



Campbell 2. of 5
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189

Coal

Murchison

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ON

THE PARTS OF ENGLAND AND WALES

IN WHICH

COAL MAY AND MAY NOT BE LOOKED FOR BEYOND THE
KNOWN COAL-FIELDS.

BY

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THE ingenious suggestion of Mr. Godwin-Austen, that coal-measures might possibly be found under London and the south-eastern part of England, was formed on a general and comprehensive view, as well as upon observation. He argued that as coal is worked under the chalk at Valenciennes, in France, and had been found to a small extent in recent sinkings under the cretaceous deposits ranging westwards towards Calais, it might further extend across the Channel, and occur under similar cretaceous rocks in the south of England.

This theory, which, from the reputation of its author, attracted considerable attention, has recently been largely and boldly applied by Mr. H. Hussey Vivian, M.P., who, in a speech delivered in the House of Commons, when moving for the appointment of a Royal Commission to inquire into the quantity of British coal, expressed the opinion that this mineral might be found in the southern counties of England, and even beneath the Houses of Parliament.

Reflection upon the order and nature of the rocks which surround the south-eastern counties of England, whether on the coast of France, the Channel Islands, or the western, midland, or northern counties of England, having led me to adopt an opposite conclusion, I beg to offer the following observations in explanation of the view which I take, viz. that no productive coal-measures can reasonably be looked for in Essex, Kent, Sussex, Middlesex, Herts, Hants, Bucks, Oxfordshire, Suffolk, Norfolk, and the eastern counties, from Yorkshire southwards. In this list Nottinghamshire is happily not included. To it must necessarily be added all the numerous tracts wherein rocks older than the carboniferous rise to the surface, as in the greater part of Wales and Herefordshire, in all of which coal cannot of necessity be found.

Let us first test the value of the data afforded by observations in France, which have led to the application of the above theory to the south of England.

But although I differ from Mr. Godwin-Austen, the difference between us is not great, inasmuch that I do not believe that my distinguished friend maintains that a really valuable coal-field is likely to be found in the south-eastern counties, but simply, that some carboniferous and older rocks may there underlie the younger deposits. His memoir is, indeed, full of originality in tracing out the gradual position of an old terrestrial area over which the vegetation that formed the coal-fields probably extended.

It is true that beds of coal of considerable dimensions are worked at Valenciennes at once beneath the chalk, all the intervening formations which exist in many other parts of the world being there omitted. This fact simply indicates that at Valenciennes the coal-bearing deposits had formerly been elevated, so as to constitute ancient lands, and had not been afterwards depressed under the sea during all the periods in which the Triassic, Liassic, and Jurassic formations were accumulated in other tracts. These carboniferous strata of Valenciennes constitute a portion of the southern edge or lip of the great coal-basin of Belgium, in which country, together with the subjacent Carboniferous and Devonian limestones, they form those great undulations so admirably laid down in the geological map of M. Dumont. The portion of these coal-strata which exists in France, and which at Valenciennes dips at a high angle to the north to pass into Belgium, has been also found to have a lateral extension on the strike for a certain distance to the west beneath the Cretaceous rocks, *i. e.*, towards the British Channel.

By trials made through the Cretaceous rocks and other overlying deposits, these same coal-strata have been proved to extend to the west of Bethune. But they there gradually thin out to a narrow band, which diminishes to a wedge-like mass directed to W.N.W. The western limit of the better portion of the field has been definitely proved by the fact that, in all the borings which have been made to the east of a village called Flechenelle, Devonian limestones, schists, and grits alone have been reached, the coal being thus completely omitted.

