

**ON THE LIGNITE
FORMATION OF BOVEY
TRACEY, DEVONSHIRE**

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WILLIAM PENGELLY & OSWALD HEER

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THE LIGNITE FORMATION

OF



BOVEY TRACEY,

DEVONSHIRE.

BY

WILLIAM PENGELLY, F.R.S., F.G.S., &c.,

AND

THE REV. OSWALD HEER,

Doctor of Philosophy and Medicine, Professor of Botany in the University and Polytechnicum of Zürich,
Director of the Botanical Garden, &c.

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1863.

TO

MISS BURDETT COUTTS

THESE MEMOIRS,

RESULTS OF HER MUNIFICENT AND ENLIGHTENED

ENCOURAGEMENT OF SCIENCE,

ARE RESPECTFULLY DEDICATED BY

THE AUTHORS.

PREFATORY REMARKS.

THE precise chronological position of the lignite deposit at Bovey Tracey has long remained one of the most unsettled points in the geology of England. The memoirs here reproduced from the Philosophical Transactions, furnish, it is believed, more definite and satisfactory data for the solution of the problem than have been heretofore available.

Professor HERR's memoir is reprinted textually in the form in which it was communicated to the Royal Society; but as matter which is not original is excluded from the Philosophical Transactions, it has seemed advisable to add, as prefatory, such historical and illustrative details, necessarily omitted in the descriptive and stratigraphical memoir, as are calculated to render the present reprint, in some measure, a monographic account of the Bovey formation.

This deposit first became the subject of scientific inquiry upwards of a century ago. In 1760, a letter, addressed to the Earl of MACOLESFIELD, entitled "Researches on Bovey Coal," by the Rev. Dr. JEREMIAH MILLES, was read before the Royal Society and printed in the Philosophical Transactions, vol. li. Part II. p. 534, &c.

From this communication it would appear that the lignite was discovered about the year 1745. We shall see hereafter, however, that it must have been known much earlier. According to Dr. MILLES, the coal strata reached to within a foot of the surface, under a sharp white sand mixed with ash-colour clay, and dipped southwards about 20 inches to the fathom; there were six beds of coal alternating with as many of clay, the aggregate thickness being about 70 feet. In the upper part, the beds of clay and lignite were about equally thick, and varied from 18 inches to 4 feet; the lower beds of the latter were thicker, whilst those of the former were correspondingly thinner. The lowermost stratum of lignite was 16 feet thick; it lay on a bed of clay, beneath which was a bed of sharp greensand, not unlike sea-sand, 17 feet in thickness; and under this was a bed of coarse clay, which had been bored but yielded no coal. A spring of clear blue water, called by the workmen mundic water, arose from the sand. Amongst the clay, but adhering to the veins of coal, were found lumps of a bright yellow substance, extremely light, which burnt like sealing-wax and emitted a very agreeable aromatic odour. Dr. MILLES believed this to be "loam saturated with petroleum."

Three distinct kinds of "coal" were recognized, namely: 1st. That having a "laminous" texture, the laminae running in such oblique, waving, and undulating forms as to bear

a strong resemblance to the roots of trees. This was known as "*Root coal*." 2nd. A black, compact, solid and comparatively heavy and bituminous variety; distinguished by the name of "*Stone coal*," from its resemblance to ordinary coal. It produced a stronger and more lasting fire than the other kinds. 3rd. "*Wood*" or "*Board coal*;" so called from its having the "appearance of deal boards." It occurred in pieces 3 or 4 feet long, and even longer; it was of a chocolate colour or shining black; very elastic when first dry, but exposure to the air deprived it of this quality and rendered it quite crisp and short; it easily separated into laminae, especially after exposure to the sun. Pieces of *spar* were occasionally found in the middle of this variety.

When put into the fire, the "*Coal*" was found to crackle, to separate into laminae and irregular pieces, to burn for some time with a heavy flame, become red-hot, and gradually consume into white ashes; if quenched when red-hot it did not look like charcoal. It gave out a thick heavy smoke and a disagreeable fetid odour, much resembling that of the asphaltum of the Dead Sea.

Dr. MILLES subjected the lignite to analysis; and, from one pound of the "*Woody*" kind, obtained four ounces and a half of water having a bituminous smell and taste, nearly four ounces of a turbid, whitish, bituminous liquor, of an intolerable fetid smell and extremely pungent to the tongue, about two drachms of a heavy bituminous matter which would not mix with the former liquor, but sank to the bottom, and about seven ounces of a very black powder which had the same bituminous smell. The ashes of the lignite yielded no salt on being boiled in water.

