X.

NOTICE

OF THE OCCURRENCE

OF

COAL AND LIGNITE

IN THE

HIMALAYA.

By LIEUTENANT CAUTLEY.

To the Secretary of the Asiatic Society.

Sir,—Near the small village of *Siláni*, in the lowest range of mountains westward of the *Karda* Valley, about four miles from the point where the river *Choura Pani* opens into the plains, a Geological exposé of some importance has been developed by the slipping of the right bank of the *Jajar Nadí*, (which, at the point of fracture, rises from 70 to 80 feet) into the bed of the stream. In a series of alternations of indurated clays, and white micaceous sand-stone, seams of coal, varying from ½ to 2½ or 3 inches in breadth, are a prominent feature; their general position being at an angle of 80°, or thereabouts, though frequently interrupted by partial slips and sinkings of superincumbent and contiguous strata, which, together with their extreme minuteness, gives the seams more the appearance of a venous, than an alternating structure.

A stratum of a tenacious blue* clay, alternating with this micaceous sand-stone, appears to develope the greatest deposit of the above mineral, although the distribution of it throughout the bank is by no means confined to this particular spot, a similar deposit taking place about 200 yards lower down the stream, in the total absence of the blue clay, where the white sand-stone, of an extremely friable quality, is perforated with (to all appearance) veins of coal, having in its immediate contact a distribution of light earth, highly impregnated with native Sulphur.

From its appearance and mineral feature, I should class it in that variety which exists in the transition from common brown to pitch coal, a classification authorized by its alluvial position, &c. although the casual observation made by myself, urges me to confess, that the remark is made with considerable diffidence.

Color, velvet black, lustre resinous; principal fracture in the small fibrous, great, slaty; cross fracture smooth, and even in the friable specimens; in the large perfectly conchoidal; brittle and easily frangible, breaking into splintery, rhomboidal, or trapezoidal fragments; specific gravity 1.34; Burns slowly with a Bituminous (and in those parts which have been in contact with the white sand-stone a highly Sulphureous) odour; when

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* 'Shale clay,' Color denominated green bice verging to blue; texture foliated, unctuous and greasy feel. Breaks down by exposure to weather in rhomboidal, and irregular four-cornered pieces, adheres to the tongue, and plastic.

The stratum above mentioned had been partly excavated by the village people, who use it, as I was informed, in cleaning the floors and walls of their huts after solution in water.

Another species of indurated clay, or rather Shale, into which it passes, of a reddish color, and unctuous and greasy feel, containing imbedded nodules of the above blue clay, forms a great portion of the bank. The coal deposits, however, appear to be solely in alternation and junction with the blue clay, and white micaceous sand-stone.

ignited in open fire, it leaves behind a residue of a reddish brown color; does not soil with the touch; contains minute crystals of Pyrites. The general structure appears to consist of thin lamina parallel to the line of seam, jointed.

It is a matter of little doubt, that an excavation at the point where these seams have been discovered would produce a result highly satisfactory in the exposure of a greater deposit; as it is a circumstance not to be passed over, and well known to Geologists, that the presence of Shale, or the tenacious blue clay into which it decomposes, is supposed to be the strongest indication of the existence of a coal formation in its vicinity; and Aiken, in making the above remark, concludes:

"There are few situations in which this shale or clay occurs, where an "accurate search will not discover detached fragments of coal, and often the "crop or outburst of the seam itself; and even should these be wanting, it "will be well worth while to employ the borer, and pierce through the shale; "immediately beneath which a seam will be found, if it belongs to the coal "formation."

To the Secretary of the Asiatic Society.

Sir,—In continuation of the paper, which I had the honor of presenting relative to the appearance of coal in the *Jajar Nadi*, it is necessary for me to observe, that although the mineral, of which specimens are presented, bears undoubtedly the character of coal in a mineral sense, and as a specimen, may be admitted as such into a cabinet, there may be doubts whether, geologically speaking, its position, and the formation in which it has been discovered, would entitle it to a higher rank amongst the Bituminous minerals, than the intermediate grade between coal and peat, or a Ligneous deposite under various degress of Bituminization.

The presence of marine remains, which is supposed to be an essential distinction between the Lignite and Coal series, would leave but little doubt of the classification of the mineral in question: unfortunately, a very strict search has not discovered organic remains of any description: in conformity therefore to the experience of others, and particularly of Mr. McCulloch, who remarks, that marine remains occur in *all* the Lignites, I decline giving an opinion on a subject intricate in itself, and upon which so much uncertainty prevails even amongst the first Geologists.

