

XI.

N O T I C E

ON THE

OCCURRENCE OF COAL,

WITHIN THE

INDO GANGETIC TRACT OF MOUNTAINS.

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THE discovery of Coal in India, may be considered a recent occurrence. The first notice of this mineral, appears to have been in the Burdwan district, about sixty or seventy miles from the town of that name; where the late Mr. Jones, who formerly owned the works known as the Albion Mills, conceived, and executed the spirited design of rendering available, whatever supply of the mineral might eventually be found; and thus of introducing into general use in India, a substance, which, perhaps, more than any other, has exercised, and will exercise, an influence in advancing the prosperity of nations. He appears to have made an examination of the ground, by boring; before venturing on an experiment, which would require some outlay of capital, and, according to the report which I had of his proceedings, these preparatory trials gave indications of a very extensive bed of Coal; having

considerable thickness, and but little removed from the surface. Of his successor's proceedings, I can give no account ; but at the time I visited the mines (the beginning of 1823,) the works had attained a considerable degree of forwardness, upwards of ninety-three thousand maunds of Coal having been raised to the surface.

These mines are situated in the undulating low country, which lies at the foot of that mountain range, along which part of the new road from Calcutta to Benares runs. The road begins to ascend it at *Bankora*, where an earthy decomposing Granite may be seen at the surface, intermixed with Gneiss, which appears to be the prevailing rock on the line thence to *Katham Sandi*, a little beyond which the descent is made to the plain country, by the *Dangai* Pass. Mica slate is also found in many places. The Gneiss often contains Granite veins, (*Katham Sandi*,) the Felspar of which is of a reddish hue. In the Mica slate, (and Gneiss also, probably) is found disseminated abundance of octahedral iron ore, in grains, and the sand of some of the nullahs is highly charged with it.

These mountains then belong, beyond doubt, to the Primary class of formations—whether bounded along their whole extent by secondary rocks, I cannot say ; but on the banks of the *Damuda*, we have at the mine, and but a few feet below the surface, a micaceous sand-stone frequently of a reddish hue, very tender and friable, and under it, the regular bituminous shale of the coal strata.

The next notice of coal, as far as I am aware, is that found by Mr. D. Scott, on the Sylhet frontier, which appears in the Geological Transactions, (New Series, vol. 1.) The specimens were all derived from very small masses, having, in some instances, all the appearance of an imbedded tree or plant, frequently in very thin seams. It is described as occurring in

the sand-stone, which there borders the great mountain zone, forming the continuation in that quarter of the *Himálaya*. This formation, I should be inclined to consider as equivalent to one sand-stone of the Indo Gangetic tract, were it not that it is said to contain beds of bituminous shale, a rock never observed in this quarter. The statement is important, and well deserves verification, as, if not originating in some mistake, it may be considered to hold forth a well-grounded hope of discovering profitable beds of Coal.

A third notice appeared in the Newspaper, of Coal, found in digging a well at *Ságar*, or *Jebbelpur*, (I forget which): of the nature of the rock, or mode of occurrence of the Coal, I have never been able to learn any further particulars.

The fourth notice of Coal in India, is one lately submitted to the Society, by Lieutenant Cautley, Assistant to the Superintendent of the Doab Canal: specimens of the Coal, and including rock, were obligingly submitted to my inspection by that officer. Having myself also, discovered several other localities of this mineral, I have thought it might not be altogether uninteresting, to submit to the Society the several particulars which I have thrown together on the subject.

The Coal found by Lieutenant Cautley, in the vicinity of *Nahn*, is part of a series of thin seams or flat veins, which are traceable along the whole line of sand-stone hills, that lie at the foot of the great *Himálaya* chain or system, and form the transition to the plain country. This sand-stone is (I think it almost certain) part of an extensive secondary formation, which, on the one hand, includes the sand-stone hills of Sylhet, and on the other, the saliferous range of Lahore. This latter opinion, if founded in fact, would tend to establish the identity of this range with the rock marl of England,

the rock which, in most of the Coal fields, immediately overlies the Coal. It possesses coincidences in Mineralogical and Geological character, which add strength to the supposition—such are its argillaceous and conglomerate beds, its low degree of consistence, &c. &c.; but leaving this question for the present, as one for the determination of which further evidence is required, I shall proceed to give the result of my examination of this rock, along nearly the whole of its extent within the British possessions in this quarter, adding such particulars with regard to the occurrence of Coal in it, as I am in possession of.