The principal aim of this author was to prove the *mineral* origin of the lignite, in refutation of Professor HOLLMAN of Göttingen, who, in a paper previously presented to the Royal Society of London, and printed also in the Philosophical Transactions, vol. li. Part II. p. 506, &c., had assigned a *vegetable* origin to the "*Fossil Wood*" found near the city of Munden and elsewhere in continental Europe, and which was believed to correspond in many particulars to the Bovey coal. Dr. MILLES contended that the great quantity of the lignite, the firmness of the accompanying soil, the regularity of the stratification, the flatness of the "*Wood Coal*," the absence (as he believed) of all signs of roots, branches, bark, round pieces, and concentric year circles, its defective combustibility as compared with that of wood, the products obtained by analysis, and their behaviour under chemical treatment conclusively proved that it differed from all known wood and was "an actual mineral substance." Consistently with this view, he held that certain "small protuberances like knots of trees" (which they no doubt were), which sometimes appeared on the "*Wood Coal*," were only mineral nuclei.

This drew forth a series of papers on the subject from Professor HOLLMAN; so that the controversy was kept before the scientific world for upwards of twenty years*. It appears to have been all but fatal to the *mineral* theory, as no writer on the lignite, subsequent to Dr. MILLES, seems to have adopted it, though, as we shall see, some of

* PARKINSON'S '*Organic Remains*,' vol. i. Letter XI, p. 120, &c.

them thought it required, and was worthy of, refutation. It still maintains a humble existence, however, amongst the workmen, who seem reluctant to allow it to die.

The third part of Mr. KIRWAN'S 'Elements of Mineralogy,' published in 1794, is devoted to "Inflammables." In his fourth genus of this class, the author placed "Vegeto-Carbonated Substances"—his first species being "Carbonated Wood," which he divided into three varieties, namely, "Ligniform," "Scaly or Earthy," and "Compact." The first includes the *Surturbrand* of Iceland, and the last the *Piligno* of the Italians, and *Bovey Coal*; the specific gravity of which he fixed at from 1.4 to 1.558, and added that Mr. FABRONI discovered its organic structure by boiling it in dilute nitrous acid, its fibres being thereby laid bare, and that this species of coal is "nothing else but wood whose oil has undergone a change of the putrefactive kind"*.

Dr. MATON'S 'Observations on the Western Counties of England, made in the years 1794 and 1796,' contain some particulars respecting the Bovey deposit. Though this author had evidently visited the district, his description appears to be mainly a copy of that given by Dr. MILLES. He adds that the pits were of considerable service to a pottery close by; that they were often filled with water to the height of 40 feet or more, which was carried off by machinery; that an ochreous sediment was found in the water; that a large turf bog existed at a short distance from the pit, where decayed roots and, indeed, whole trees were often discovered, none of which bore the least resemblance to the "Coal"; and that he had found exactly the same substance as the lignite, at a depth of several feet, in blackish clay near Shotover Hill in Oxfordshire. On this last point, Professor PHILLIPS obligingly informs me that "no doubt it was *jet* which Dr. MATON saw in our Kimmeridge clay. There is no Cainozoic deposit like that of Bovey in the neighbourhood of Oxford."

The arithmetic of the formation given by Dr. MILLES, and copied *verbatim* by Dr. MATON, differs somewhat from that obtained from the present excavation. The *Dip*, southwards as now, was "twenty inches to the fathom," or about $15\frac{1}{2}^{\circ}$ instead of $12\frac{1}{2}^{\circ}$; and the strata were fewer and thicker. It is possible that thin layers of dark clay, separating coal strata, were sometimes disregarded, and the whole measured as one bed. Probably, also, only those beds of lignite which were thick enough, or of sufficiently good quality to pay for working were registered. Moreover the early workings were at some distance from the present pit; so that the sections described by the first observers are no longer visible, it having been the practice formerly, as it is still by the *clay-diggers*, to re-fill abandoned excavations with the refuse of new ones. The small number of beds, however, was mainly due to the fact that (as we shall hereafter see) the lower lignite series had not then been discovered.

In 1797, a paper entitled "Observations on Bituminous Substances, with a Description of the Varieties of the Elastic Bitumen. By CHARLES HATCHETT, Esq., F.R.S. Lond. and Edinb., F.L.S. &c.," was read before the Linnean Society and printed in the 'Transactions' of that Body, vol. iv. p. 129, &c. Under the head of "Bituminous Wood," the

* Elements of Mineralogy, vol. ii. p. 60, &c.

author described the characters and situation of the Bovey "Coal,"—stating that the first stratum commenced at about 6 feet below the surface, the overlying mass being a pale brownish clay mixed with quartz pebbles; that there were seventeen strata, the thickest being from 6 to 8 feet; that the lowest beds, and the most southerly portions of them, produced the best "coal," which burnt readily, with a flame like half-charred wood, did not crackle, and, if but moderately burned, formed charcoal, or if completely burned left a small quantity of white ashes exactly similar to those of wood; that the strata exhibited none of those irregularities on the surface which might be expected on the supposition that they were formed by the roots, trunks, and branches of trees long buried in the earth; that it was difficult to imagine wood to have been transported and deposited in the same place at seventeen different periods, whilst it must be allowed that the strata had been formed by successive operations; and that, though he had twice visited and examined the spot expressly for the purpose, he still found himself utterly unable to offer any opinion on the subject. He was, nevertheless, quite satisfied that the "coal" is of vegetable origin; and stated that, though it resembled half-charred wood and was in a condition nearly similar, it did not follow that fire had been the cause; he was inclined rather to attribute it to changes produced in the original vegetables in the progress of putrefaction; and he regarded the oily and bituminous matter, which he had obtained from the "coal" by distillation, as the remainder of the vegetable oils and juices, which had been partly modified by mineral agents.