The certainty of this mineral being coal, is rendered also less clear, from a further discovery of a carboniferous deposit in the same range of hills; in the proximity of similar rock formations; and in the presence, of a variety of the blue clay or shale, described in my last notice, which bears so decidedly the character of a Ligneous deposit, from the absolute exposure of trunks or roots of trees in a state more or less Bituminized, as to leave little doubt in my mind, that the venous appearance of the seams at *Silani*, which I did not satisfactorily account for at the time, was nothing further than the appearance natural to the ramification of minute branches or roots of trees;* more particularly, as the extreme high angle at which they were placed, together with the irregularity that prevailed in their position, would make it difficult to reconcile the arrangement with the outcrop of regular seams of coal: allowing, therefore, the possibility of an excavation discovering a coal series at this point, we may with safety refer the mineral found, either to Lignite itself, as defined by McCulloch, and with which it agrees in every respect, with the exception of the proximity of marine remains; or to some of the intermediate grades existing before the approach to coal.

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* *Coal pipes*, English Mines.

That these hills contain abundance of this matter is evident, and although in my visits to a number of the Ghats or passes, I have only discovered three deposits, viz. one at *Silani*, and two in the *Kalawala* Pass, eastward of the *Jumna* river, of which I hereafter make mention, I find so little difference in the rock, which constitutes the formation, and so much of the blue, red, and purplish clays and shales throughout the whole line, that a search more strict than my time or duties will allow, would, I am convinced, enable me to place these carboniferous strata amongst the general formations of the lower ranges.

Without entering into a detailed Geological Survey, it may be necessary, in elucidation of the present subject, to state, that these hills consist entirely of clays, sand-stones, and diluvial beds of various thickness, alternating one with the other without any appearance of regularity, inclining to the horizon at an angle of from 20 to 35° N. E. The sand-stone, more or less micaceous, occasionally abounding in white mica to such a degree as to modify the appearance of the rock, and as frequently bearing in its composition minute specks of black mica alone, varies from extreme pliablity, to a compactness, which, together with its slaty character, adapts it to use in buildings. It alternates, as I before remarked, with clays of various colours, and of various consistency, and also contains imbedded nodules of these clays from the size of a pea to a foot in diameter. The color, indeed, of the sand-stone, appears to be in a measure dependant on that of its adjoining stratum of clay, which frequently gives a consistency of extreme toughness when in connection, terminated by a conglomerate of clay, sand-stone, and frequently carbonate of lime, entangled in a confused mass. This conglomerate appears to be a leading feature throughout, appearing in distinct strata of variable thickness, and from the adhesive qualities imparted by the clay, in projecting points and abutments to the stream, where the sand-stone, unable to withstand the continued attrition, has been removed entirely.

The cement of this sand-stone may be considered as argilloferuginous, though, from the intimate mixture of calcareous matter that partially takes place, it effervesces with acids in a greater or less degree. In the white and light colored varieties, carbonate of lime appears to be the sole cementing ingredients, and throughout the whole of the formation, although partially admitted, calcareous matter may be considered as a general accompaniment. The springs from this cause, carry a quantity of lime in solution, sufficient to give a coating to the rocks over which they pass, as well as to form considerable deposites of Tuffa, though not in sufficient abundance, to form masses capable of being turned to account in lime burning. I have in my possession, specimens of Stalactites formed by these springs.

The enormous strata of diluvial gravel, rising at an angle of from 20 to 35 degrees, which add a feature to these hills of such great interest, are, in many parts, by the intervention of the calcareous ingredients, formed into a solid conglomerate, cemented by the chastest and purest lime. In conclusion, I cannot pass over a singular decomposition that takes place in these gravel beds; Boulders of the hardest and most compact rocks, amongst which I may enumerate granite, gneiss, mica slate, hornblende schist and green-stone, being reduced to a perfect state of friability by the decomposition of the felspar: a point upon which the limits of my letter will not allow me to enter, and which, therefore, is left to be described by those of greater experience and research.

Having given a cursory description of the formation itself, I now come to the first position, in which the carboniferous matter was found at the *Kalawala* Pass: the second, was found at some distance in the same line of hill, containing branches and roots much less bituminized, and more clearly defined in the impression of vegetable remains than the former.

The deposit consists of a stratum of loose arenaceous sand-stone, varying in color from white, which is generally in contact with the mineral, to various shades of red and yellow. The Lignite (by which name I shall call the substance in question) appearing in horizontal layers, frequently contorted, varying from minute threads to the thickness of one and two inches. At other places, transverse sections of trunks of trees, evidently flattened by a vast pressure, and the interior of which has been displaced by the ingredients of which the stratum is formed, are scattered indiscriminately: the state of carbonization to which they have arrived is various, some specimens of a reddish hue, appear as if half charred, soiling the fingers with an ochry powder, and of a texture hard and tough; whilst others, brittle, and giving way on exposure, present an appearance altogether similar to a coal deposit. To describe the appearance of this stratum, I can compare it with great correctness to the variegated mixture of color of a Tiger's hide, the stratum itself posessing a color precisely corresponding with the whitish red, while the position of the Lignite completes the resemblance in the addition of the black stripes.

