper strata have been entirely denuded from the southern portion of the Coal-field by the same denuding force as produced the Symon fault described by Mr. Marcus Scott (*Journal of the Geological Society*, 1861, vol. xvii., p. 457). Mr. Prestwich remarks, "The Ironstones thin out in their range southward in descending order; thus the Chance Pennystone first disappears, then the Blackstone, and others after; so that at Broseley we find only the Pennystone and the Crawstone, and to the south of Broseley the Crawstone by itself." The same remark holds good with the coals, and the reason why they are not observed to crop out is, that over the denuded older strata newer strata were laid, and covered up the denuded edges of the coal.

In the Silurian System of Sir R. Murchison we find the Hills-lane

¹ The limestone was at that time supposed to be of freshwater origin.

Section given as "an instructive example of the succession in one spot where the strata are pretty fully developed." This is not the case, as there are wanting "The Big Flint," "Yard Coal," "Double Coal," "Three Quarter Coal," "Top Coal," "Gur Coal," "Stone Coal," "Foot Coal," and "Fungous Coal," all of which have been denuded. Most of the other remarks on this question in "The Silurian System" appear to be derived from Mr. Prestwich's paper.

Now if we examine the various pit sections, commencing in the north and proceeding southwards, we shall find there has been a denudation of the older Coal-measures of precisely the same character as that shown to have taken place along the eastern boundary, and known as the Symon fault. For the purpose of showing my views upon a small map, and to avoid the confusion which would arise from having a vast number of lines drawn over the map, even if it were possible to get the exact data requisite to enable me to plot them, I have grouped the seams as they occur in a vertical position, distinguishing each group by a distinct kind of line, thus—

1. Chance Pennystone.	} See
Explanation
on Plate V.
Fungous and Gur Coal. }	
2. Top Coal to Yard Coal.	
3. Big Flint Coal, Pennystone, and Sulphur Coal.	
4. Best Randle Clod and Little Flint.	

At the end a list is given of sections grouped according to the seams which they contain. We may thus draw lines which will approximately show the margin or denuded edge of the vertical groups.

I have been at some trouble in ascertaining whether the denudation took place before or after the dislocations; because, if before, then my lines would be a nearer approximation to the condition of things; but if after, then the denuded edges would be thrown forward or receded according to the "down-throws" or "up-throws." Mr. Marcus Scott and Mr. Parton have given me data, from which it appears quite certain that the denudation took place long before the dislocations. The Calaminker (a mottled clay of the upper Coal-measures, lining the valley of denudation, called the "Symon fault") and Upper Strata, which were deposited after the denudation, are influenced by the dislocations, which must have occurred necessarily even still later.¹

I have before said, the highest workable stratum of what are called the lower or productive Coal-measures is the Chance Pennystone. We find it in the Donington Wood Colliery, and as far east as the Granville Pit. It is not found south of a line drawn from Ketley to a little south of Snedshill (*vide* Plate V.). Between Snedshill and Prior's Lee its boundary proceeds northwards, to join the stratum near Granville Pit. The Fungous Coal being about 50 feet below the Chance Pennystone, and consequently a little more protected from denudation, it ranges a little outside of the margin of

¹ In this I find my views at variance with those of Mr. Randall, expressed in his 13th letter to the *Mining Journal*, where he says, "The whole of the Coal-strata found in the Halesfield Pits of the Madeley Wood Company was saved from denudation by the mere fact of its having been let down by faults below the same strata which suffered from denudation in the neighbouring field of Storchley," etc.

the Chance Pennystone. Mr. Prestwich seemed to think that the reason why the Chance Pennystone was not known in the southern part of the Coal-field was that the nature of the stratum had changed in its extension southward. But this is not so, as both it and the Fungous Coal are entirely absent. Mr. Randall, who recently contributed a series of letters to the *Mining Journal* on the Shropshire Coal-field, speaking of the Chance Pennystone (*vide* Letter No. 7), says, "This ironstone, as the name implies, has always been found to be irregular and uncertain; it was confined to the *south* of the Coal-field, like the others already described in this article, and is now, we believe, entirely exhausted." The word "south" should have been "north," as Mr. Randall has explained to me.