For general purposes the geological map of France, by Messrs. Elie de Beaumont and DuRoi, sufficiently explains this thinning out to the west of the Valenciennes coal-field. My conclusions, however, are more specially drawn from a good statistical coal-mining survey map of France, recently prepared by able civil engineers, as laid down on the maps of the Dépôt de la Guerre, as well as from my own observations in the Boulonnais. On this map, every concession or grant of a right to sink for coal (in number exceeding 200) is marked; the results of each sinking, and the depths being regularly given. The limits of the coal-bearing strata on the north and on the south of the Carboniferous Zone have been thus ascertained by trials, all of which show that the Devonian rocks flank on each side this narrow tongue of coal-measures, the extreme point of which is at Flechenelle. Between that village and Boulogne, Devonian rocks only are found under the secondary deposits in all the borings that have been made. It is only to the north of Boulogne, at Hardingen, that a detached mass of carboniferous limestone, with an insignificant patch of worthless coal associated with it, is seen to be basined upon those Devonian rocks which there rise to the surface. In short, all the practical French geologists with whom I have conversed are of opinion that the coal-basin of Valenciennes and Belgium terminates, as far as productive value goes, a few miles west of Bethune.

As the coal-measures thus thin out towards the British Channel, though some traces of poor coal have been found near Calais, we have a clear demonstration in the Boulonnais that no productive coal-measures are superposed to the carboniferous or mountain-limestone. In other parts, indeed, of the same district, the true Devonian limestone, with many fossils, as well as crystalline carboniferous limestone are at once covered by oolitic and cretaceous rocks to the entire exclusion of any workable coal. Judging, then, from the gradual deterioration and extinction of the coal-beds as they approach the French side of the Channel, I hold that there can be no reason to hope that better conditions can be looked for throughout the southern counties of England.

Looking, however, to the well-ascertained data that the secondary rocks of the

western and central parts of England which lie beneath the chalk, viz. the Trias, Lias, and Oolites, thin out in their extension to the south-east, as well proved by a memoir of Mr. Hull, still it is by no means improbable that the part of the oolitic series which appears in the cliffs north of Boulogne may be persistent under the cretaceous and wealden rocks of Sussex and Kent. But the question is What will the fundamental rock prove to be in these districts if it should ever be searched for? Reasoning from such data and the visible outcrops in the Boulonnais, my inference is that, if not in part Jurassic, they will probably prove to be a thin band of carboniferous limestone without any productive coal, or more probably Devonian rock only. So far, then, I agree with Mr. Godwin-Austen as to palæozoic rocks (but unproductive of coal) being possibly found in the south-east of England.

Again, if we follow the course of the older rocks in France southwards from the Boulonnais, everywhere Devonian rocks only have been found beneath the secondary strata; and, proceeding through Normandy and Brittany, we find that the Jurassic rocks repose at once on lower Silurian rocks to the total exclusion of everything Carboniferous or even Devonian; whilst in the Channel Islands nothing but crystalline rocks of granite, gneiss, and slate occur, with no signs of any intermediate strata between them and the Wealden and cretaceous rocks of the Isle of Wight and Hampshire.

Tracing the line of the older rocks which separate the south-eastern from the south-western counties, we see the Devonian rocks of the Quantock Hills, in West Somerset, at once overlaid by new red sandstone, oolitic, and cretaceous rocks, without a sign of anything carboniferous. When we advance northwards from the Mendip Hills, the phenomena we there meet with are, it seems to me, indicative of the hopelessness of seeking for any productive coal-measures between these hills and the Straits of Dover, *i. e.* in Wilts, Hants, Sussex, Kent, Surrey, Middlesex, Essex, and Herts. For, on the west, the mountain-limestone forms the outward eastern girdle of the great Somerset and Bristol coal-basin from Wells and Elm, near Frome, on the south, to Chipping Sodbury, Wickwar, and to near Tortworth on the north.

Throughout a distance of about 35 miles, the carboniferous limestone with traces only of mill-stone grit, which is the unproductive bottom-rock of every coal-bearing stratum in the south of England and Wales, is everywhere and at once surmounted on the east by new red sandstone, or the lias and oolitic formations. It has been said that an exception to this rule occurs in the neighbourhood of Frome, where the unproductive limestone is said to exhibit an axial form with coal-measures on two sides. Not having been for many years in that tract, I ask for information, and will only now say that, if the coal so worked be not on the eastern flank of the limestone but on the southern side, and is not seen to dip to the east and so pass under the secondary rocks, my reasoning is unaffected.

