mud, with the organisms living in, and common to, a great river. In the latter case the vegetable growth is covered up by marine silt, sea-shells, etc.

One difficulty, however, not met by these illustrations, and requiring to be explained in order to clear up the origin of coal, is its *exceeding purity* and *freedom from admixture of foreign matter*; each coal-seam being, so to say, *completed* and then *sealed up*, so that its hydro-carbons should all be retained in the best possible condition for fuel. This could not have taken place in a mere Cypress-swamp or Mangrove-swamp, such as one sees in tropical America at the present day.

If, however, you picture a vast alluvial plain covered with a Cryptogamic forest of giant *Lepidodendra* and *Sigillaria* growing on a stiff tenacious clay-soil, capable of retaining the rain-fall, then you have the conditions suited for the rapid accumulation of peat, and that is the purest form we know of any great accumulation of vegetable matter *unmixed* with foreign material, which is the peculiar feature of the Coal-measures.

If any stronger argument than we have used against claiming for the Coal-period special and abnormal conditions were needed, it is to be found in the fact that we have Coal of Tertiary and Secondary ages as well as Primary or Palæozoic.

The Tertiary Brown Coal of Germany and Russia, the Bovey-Tracey Lignites, the Miocene Coal of the Mackenzie River, North America; the Kimmeridge Coal; the Brora Coal (Oolitic in age); and, indeed, judging by the plant-remains, there is good reason for believing the Coal of China to be of Secondary age; the accumulated growth of plants, such as Cycads, Taxineæ, Araucarians, Equisetaceæ and Ferns, corresponding in character with those found in the Oolitic plant-beds near Scarborough, Yorkshire.

Again, there is reason to believe that some coal may be of Devonian age, for Dr. Dawson has already made known a land-flora and fauna of Devonian times, agreeing somewhat with the plants which form the true coal.

Lastly, Lycopodiaceous seeds occur in the Upper Silurian, and lower still, we get Graphites, which may owe their origin (as the oil-bearing strata of pre-Carboniferous age no doubt did) to the destructive distillation of old Silurian Coal-beds, the products of old land-surfaces, distilled in Nature's own retort.¹

II.—REMARKS ON THE PROSPECTS OF COAL TO THE SOUTH OF THE MENDIPS.

By H. W. BRISTOW, F.R.S., F.G.S., and H. B. WOODWARD, F.G.S., of the Geological Survey of England.

THE question as to the probable existence of a Coal-field on the south side of the Mendips having lately been prominently brought before the public in the Report of the Royal Coal Com-

¹ Read also before the British Association, Edinburgh, Section C, August, 1871.

mission (vol. i.), it may not be uninteresting to offer a few remarks on the present aspect of the question.

But few new facts have been brought to light during the re-survey of the geology of the district.

Traces of Old Red Sandstone and Lower Limestone Shales were detected in a wooded hollow extending in a north-westerly direction from the entrance to the picturesque Mountain Limestone ravine to which the name of Ebber Rocks is given. These beds are brought in by a fault which throws the Old Red Sandstone against the Mountain Limestone on the western side. (See section.)

Higher up there is marshy ground, where a spring is given out; and on still higher ground above this, at the head of the ravine, we come suddenly upon Millstone Grit,¹ large boulders of which lie strewn about the surface. Crossing over the lane between Easton and Priddy, there is a dilapidated old building, where the Mountain Limestone is seen dipping at an angle of 35° S.W. A few yards to the south, hard close-grained quartzites, with small reddish-brown ferruginous specks, occur, overlying conformably the Mountain Limestone. Their extension in a westerly direction is concealed by the Dolomitic Conglomerate. These are, undoubtedly, the bottom beds of the Millstone Grit, and in places thin beds of hard grit and shale may be seen. A little east of the lane, near the bends, there is a shallow hole, apparently a trial-shaft, from which black Carbonaceous shales have been obtained, and which, no doubt, are beds belonging to the Millstone Grit. The working was evidently abandoned after a very short trial, when, probably, the Mountain Limestone was reached. To the east, at the head of the ravine, the Millstone Grit is cut off by a north and south fault, which brings in the before-mentioned Old Red Sandstone and shales; and a short distance down the ravine, we were astonished, when paying a visit to the spot in October, to find a shaft was being sunk, with steam winding machinery, in search of coal in the Lower Limestone Shales, which had evidently been passed through, inasmuch as the rock then brought to the surface was Old Red Sandstone. The fragments of Carbonaceous shale in the old trial-shaft had probably misled the prosecutors of the second undertaking to suppose that the Coal-measures were present, and that lower down, in a southerly direction, they would be likely to succeed in finding coal. (See Woodcut, p. 502.)