This stratum lies between two others of conglomerate formed of clay and the calcareous sand-stone, of a quality extremely tough, under which is the blue clay, much inclined in position to the adjoining strata, which stratum is about a foot in depth, of a blue slaty colour, and globular concretionary structure, effervescing strongly with acids, and crumbling to pieces on exposure: the inferior strata consist entirely of a bluish sand-stone which terminates the section to the bed of the river. From the general inclination of the strata throughout these hills, it may be inferred, that an angle from 20 to 30 N. E. is the actual dip longitudinally.

In drawing a comparison between this and the coal at *Silání*, independant of the difference in position, and contiguity of the blue clay with the

coal, it may be remarked, that a very material difference exists, which may be considered as favorable to the latter being admitted as a member of the coal series. The *Silání* coal, although equally brittle at parts, comes out in masses, giving a large conchoidal fracture, is accompanied by Pyrites, as well as native sulphur, the result of its decomposition, circumstances not met with in the present deposits. The former may be accounted for, by the *Kalawala* not having arrived at that state of bituminization, which characterises that at *Silání*; but the latter, if it proves to be the case, that sulphur is totally absent at *Kalawala*, is an indication upon which we may form a very warrantable decision on its approximation and dependence on the Lignite family. The only doubt therefore that arises is, in the classification of the *Silání* mineral: that at the *Kalawala* Pass bears so decidedly the character of a submerged deposit of vegetable remains, bounded by the limits of its own peculiar stratum, that it may be placed with those carboniferous substances so frequently met with in diluvial beds, and the secondary sand-stones. From a point above the yellow stratum, in which a mixture of conglomerate had taken place, I extracted a specimen of a branch of a tree, the charring of which was so trivial, as to give it the appearance of a petrefaction: the diameter of the branch was about an inch; but the discovery of this alone, even had there been doubts before of the family to which it was allied, would, I conceive, have removed all difficulties on the subject. Throughout the whole, however, it may be observed, that the outer coating of the wood appears to have been the only part that has undergone the chemical change, the interior being in almost every instance replaced by the sand-stone or the rock in which it is imbedded.

The Second deposit at the *Kalawala* Pass, corresponds so closely with the description already given of the preceding, that it would merely be a repetition were I to enter into the details. The sand-stone, however, in which it is imbedded is of a bright yellow color arising from the same source, as the

coloring principle, throughout the formation, which appears to be oxid of Iron, as the presence of Sulpur could not be detected.*

In writing this notice, my object is to give local information alone, without any intention of entering into theoretical detail, or pronouncing an opinion on the origin of this stratum, or of the inclined position of the strata of gravel, which form such an extraordinary and unaccountable feature of these Hills: both of these subjects are worthy of a better pen, and I feel unequal to attempt such a description as would merit the notice of the Society.

The sand-stone formation, which extends from the entrance into the Hills to the clay slate that skirts the valleys of *Dehra* and *Karda*, and constitutes the mountain of that range, on which stands the Fort of *Jytek*, obtains in its proximity to the clay slate, a highly argillaceous aspect, as well as a tenacity adapting it to use in building, and to architectural purposes generally; its structure, moreover, depending on the smaller portion of the Mica, admits of its being easily worked, and formed into blocks of any thickness. A purplish and greenish color distinguishes the sand-stone in the *Nahn* and *Jytek* vicinity, from that of the lower ranges, as well as the presence of a metallic oxid, which, together with a variety of iron-stone, is found in nodules throughout the mass. I am not aware that this sand-stone formation has, as yet, been compared with that of England or other countries: to desire information therefore upon a subject which has, as yet, been little attended to, and in the hope of promoting an enquiry, as well as a strict Geological examination of the series to which this sand-stone may be referred, I

* Although I have been unable to detect Sulphur in this sand-stone, I am strongly of opinion that it exists, as specimens in my possession have every appearance, as far as color is concerned, of its presence.

shall conclude with an opinion, that it approximates to the red marl, or new red sand-stone of English Geologists. That it is daily forming, is a matter of no doubt whatever, but we must refer those beds alternating with the inclined gravel strata, to a catastrophe which has totally inverted the order of things, and evidently placed the *Dehrah* and *Karda* valleys between the debris and the parent rocks of the primary ranges. The vast slips and fallings of these Hills, provide boulders and gravel for the beds of the mountain streams, which must, of course, be undergoing a proportionable degree of elevation, in the depressions of the Hills themselves. This annual supply of new gravel may also account for the quantity of lime stone which is found in the beds of these streams, and which, after the annual rains, leads merchants and lime burners to the Ghats for the purpose of collecting and burning the stone.

A total absence of organic remains, a feature of the new red sand-stone of England, with the variety in color, impregnation with calcareous matter, and presence of carbonaceous, are points of comparison, assimilating it with the red marl of England.

It may also be observed, that a singular and striking peculiarity of these Hills exists in their peaked and pointed tops, resembling the outline of a primitive formation, more than that of simple stand-stone and its accompaniments. This peculiarity of appearance is, I consider, owing to the extensive distribution of clay and carbonate of lime, which protects it from undergoing the rapid decomposition and disintegration that would necessarily attend upon the sand-stone, if unaccompanied by these ingredients.