However this may be, we know that all along the remainder of the outcrop of mountain-limestone which forms the eastern boundary of the Bristol coal-basin, the strata of that limestone are highly inclined to the west, thus passing under the Bristol coal-basin proper. Now, it is on the highly inclined and upturned edges of that mountain-limestone that the secondary rocks lying to the east at once repose, without any portion of those deposits of coal which are so thickly spread out to the west of this band, whether in the Bristol basin, properly so defined, the Forest of Dean, or the great South Welsh coal-field.

So much for nearly the whole of the country lying to the east of the outermost or underlying band of all the carboniferous rocks of the south of England and Wales, including the Forest of Dean, to the east of which the non-existence of any coal-measures is rendered still more striking; because, in addition to a rim of mountain-limestone, wholly unproductive of coal, the Old Red Sandstone and Silurian rocks are interposed in the Tortworth country, and on the east are immediately covered by the lias and oolites. The same date and the same reasoning must, indeed, be applied to the country extending from that tract northwards, and to the valley of the Severn, and the Cotswold Hills, as well as to all the country lying to the south-east of Cheltenham.

Who, for example, would speculate on the chance of finding coal to the north of the poor little outlying coal-tract of Newent, in Gloucestershire, when it is known that on the north the Silurian and older rocks rise to the surface; their flanks being covered at once by Permian or New Red Sandstone? Equally absurd would it be to look for coal in those parts of the Severn Valley of Worcester, which lie to the east of the Malvern Hills, where the New Red Sandstone also lies directly upon the crystalline and other rocks of that range.

The Malvern Hills on the south-west, and Charnwood Forest on the north-east, each composed of Cambrian rocks older than the Silurian, form salient promontories which seem to me to be indicative of the former southern coast-line of those productive coal-fields of the Central Counties, which have been raised up through the Permian and New Red Sandstone formations. I would not affirm that the southernmost of these fields, those of Leicestershire and Warwickshire, have no southern extension, though they give strong signs of deterioration in that direction. I know, however, that to the south of the South Staffordshire coal-field, all the productive coal-measures have been found by actual trials to thin out, old rocks of Silurian age being reached beneath. I presume, therefore, that no further efforts will be made in the more southern counties in that meridian.

On the other hand there can be little doubt that vast supplies of coal will eventually be worked to the north and west of those fields, far beneath the Permian and New Red Sandstone formations of the Midland Counties, wherein the coal-measures have been raised to the surface by upheaval through those younger deposits. Thus, in the Red Sandstone tracts between Wolverhampton and Coal Brook Dale, in Cheshire, between the Flintshire and Lancashire Coal Fields, and over other large areas similarly circumstanced, there can be little doubt that coal will ultimately be worked—a view which I advocated thirty years ago, and published in my work, the 'Silurian System.'

To return to the consideration of the wide southern area in which London lies, let us proceed due north from Reading. On this line the first ancient rocks we meet with are the slates of Charnwood Forest, which are admitted to be of Cambrian or infra-Silurian age. To the west of these, indeed, lies the Leicester coal-tract, as well as other coal-fields of the central counties to which I have alluded; but to the east, on the contrary, nothing is seen but secondary rocks,—from the New Red Sandstone and lias to the oolites and cretaceous rocks. Who, then, with such an outcrop of Cambrian slates in the west, would sink for coal in any of the counties lying to the east of Charnwood Forest and Hart Hill? The recent well-sinking at Harwich to procure water has, indeed, completely solved this portion of the problem. There, beneath 1025 feet of chalk, the trial ended in the discovery of a hard slaty rock, with fossils of the lower carboniferous limestone, evidently older than any coal-bearing stratum. Specimens of this rock are preserved in the Museum of Practical Geology, Jermyn Street, as a warning to those speculators who would search for coal in the eastern or south-eastern counties of England. This fact shows indeed conclusively, that the great Belgian coal-field does not extend eastwards to England, though the older rocks on which it rests are persistent into our country.