A more unpromising place for finding coal could scarcely have been selected anywhere in the neighbourhood, for the spot where the shaft was being sunk is closely surrounded on all sides by rocks of greater age than the Coal-measures; in fact, the little valley in which the works were being carried on may, in general terms, be described as two narrow strips of Lower Limestone Shale and Old Red Sandstone a few chains wide, and surrounded by higher ground composed of Mountain Limestone. The sinking of this shaft under such manifestly hopeless conditions shows a want of knowledge of the elements of geology and coal-mining that could scarcely be sup-

¹ Noticed by H. B. W., *GEOL. MAG.*, Vol. VIII., 1871, p. 152.

posed to exist at the present day on the part of persons likely to embark in a search for coal within five miles of a Cathedral City.¹

In addition to these new traces of Millstone Grit, Lower Limestone Shale, and Old Red Sandstone, another small mass of Millstone Grit, not previously noticed, has been detected east of Wells, near Dinder,² while between Cheddar and Draycot a trace of Old Red Sandstone has been mapped by Mr. J. H. Blake, F.G.S.

These new additions to the geology of the district have little bearing on the question of the occurrence of coal on the south side of the Mendips; the appearance of the Old Red Sandstone near Draycot seems to be due rather to local disturbance than to anything affecting the general anticlinal structure of this range of hills, upon which many years ago Professor Ramsay based his opinion as to the presence of coal in the district to the south of it.³

The abortive search for coal mentioned by Mr. Prestwich,⁴ as having been made at Witham Hole, about four miles south of Frome, in 1867 and 1868, is of an altogether different kind from the attempt at winning coal near Wells, for the borings were commenced in Secondary strata, far above the place occupied by the Coal-measures in the geological scale. This last boring was carried to a total depth of 600 feet without coming upon any sign of Coal-measures. There seems to be some confusion in the details of this as given by Mr. Prestwich. The strata comprised under the head of Cornbrash (?) in the printed section seem to be referable rather to the underlying Forest Marble, while the lower 36 feet assigned to the Oxford Clay might be placed with the Cornbrash. As regards the uppermost beds of the section, the footnote to the effect that "it is a question with some whether it is not Lias," is apparently an oversight; for the published maps of the Geological Survey prove beyond the possibility of a doubt that Oxford Clay, and not Lias, is the rock at the surface.

¹ When surveying Black Down (Mendip), Mr. J. H. Blake came across an old Shaft, with machinery and building, now abandoned, which had been sunk in the Lower Limestone Shales to a considerable depth in search of coal.—H. B. W.

² By H. B. W.

³ Mem. Geol. Survey, vol. i.

⁴ Report of Coal Commission, p. 163.

Another boring in search of coal has been made about three miles north of Langport, near High Ham ; but this also was given up after it had been carried down to the depth of 90 feet. Begun in the Rhætic beds, it was only carried a little way into the Keuper Marls, in which beds of Alabaster, 20 feet thick, are said to have been met with ; and it was probably the presence of the black paper-shales of the Rhætic series which led to this trial for coal.

An attempt to find coal was made in the Lower Lias at Badgworth, near Wedmore, but of this we have no details.