From 60 to 80 feet below the Gtr Coal, we have the Top Coal, a seam having a much wider range to the south than any of those previously mentioned. We have it in the Granville Pit, which I may remark by the way is the only pit shaft in which a regular sequence from the lower Coal-measures into the upper is traceable, and is consequently the most typical of the original Coal-field; all the other shafts give evidence of subsequent change by denudation. The Top Coal is wanting in the Stafford Pit. As the Three Quarter Coal, lying a few feet below, is found in that shaft, the denuded edge of the Top Coal cannot be far to the west of the shaft. It then falls back to within a short distance east of the Puddley Hill Pit and Langley, then passing to the east as far as the new pit at Kemberton, it is there found to exhibit signs of denudation. Following an irregular line, somewhere between Madeley Court and the Meadow Pit at Madeley, it runs northward towards Great Dawley and east of Lawley, and is lost a little south of Ketley, against the western boundary fault. It does not occur in the Madeley Meadow Pit, and is not met with in any portion of the field to the south of that shaft. It will not be necessary to trace the boundary of the Three Quarter, Double, and Yard Coals; it is sufficient to say that they are cut off in succession by the same process of denudation one after another.

We will now trace out the denudation of another zone shown on the map (Plate V.), which will include approximately the Big Flint Coal, Pennystone, and Sulphur Coal. These strata are found as far south as Broseley. Their boundary passes a little north of Amies; it then passes eastward for some distance near Kemberton, and eventually northward in a line of the same character as that in the Top Coal, more or less parallel to it. The Clod Randle and Little Flint Coals behave in the same manner to the south, and eventually the base of the Coal-measures, Silurian Limestone, is met with, and there is an end of the productive Coal-measures. Coal-measures are met with still further south for many miles, but they are all upper Coal-measures, except at Harcott, where a patch of the older Coal-measures, like that at Shirlot, is met with beneath the younger formation. I believe I am the first to point this out; and I may go further by saying that I have established, to my own satisfaction at least, the co-relation between the patch at Harcott and those on the two Clee Hills; but this is not the place to enter into

this subject, except for the purpose of showing that the Coal-field of Coalbrook-dale once extended far to the south, but was afterwards cut away by denudation to its present limits.

Taking this view of the matter, we can now readily understand how it is that the *Spirorbis* Limestone of the upper Coal-measures is found in the south of the field at 170 feet above the base of the older Coal-measures. The greater part of those older strata have been washed away, and the younger Coal-measures, with the *Spirorbis* Limestone, have been subsequently deposited upon the remaining reduced thickness of the old strata. When therefore Mr. Prestwich gives the total thickness of the Coal-measures of this field at 750 feet, as shown in the Madeley Meadow Pit, it should be added that a middle slice of about 250 feet is wanting in that shaft. Thus it appears that the denudation did not affect the eastern boundary, only producing what is now known as the Symon fault of Mr. Marcus Scott; but it affected the whole of the southern part of the Coal-field from a line drawn between Ketley and Prior's Lee. The plan, with its lines of denudation shown at several vertical ranges, is only given to illustrate my view, and those lines must only be taken as approximate.

There is one more point to which I must advert. Mr. Randall says, in his ninth letter to the *Mining Journal*, "The valley of denudation, however, does not appear to have been filled up by these younger members of the Coal-measure series, hence the Permians come up and overlap the whole along an undulating line running north and south parallel with that of the Symon fault." And again, "It is remarkably instructive as regards the nature of this fault that just on the line where the Coal-seams terminate the Permians make their appearance, rapidly increasing in thickness as one after the other of the former disappear." (Letter ix.) The following section would represent what Mr. Randall means:—

FIG. 1. Valley of Denudation, according to Mr. Randall.

Now the fact is that the younger Coal-measures not only fill up the eroded valley, but overlap the older Coal-measures, and the Permian overlies the younger formation, thus—

FIG. 2. Actual Valley of Denudation Coal-Measures.

Coalbrookdale Coalfield, Showing the denudation of the Coal Measures.

Indeed, the younger Coal-measures not only fill up the vacuity and cover over portions of the older strata, but range over a large area to the south, as far as the Abberley Hills, in some places being not less than 1100 feet thick, as shown by the sinking at Shatterford.

I wish it to be clearly understood that the denudation to which I refer in this paper is that which took place previous to the deposit of the younger Coal-measures. This does not account for the exact condition of things in those parts of the Coal-field in which the younger Coal-measures are absent, as at the Hatch and Steeraway, where we find isolated patches of the lower coals. Several periods of after denudation may have caused this, and in the same way have reduced the patches at Cornbrook and Brown Clee from what they were as left by the denudation in question. It is probable that the Cornebrook, Clee Hill, and Shirlot districts stood above the level at which the younger coals are formed. We find no older Coal-measures underlying the Carboniferous patch, at Cleobury Mortimer, for instance, and thus the elevated strata have been exposed to all subsequent denudation, and would have given way to it had it not been for the capping of Trap which has protected it. Seeing that at Little Wenlock, No. 17, we have the Pennystone protected from this more recent denudation by faults, and it is certain that the faults came after the denudation of which this paper treats, I am inclined to think the Coal-measures extended much more to the west, and that the old line of erosion has been, with the Coal-measures, swept away by a much more recent washing; and it may be that some of the lines in my plan on the west side may be due to these later destructions.