Along the whole of this tract, which is bounded by the *Setlej* and *Káli* rivers, this sand-stone forms the common boundary of the plain, and mountain countries. It does not attain to any considerable elevation: its highest peaks, which are between the Jumna and the Ganges, rising about two thousand feet above the plains at their feet, or three thousand above the sea. In other quarters, as at *Ropar* on the *Setlej*, it is scarcely elevated one hundred above the bed of that river, which itself is about one thousand feet. It is found under three very distinct and well marked types. 1. The first is a Micaceous sand-stone of a grey color, containing also scales of Chlorite, and not unfrequently a minute proportion of Carbonate of Lime. When the latter is at all considerable, it possesses great hardness and tenacity, but it is friable and incoherent very often, and little better than loose sand. This type is rarely of the conglomerate structure, and never to any depth. 2. Argillaceous beds of a reddish color with particles of Mica, and also of Chlorite disseminated, which may be separated by mechanical analysis from the finer portion, a reddish bole, composed of Alumina and Silica, colored by oxid of iron. A small portion of Carbonate of Lime is also found, and when this is more abundant, it assumes the hardness and sonorous qualities of the more well-defined rocks. The Carbonate of Lime is generally found in greatest quantity in the hard tubercular masses of every size, which are peculiar to these and

the sand-stone beds. They also contain thin seams or veins of the bole, which forms the finer part of the general basis. These beds, if seen unconnected with the other strata, would be described as a deposit of brick earth. They occasionally pass into a well defined reddish shale, having a perfect schistose structure, and in hard specimens frequently not distinguishable from some varieties of the older slates. 3. Conglomerate Beds, which consist of the preceding reddish earth as a basis, with perfectly rounded fragments of Quartz Rock, Grey Wacke, Granite, Horn-blende Rock and Limestone. The first constitutes nine-tenths of the number, the last is the most rare of all. The arrangement of these water-worn fragments though not agreeable to the position which gravity would assign them, as far at least as size is concerned, is yet very regular, both as regards the definiteness of each stratum, and the parallel position to the stratiform, which those fragments hold that have any thing of a flat shape: some of these layers alternating with argillaceous beds, or occasionally with sand-stone strata, are not above three inches thick, while others are fifty feet. It is not unusual to see them gradually extenuated till they disappear, thus forming what are called Lens-shaped strata. Sand-stone occasionally, but rarely, forms the basis.*

It is then in this rock that the Coal occurs, in every instance but one, in the sand-stone type. Its mode of occurrence, as far as I have been able to judge, is in flat veins or seams, more or less inclined to the horizon. The quantity is never considerable, the largest vein yet discovered, being about nine inches or a foot in thickness. In general they are much smaller, and some are not more than one-twentieth of an inch. The line of contact with the sand-stone is always sharp, and well defined, there being nothing interposed analogous to the shale of the Coal formation, and the only peculiarity

* In strictness perhaps, there are but two types, the Argillaceous and the Arenaceous—the Conglomerate being considered a modification of either.

observable in the sand-stone, being an ochreous stain, extending to a certain distance, but strongest in the immediate contact of the vein. In one locality, a saline efflorescence accompanies it, as also, sulphurous incrustations. Specimens have been obtained from another locality, with disseminated pyrites.

The specific gravity varies from 1. 32. to 1. 58. The latter being too high from adhering sand-stone. The hardness rather exceeds that of Selenite : 2. 0. to 2. 5. of Mohs' system, may represent the limits : it is of a jet black color, possesses considerable lustre, particularly the smaller veins, which are extremely beautiful. The composition is, in general, impalpable, but it has sometimes the ligneous structure—in the latter case, the lustre is low in the direction of the fibres, and the fracture less like that of true Coal. The transverse fracture has, however, the usual lustre, and when reduced to fragments, it is not distinguishable from the other kinds. Where the ligneous fibre has disappeared, the fracture is perfect conchoidal, and uneven, the former being frequently marked with concentric circles, similar to what is observed in Cannel Coal. The fragments are indeterminately angular, approaching to wedge-shaped. It burns with flame, giving out a thick smoke and bituminous smell, which, in some specimens, is accompanied by the odor of sulphurous acid. It leaves a reddish brown ash, of equal bulk with the original fragment.