The most vigorous attempt, however, was that made at Compton Dundon, in 1815.¹ The lower beds of the Rhætic series were passed through, and the shaft was then sunk for nearly 600 feet in the Keuper beds.

These borings are of no value as regards any information they might be expected to afford as to the possible occurrence of coal under the Secondary rocks at the places where they were made. Probably they originated from some misapprehension of the depth of these rocks, or of their identity ; but in any case they should have been continued to much greater depths to have thrown any light on the question, as the Coal-measures could certainly not be expected to occur at a less depth than one thousand feet below the surface.²

It would seem to be highly probable that a coal-basin may set in south of the Mendip Hills, beneath the flat alluvial lands of Sedge-moor, and the course of the River Brue ; but how far it may extend in this direction, or to the east, it is very difficult to imagine, as there is no evidence to show. The prevailing dip of the Mountain Limestone along the southern flank of the Mendips is in a southerly direction ; we have noted the Millstone Grit to appear in two places. The probability, therefore, seems to be that in the rolling over of the Mendip range, the Palæozoic strata on its south side have been thrown into a great synclinal trough, and thus have been the means of preserving the Coal-measures from the enormous amount of denudation which, as Professor Ramsay has shown, the same rocks have been subjected to that formed the anticlinal ridges.³

At some future time, when the increased price makes it worth while, or the adjacent Coal-fields approach exhaustion, this district will not fail to attract the attention of enterprising persons interested in coal-mining. To prove the question trials might be made near Meare, Wedmore, Polsham and Pilton, which are all places favourably situated for the purpose, and where the Coal-measures might reasonably be expected at a depth of 1000 feet, estimating 100 feet for the Lower Lias and Rhætic beds where present near these localities, and 800 feet for the Keuper beds.

¹ Recorded by Mr. C. Moore, *Quart. Journ. Geol. Soc.*, vol. xxiii., 1867, p. 457.

² In Mr. Prestwich's opinion, coal would not be found at a depth less than from 1500 to 2000 feet. *Report of Coal Commission*, p. 163.

³ *Mem. Geol. Survey*, vol. i. Mr. Prestwich thinks "it is possible that the great thickness of the Secondary strata south of the Mendips may arise from a greater denudation of the Palæozoic rocks on the south than on the north of the Mendips, in which case a larger portion of the Coal-measures may have been there removed." *Report of Coal Commission*, p. 163.

It should, however, be borne in mind, that the Coal-measures of Somersetshire possess three divisions, an upper and lower productive series, separated by a middle one, the Pennant Grit, which is from 2,000 to 3,000 feet in thickness, and contains but two or three seams of coal.

The opinion has been expressed by Mr. Prestwich and Mr. Etheridge¹ that possibly to the south of the Mendips the Coal-measures might assume the Devonian type of Culm-measures. This goes to the heart of the Devonian question, for if we regard the Culm-measures as representing the true Coal-measures, Professor Jukes's classification must be accepted. For it is acknowledged that the boundary line between the Culm-measures and Upper Devonian of North Devon is so gradual that it is hard to separate the two; and therefore the latter must represent the underlying Carboniferous formations. Be this as it may, we cannot consider this great and difficult question as by any means finally settled at present, and we must look forward to the careful working out of the area by the Geological Survey as the only way in which it will be definitely solved. We do not, however, see any reason to suppose a great change in the Carboniferous strata immediately south of the Mendips, for at Cannington Park we have the Mountain Limestone presenting its ordinary features, as they are so well displayed in the corresponding beds at Clifton, on the Mendip Hills, and in South Wales.

The Report of the Royal Coal Commission is one of the most remarkable works of this or any other age or country. When the two remaining volumes are published, the whole will be an enduring monument to the honour of its authors, who seem to have spared neither time nor labour in the preparation of a mass of information relating to the Coal in the United Kingdom, such as has never been brought together before, and which will every day become of increasing value to all persons interested in this most important branch of our industrial resources. The country at large is under a great debt of obligation to the Commissioners, who, in the midst of public or private business, have given their best energies, without fee or reward, to a subject which most persons would consider sufficiently onerous in itself, apart from other duties.