On comparing this description with that of Dr. MILLES, a few points of difference are noticeable. The beds recognized by the later author were more numerous and thinner, and the uppermost was six feet below the surface, instead of *one* foot; in fact the figures approximate those of the present pit sections. The apparent discrepancies probably arose from the discovery of the lower series of lignites and the change in the situation of the excavation. The number of the beds, however, though nearly three times as great as that recorded by Dr. MILLES, is but little more than half that given in "Section 1" of the late explorations—seventeen instead of thirty-one (see page 4, &c.). This difference may be, perhaps, explained away in the manner previously hinted.

Again, Dr. MILLES stated that, during combustion, the "coal" crackled, and that, on being partially burnt, it did not assume the character of charcoal; whilst, according to Mr. HATCHETT, it did *not* crackle, and *did* form charcoal. On both points modern experience confirms the statements of the latter.

Mr. BRICE, in his 'History and Description, Ancient and Modern, of the City of Exeter,' published in 1802, gave a somewhat minute account of the formation. He attributed the broken features and surface inequalities of the Bovey plain to "ancient stream-works of the tanners"; and stated that the lignite was taken from an extensive open mine of easy descent for horses to bring up its contents; that the strata run nine miles to the southward through the Heathfield, Knighton, Teigngrace, and Newton Marshes to Aller; and that the "mundic water" mentioned by Dr. MILLES was said to abound in sulphur and vitriol, and was as warm as some of the Bath springs. He

discussed the question of the vegetable or mineral origin of the lignite, deciding in favour of the former, which seems to have been the prevalent opinion at that time, as he stated that "the basis of the Bovey 'coal' is generally supposed to be vast assemblages of trees that have, in various and distant ages, been washed by torrents from the neighbouring hills, and on which, from time to time, the intervening beds of clay have been deposited," and added, what he supposed to be a confirmatory fact, that "the people of Bovey have a number of railing-posts formed of the fossil." On this last point he was certainly in error; no sample of lignite was ever found suitable for such a purpose. There can be no doubt that the "railing-posts" were made out of trees found in the bog first mentioned by Dr. MATON. In this view I am confirmed by Dr. HAYDON of Bovey, who, in a letter to me on the subject, says, "There is a gentleman residing here who remembers post-and-railing in his father's garden, in this place, made from *bog-wood* raised on the Heathfield by his grandfather. He says it was *Fir*, of a dark colour, and burnt as a torch when lighted." Mr. BRICE supposed it very probable that the Heathfield might have once been a deep morass or stagnant lake, into which the wood was transported from the neighbouring hills; he also held that stagnant water of this kind would be unfavourable to animal life, and that the more tender vegetables would be destroyed before the wood could assume a sufficient consistence to receive and retain their traces; hence the alleged "absence of vegetable and animal impressions." It does not appear to have occurred to him that this would fail to account for the absence of leaves, dead shells, &c. carried into the lake.

Like Dr. MILLES and Dr. MATON, Mr. BRICE stated, almost in the exact words of the first, that "the lowest stratum of lignite reposed on clay, under which was a sharp green sand, like sea-sand, 17 feet thick, and beneath this a compact clay not yet perforated by the borer." Hence it would appear that the lowest lignite series had not been discovered in 1802; for the beds here specified are evidently the 25th, 26th, 27th, 28th, and (perhaps) 29th of the present pit section (see page 5)—that is, the basement beds of the upper lignite division. Mr. HARCHETT's mention, however, of "seventeen beds" shows that the lowest series was known to him in 1797. On the whole, then, it appears that the lowest division of lignite was certainly not known in 1760, probably not in 1794, but had been discovered in 1797; that Mr. BRICE did not publish his 'History of Exeter' until some years after his visit to Bovey, or that he adopted what, in the altered state of the excavation, had become the inaccurate description of Dr. MILLES. From internal evidence I incline to the latter alternative.

Mr. PARKINSON devoted the 11th letter of the first volume of his 'Organic Remains' (published in 1804) to lignite and kindred substances, and gave a description of the Bovey beds in Dr. MILLES's "own words." Accordingly he followed that author in the statement, equivalent to that just quoted from Mr. BRICE, respecting beds of sand and clay below the "lowest stratum of lignite," and, almost immediately, added—"beneath this was an equal, if not greater, quantity of fossil wood." This, though given as part of Dr. MILLES's account, does not occur in the original; indeed it manifestly contradicts