This general account of its properties, enables us to refer it at once to the Bituminous Coal of Mohs. The specific gravity, in some of the specimens, is a little higher, but this is obviously the effect of impurities. It is more difficult to discover, with which of the numerous sub-species and kinds of former writers, it is synonymous. The descriptions are so vague, and there is so much similarity in the few particulars that approach to definiteness, that one cannot but consider the greater part of them as merely

different shades of the same substance. If it were necessary to fix its place amongst a series of fanciful divisions that have no reference either to science or utility, I would say, that some specimens appear to approach nearest to the Conchoidal brown Coal of the Wernerians, were it not for the obvious absurdity of calling a substance brown, the color of which is in reality of the most perfect black. Other specimens, the smaller veins for instance, bear considerable resemblance to jet, and a third set to Cannel Coal, thus showing, that in reality, these are distinctions without differences. The two species of Mohs are, however, well marked, and, therefore, easily discriminated; and this not only by their chemical properties, but also by the more accessible character of specific gravity. The bituminous Coal, when not contaminated with foreign earthly ingredients, has a specific gravity below 1.4, the non-bituminous, above. To the former, our mountain Coal belongs, and its proportion of volatile ingredients, which I determine to be fifty-four per cent., assigns it a place near the most perfect Coal.

A practical division of the varieties of Coal has been: 1. Those which burn with much flame, but do not coke, or leave cinders, the refuse being a light ash. 2. Those which burn with less flame, but coke and leave cinders. 3. Those which, like charcoal, burn without flame, and leave a bulky and heavy ash. The first, which is comprehended under the bituminous species of Mohs, includes the Cannel Coal of Scotland, and Wigam Coal of Lancashire. The second division is also comprehended under the bituminous species of Mohs, and includes New Castle, Westmoreland, and Staffordshire Coal. The third is the non-bituminous Coal; the examples are Kilkenny Coal, Welsh Coal, and some varieties of Scotch Coal. The Burdwan Coal belongs to the first division, as do also some specimens of our mountain Coal, others again seem to burn with less flame, besides having a higher specific gravity than belongs to Coals of this class.

The localities of the mountain Coal yet discovered, are : 1. That mentioned in Lieutenant Cautley's communication, which has been already submitted to the Society. This vein or seam, I am told by Dr. Govan, was originally discovered, when the British army were encamped under Náhan, at the opening of the Gorkha war. 2. In the *Timlí* Pass, leading into the *Dehra Dún*, in a stratum of conglomerate. This Coal has the ligneous structure almost perfect, and differs but little in appearance from common Charcoal. The site is rendered remarkable by the saline efflorescence, and sulphurous incrustations which accompany it. Who was the first to observe this Coal, I cannot say ; but in 1817, I made notes of its occurrence, and in that year or the following, I sent specimens of it, by desire of a friend, to Mr. Ricketts, which the late Dr. Voyséy pronounced to be the brown Coal of Werner. 3. In the *Kherí* Pass, where it occurs in sand-stone, both in the form of an imbedded tree or log, with the ligneous structure almost perfect, and in numerous thin seams, having a strong resemblance in lustre and compactness to jet. This locality I discovered in April last : it is much more productive than either of the others : the principal vein, which I have compared to an imbedded tree, may be about twelve inches square. The product of this seam has a specific gravity of 1,4984. It is inflammable, but not without a high heat. It is most remarkable for its want of lustre till reduced to fragments, in which state it is not distinguishable from the jet-like variety : another curious peculiarity is the ease with which it is reducible into fragments of a certain size, and the resistance it opposes to any further comminution. In this property, its lustre in fragments, and its high specific gravity, it is easily distinguished from Charcoal, which it, in other respects, so closely resembles, as to be liable to be mistaken for it. It contains about fifty-four per cent. volatile matter, which being driven off, leaves a brilliant looking *Coke*, part of which was found to have a specific gravity exceeding that of water, part, less ; this induces the supposition, that the proportion of volatile ingredients is underrated, although it was found that, in the last hour

of the experiment, only 1.45 grain was lost, though exposed to a very considerable heat : the original quantity being one hundred grains. The retort broke at this period, and leisure was wanting for the repetition of the experiment. From the appearance of the products, which consisted of water, carburetted hydrogen, and an oily looking dark colored fluid, I should infer its resemblance to the Bovey Coal of England, from which, however, in external appearance, and in specific gravity, it differs sufficiently. The more resinous-looking varieties from this locality, in which the ligneous structure has disappeared, have a specific gravity of 1.386, a higher lustre, and are more inflammable. 4. In the same Pass, about half a mile from the preceding locality, my assistant, Captain Manson, discovered several other small veins, the Coal of which has a high lustre and conchoidal fracture.