A list of sections, in which the older series occurs from the horizon of the Chance Pennystone downwards.

(Those which are numbered are shown on the map, PLATE V.)

1. Lodgewood.	} Sections by Doody.	} Geological Survey,
Vertical Sections, No. 23.
2. Granville Pit.		
3. Donington Wood.		
4. New Hadley.		
5. Wombridge.		
6. Nelson Pit, Prior's Lee (from Stone Coal).	}	
7. Ketley. Prestwich, p. 446, "I am not aware of its existing further to the south than New Hadley and part of Ketley."		
Wombridge. Townson's Tracts. <i>Vide</i> Prestwich.		
8. Snedshill. Prestwich, p. 478.		
Edwards Piece, Hadley. Prestwich, p. 480.		
New Hadley. Prestwich, p. 481.		
Tub Engine Pit, Donington Wood. Prestwich, p. 483.		

The following range from the Top Coal, Double and Yard Coals, downwards:—

9. Lawley and Steeraway.	} Geological Survey,
Vertical Section, sheet 23.
Horsehays.	
Rickyard Pit, Prior's Lee.	
10. Lawn Pit, Malinslee.	
11. Puddley Hill.	
Portley Pit, Dawley.	
12. Deepfield Pit, Dawley.	
13. Madeley Court.	
14. Stafford Pit. Doody.	
15. Kemberton Pit. W. Ward.	

16. Halesfield. M. Scott.
Lightmoor Whinney Pit. Prestwich, p. 475.
17. Little Wenlock. Prestwich, p. 477.
New Works, New Lawley. Prestwich, p. 477.
18. Langley. (Double Coal.) Prestwich, p. 478.
19. Old Works at Dawley. Prestwich, p. 480.
Wombridge Pit, near the engine. Prestwich, p. 480.
Holywell Pits, Malinslee. Prestwich, p. 482.
Dawley Pit. Prestwich, p. 483.
Old Park Pits. Prestwich, p. 483.

The following pits range from the Lower Pennystone
or Big Flint Coal :—

Hills-lane.	} Vertical Section, sheet 23.
20. Broseley.	
21. Trial Pit, Castle Green. Prestwich, p. 475.	
22. Lodge Pit, Madeley. Prestwich, p. 477.	
Trial Pit, near Lilleshall, Old Hall. Prestwich, p. 479.	
Hemans Pitfield, near Broseley. Prestwich, p. 481.	
Yew Tree Pit, Calcut Field, Broseley. Prestwich, p. 481.	
23. Meadow Pits, Madeley. Prestwich, p. 485.	
Hills-Lane (with the local terms). Prestwich, p. 486.	

The following range from about the best coal and below :—

- Caughley. Vertical Section, sheet 23.
Limestone Pit, Lincoln's Hill. Prestwich, p. 480.
24. Amies Field, near Broseley. Prestwich, p. 478.
25. Inett. Prestwich, p. 478.

IV.—ALPHABETICAL CATALOGUE OF TYPE SPECIMENS OF FOSSIL FISHES IN THE BRITISH MUSEUM.¹

By WM. DAVIES,
Of the Department of Geology, British Museum.

THE fine series of Fossil Fishes in the National collection is exhibited in and constitutes the principal feature of Room II. in the Northern Geological Gallery. The arrangement adopted is in accordance with the classification of Prof. L. Agassiz, as indicated in his great work, "*Recherches sur les Poissons Fossiles*," but with such modifications as the subsequent investigations of ichthyologists have rendered necessary. These modifications occur chiefly among the fishes of the older formations.

Of the four divisions or Orders of Fossil Fishes,—viz., the Placoid, Ganoid, Ctenoid, and Cycloid—divisions founded upon the form or structure of their scales or dermal covering, the first (the Placoids) are arranged in table cases on the north side of the room, in cases in

¹ Having already published in the pages of this MAGAZINE, lists of the types of Fossil Fishes in two of the grandest private collections in this country, namely, that of Sir Philip de Malpas Grey Egerton, Bart., M.P., F.R.S. (see *GEOL. MAG.* 1869. Vol. VI pp. 408-413), and that of the Earl of Enniskillen, F.R.S. (see same volume, pp. 556-561), it seemed desirable to complete as far as possible these valuable synopses of Fossil Fishes by the publication of the types in the British Museum. I therefore requested Mr. W. Davies, who has for many years made careful notes of the typical and figured specimens of the Fossil Vertebrates in the collection, to do me the favour to draw up for this Journal the accompanying particulars of our grand National collection, which I feel sure cannot but be most acceptable to palæontologists.—H. W.