To widen the application of the inferences respecting those tracts where coal cannot reasonably be sought for, I may extend the reasoning to parts of Lincolnshire and the East Riding of Yorkshire, as well as to a large portion of the North Riding of the latter county. On this head I will first allude to the south side of the valley of the Tees, a tract which I have long known, extending from Croft, by Middleton-one-Row, to the town of Middlesborough, where the New Red Sandstone, of enormous thickness, is covered by detritus and northern drift. At Middlesborough the spirited ironmaster, Mr. Vaughan, being desirous of obtaining subterranean water for the working of his engines, sunk an Artesian well to the depth of 1800 feet, and at length reached a body of rock-salt, subordinate to the New Red Sandstone,—in fact, without reaching even the surface of the magnesian limestone, through which the deep coal-pits of the east coast of Durham are sunk to the extreme depth at which coal has hitherto been worked in that county. If, then, the coal-measures should be prolonged underground to the south of the Tees (which, from my observation of the rocks between Seaton Carew and Hartlepool, I greatly doubt, as

there are symptoms of a basin-shaped arrangement of the strata), and should pass under the vale of Cleveland, and the hills of the eastern moorlands, what, I may ask, would be the vast depth at which they could be won, by passing through the oolites and lias, in addition to the New Red Sandstone and magnesian limestone?

In the excellent work on Yorkshire by Professor Phillips, and indeed on all geological maps of England, it is shown that throughout a distance of many miles the lower or unproductive carboniferous rocks of limestone and millstone grit of the Yorkshire Dales are at once surmounted by the magnesian limestone of the Permian group.

On the banks of the Tees, west of Darlington, wherever the magnesian limestone forms the upper stratum, as at Concliffe, it is at once underlaid by unproductive millstone grit, which on the west lies upon mountain-limestone; the productive coal-measure which ought to lie between the millstone grit and the Permian rocks being entirely wanting, owing either to great denudation or to an ancient elevation of the tract after the lower carboniferous period. This uprise of the older rocks seems also to form a southern border of the great Durham coal-basin. In fact, no valuable coaly matter has ever had an existence in the tract extending from Barnard Castle on the Tees, to the south of Harrogate. At the latter place and its environs, we have, further, the clearest possible proof of the omission of all the productive coal-strata; for the Plumpton rocks and conglomerates underlying the magnesian limestone, and forming, in my opinion, the base of the Permian system, are seen to repose directly on unproductive millstone grit, which, in its turn, rests upon the mountain-limestone of the western dales of Yorkshire.

But whilst I give this as not merely my opinion, and that also of Professors Phillips and Sedgwick, who have surveyed the tract in question, and also that of many sound geologists, I may state that Mr. Lonsdale Bradley, acting for my friend Mr. Webb, of Newstead Abbey, is conducting experimental borings through the Red Sandstone and magnesian limestone between Northallerton and the Tees, in the persuasion that, as the mountain- or carboniferous limestone disappears rapidly beneath the superjacent deposits to the east of Middleton Tyas, there may be found a productive coal-field, like that of Durham or Leeds, between the strata which they are now piercing and the subjacent carboniferous limestone.

This view is well explained in the diagrams which Mr. Lonsdale Bradley has allowed me to exhibit on this occasion. I must, however, declare that I think the probabilities are entirely against the success of this enterprise, though as geologists we commend Mr. Webb for making this trial, by which he will have done good service to our science.

To the south of Harrogate the great coal-fields of Leeds and the West Riding appear with a well-defined boundary of millstone grit on the north and west. To the east, however, of the known boundary of these fields there is a fair probability that some coal may be found to extend under the magnesian limestone and New Red Sandstone.