The fifth locality, and the one best worthy of notice, is on the ascent from *Bhimauri* to *Bhím Tal*, in the bed of the *Balia*, close by the bridge over that stream. This vein was shown me by a Native, who also furnished me with a specimen, the half of which was Pyrites. The rock is sand-stone, and, as remarked of that in the *Kheri* Pass, is much discolored in the neighbourhood of the vein. The vein is about four inches in thickness, (that is, the largest, for there are several) and the Coal has a high lustre, and occasionally a perfect conchoidal fracture. No traces of organic structure are visible, the composition being impalpable. It is remarkable, as indeed are all the varieties, for its extreme brittleness, which is such, that no specimen of any size is obtainable. Were it not for this defect, many of them might be used as substitutes for jet, to which frequently they bear no inconsiderable resemblance. The present variety has, however, the aspect rather of Cannel Coal, and like that, when cut with a sharp knife, the surface is left full of small conchoidal depressions, which give it very much the appearance of a spongiform structure. This Coal burns with the most brilliant flame of any : occasionally being incrustated with sulphur, it develops the odour of that substance in combustion.

I shall here enumerate, for comparison, my determinations of the specific gravity of these specimens, with those of the best defined varieties, as distinguished by Mineralogists.

The Balia Coal,	1	3236	Splent Coal, (Govr. Colln.)	1	2903	
Another piece,	1	3287	<i>The following are from Books.</i>			
A third,	1	335	Bovy Coal, by Hatchett,....	1	13	} Bituminous.
A fourth,	1	3435	Glasgow Coal, by Ure,	1	23	
The Kheri Coal, (ligniform)....	1	4984	New Castle Coal, by Wat-			
Another piece,.....	1	43	son,.....	1	27	
A third, (piciform).....	1	386	Kilkenny Coal, by Thom-			} Non-Bitum.
Burdwan Coal, (Slaty)....	1	493	son,.....	1	43	
Cannel Coal, (Govr. Colln.)	1	278	Ditto, by Muschet,.....	1	60	

It will be, perhaps, asked; is this Coal, of which the traces are probably widely diffused in our sand-stone range, likely to prove of any value, or do these many indications afford any ground to hope for the discovery of more extensive and profitable deposits? To this it may be replied, that the considerations on which are founded the hope of discovering, in the neighbourhood of these mountains, the true Coal formation, are quite independent of its occurrence under this type and in this form. If any thing, perhaps, they are rather unfavorable to the expectation of eventually discovering beds of the true Coal formation. For it has been noticed, that in those countries in which the Coal beds are most largely developed, as in England, the traces of the mineral, in the superincumbent sand-stone, are rare, if not altogether wanting; while on the Continent, where the true Coal beds do not occur, small seams or veins are frequently met with in this rock.

But taking into consideration the arrangement of the surface in India, and the fact, that we have a trough, or basin, as it were, situated between

the great *Himálaya* system on one side, and the table land of *Makwa* on the other, bounded, too, by rocks that are always found associated with the Coal measures, it does not appear improbable that a valuable deposit of this mineral may yet be found somewhere between the line of secondary sand-stone described in this paper, and the primary sand-stone, which makes its appearance at *Dehli* and other places. But, for the full and correct consideration of this question, data are still wanting. The above are the containing rocks of the Coal formation ; it being never found above the one or below the other, and in this fact, combined with the configuration of the surface, are contained the true grounds on which the discovery may be looked for. Certainly not in the occurrence of the trifling veins and seams above noticed.

The grey-wacke formation being considered, by most Geologists, as synonymous with the old red sand-stone, the occurrence of Coal, underneath the former rock, does not invalidate the truth of the opinion, which assigns a fixed place to the Coal measures in the general arrangement of formations. It would appear, however, that the Coal found subordinate to grey-wacke is, generally, of the non-bituminous species. Another fact connected with the occurrence of Coal, as associated with this rock, is the prevalence of trap rocks. In the Indo Gangetic tract of mountains, grey-wacke supplies the place of the old red sand-stone, lying immediately on the rock described in this paper, believed to be the new trap rocks, which have not, however, yet been traced to any extent, although there are certainly indications of them in more than one place. The Coal found in the *Baía* does, certainly, lie very near the junction of the two rocks, and there are undoubted trap rocks in the immediate neighbourhood. In particular, I may enumerate a green stone, a felspar porphyry, and a porphyry, with a greenish grey basis, almost compact, with imbedded crystals of felspar. These circumstances bear some kind of resemblance to those described, as belonging to the Welch coal-fields ; but in the greater elevation of our grey-wacke, and the absence of every thing like a

Coal basin, the comparison fails: the Welsh Coal is, however, of the non-bituminous kind, and therefore not so valuable. The circumstances too, here noticed, on which, after all, no great stress can be laid, are only found in the neighbourhood of this single locality; all the others being far removed from the grey-wacke formation, and having no trap rocks in their vicinity.