This is especially noteworthy with regard to the contributions of Messrs. Ramsay, Prestwich, and Hunt, whose labours can scarcely be appreciated at their fullest extent except by those persons who have been engaged in inquiries of a similar nature.

The results arrived at by the Commissioners show that the public fears as to the immediately approaching exhaustion of the available coal were altogether groundless, and they establish the fact that the country possesses a supply of coal sufficient for the wants of the nation for a long period, equal to about three hundred years. In the face of that conclusion the Commissioners, as a body, have scarcely felt themselves justified in recommending that experimental borings should be made for the purpose of testing the existence of coal in areas where its occurrence has only been hypothetically inferred.

¹ Report of Coal Commission, vol. i., pp. 147, 163.

Otherwise such borings might have been made in the country to the south of the Mendips, as well as in other localities in the south of England, where the presence of Coal-measures has been inferred beneath the Secondary rocks.¹

III.—NOTE ON A FUTILE SEARCH FOR COAL NEAR NORTHAMPTON.

By SAMUEL SHARP, F.S.A., F.G.S.

HAVING had my attention drawn to a communication from H. W. Bristow, Esq., F.R.S., District Surveyor of the Geological Survey of England and Wales, which appeared in the *Wells Journal* of 12th October, and which relates how he came upon a shaft (with steam-engine, etc., in full operation) that was being sunk for Coal about three-quarters of a mile North of Easton, in Somersetshire, and which shaft penetrated the Old Red Sandstone to a depth of 112 yards, starting at a point from 3,000 to 4,000 feet below the horizon of the lowest strata of the true Coal-measures, I think it not undesirable to make known the fact of an as unwise and hopeless search for Coal in Northamptonshire, at a point probably more removed vertically, but in the opposite direction, from any strata in which Coal would be likely to be found.

About thirty-five years ago, a company was formed, based upon the advice also of "a practical man," at Northampton, and a shaft was sunk at Kingsthorpe, a village lying immediately North of that county town. The spot selected was nearly the highest in the neighbourhood, and remarkable for the presence of quarries in a bed of Limestone of the Great Oolite formation, of a thickness of about twenty-five feet; which limestone overlies an estuarine Clay (also Great Oolite) of fifteen feet. These are succeeded by the three divisions of the Northampton Sand (Inferior Oolite), having an aggregate depth of say eighty feet, which repose upon the Upper Lias. So that these upper beds have a depth of about 120 feet.

No accurate detailed section of the shaft was taken at the time; but at a depth of 210 feet from the surface, a water-yielding "Limestone rock," in the Middle Lias (Marlstone), was pierced, which produced 36,000 gallons of water per hour. At the depth of 880 feet (as is stated in pencil-notes on a diagram in my possession, which notes are said to have been made by Dr. Wm. Smith, F.R.S., F.G.S., etc.), the New Red Sandstone was reached, and a flow of brackish water of a like volume to the former occurred. The New Red Sandstone is stated to have consisted of "sixty feet of Sandstone, twelve feet of Red Marl, and fifteen feet of Conglomerate." At this point (a depth of 967 feet having been attained, and about £30,000 expended) the enterprise was abandoned.

¹ Mr. Prestwich remarks that a few trials for coal would not be very costly, and that they could hardly fail in important results, as in case of failing at once to hit the Coal-measures, we might possibly find the Lower Greensands, and obtain its pure and abundant waters, a consideration of high importance to the metropolis. Report of Coal Commission, p. 165.—This is not the place for going fully into the question of the occurrence of Coal in the south-eastern counties, but I agree with Sir Roderick Murchison that it is highly improbable that a remunerative Coal-field will ever be discovered in that area.—H. B. W.