As we proceed southwards along the escarpment of the magnesian limestone in its range from Yorkshire into Nottinghamshire, and thus flank successively the Sheffield and Derbyshire coal-fields, we find a progressive thickening of the coal which lies beneath the Permian rock. Whilst thin and poor beds only have as yet been worked in the south of Yorkshire beneath the magnesian limestone, we now know, thanks to the spirit and energy of the late Duke of Newcastle, that at Shire Oaks good seams of coal, the prolongation of the Sheffield field, are worked to profit. But the most important phenomenon of all others to the inhabitants of Nottingham is, that in the tract between Mansfield and that town, the coal-strata of Derbyshire, rich as they are, become thicker and richer as they dip to the east under the magnesian limestone. When visiting Mr. William Webb, at Newstead Abbey, in the year 1863, I had sincere pleasure in announcing this important fact in a lecture which I gave in the Mechanics' Institution at Mansfield, inasmuch as the realization of it rendered the properties of my friend and his neighbours much more valuable. The coal-pits which have almost been sunk along their lands near Hucknall and other places, are satisfactory proofs of the certainty of now finding excellent coal, superior, indeed, in quality and in dimensions to most of the coal-beds of Derbyshire, in position and in tracts where no one, even a few years ago,

except geologists, thought of their existence. Indeed it is possible that at some distant day, and when the more easily attainable coals are exhausted under the magnesian limestone, the mineral will be worked under the new red sandstone to the north of Nottingham, though at depths which at present would render such operations unremunerative.

But whilst I thus advert to portions of Nottinghamshire as included in those British areas in which future supplies of coal will in all probability be obtained by sinking deep through overlying deposits, it forms no part of this communication to dwell upon this point,—still less to treat of the known coal-fields, whether they be basins subtended by old red and mountain limestone, as in South Wales or the Forest of Dean, or upcasts through the Permian and new red sandstones of the central counties. These subjects, which have already been ably handled by Mr. Hull, one of my associates in the Geological Survey, and whose work, as well as that of Mr. Jevons, has excited great public interest in reference to the duration of British coal, will, I know, be well inquired into by the Royal Coal Commission. My sole object is to exclude from the reasoning upon the English coal-fields, whether near the surface, or attainable through overlying rocks, those hypotheses which, however ingenious in theory, are, in my opinion, negatived by fair reasoning on the data we possess. Thus, when we exclude, as of necessity, 21,800 square miles, or nearly one-half of England and Wales, as consisting of rocks older than the coal-measures, and in which no coal can possibly be found; and when I have further shown strong *à priori* reasons for setting aside the hypothesis that productive coal-fields may exist under our southern and eastern counties, we have first to proceed to form the best approximate estimate we can of the amount of coal left in those fields which have been long worked. Next to endeavour to ascertain what is the prospect of a profitable extraction of coal from deep-seated beds, by reaching them at certain depths beneath the superjacent Permian, or other overlying deposits, through which they have been upheaved to constitute the coal-fields of the Midland Counties. Such will be the objects of the Royal Coal Commission recently appointed, and on which I am as yet unable to give any reliable opinion.

By excluding from the inquiry into the present or probable future coal supply of England and Wales, all the tracts of crystalline and paleozoic rocks which rise out from beneath the carboniferous strata, and in which no trace of coal can ever be discovered, and also all those secondary and tertiary rocks beneath which, for the reasons given, there can be scarcely any hope of finding that mineral, it will be seen that the existing and possibly future supplies have, for all practical purposes, an approximately defined limit, and that they range over little more than one-eighth of England and Wales, or an area of about 6000 square miles.

Declining to express any opinion as to the duration of the accessible coal-beds in Britain until a closer survey shall have been completed, I fully appreciate the anxious desire which is felt by all persons who are interested in the future welfare of their country, to have the subject fully and fairly inquired into; the more so as I have now in conclusion to announce that, by the last inquiry made by Mr. Robert Hunt, the indefatigable compiler of the Mining Records in the Government establishment under my direction, the last year's consumption of coal reached the portentous figure of nearly one hundred millions of tons. Most judiciously, therefore, did Sir W. Armstrong revive attention to this important national subject at the Newcastle Meeting of the British Association; whilst in this communication I have simply endeavoured to indicate that the public are not to believe in the almost boundless range and contents of our coal-fields which some persons would assign to them.

