

ON THE SILURIAN DEPOSITS OF THE NORTH OF ENGLAND. 113

7. In conclusion, the Ludlow rocks alone remain to be considered, and on this point very little indeed need be said. The only locality in Scotland in which rocks of undoubted Ludlow age are known is in the Pentland Hills, but they here present the satisfactory feature of being highly fossiliferous, so that there cannot be the remotest doubt as to their true position and age. You are so well acquainted with these beds, both as regards their lithology and palæontology, that it is wholly unnecessary for me to make any further remarks about them. I will only add, that they are the undoubted equivalent of the Ludlow rocks of Kendal, which attain in the north of England a thickness of several thousand feet, and are charged with the characteristic fossils of the Ludlow formation.

---

*Thursday, 19th January 1871.*

JAMES H. SANDERSON, Esq., Councillor, in the Chair.

The following Communication was read:—

*On the Origin of Cabook, or the Laterite of Ceylon.* By H. F.  
ALEXANDER, late of Colombo, Ceylon.

(*Abstract.*)

The views embodied in this paper were the results of the actual observation of cabook, in its native beds in the vicinity of Colombo; and they were illustrated by specimens, by photographs, and by a map of the district, illustrative of the principal geological features.

Cabook appears to be a formation peculiar to the east. It is found in India, in Ceylon, and, it is believed, in the Malayan archipelago. Cabook is the name by which it is familiarly known to the natives of Ceylon. All the hills in the immediate vicinity of Colombo are composed of it. It forms the great building material of the district; and is largely used in the formation of the roads: it therefore meets the observer at every turn. Its colour may be said to be a brick red.

The received opinion is, that it is simply disintegrated gneiss; but, undoubtedly, there are strong reasons for believing that this view of it will be found to be wrong, and that further investigation will prove it to be of volcanic origin: a clay lava, if it may be so expressed. Tennent, in his work on Ceylon, styles it "a product of disintegrated gneiss," and refers, as authorities, to Drs Macvicar, Gardner, and Davy. In conversation with the writer, he stated that his views (though he had

never before been led to question them) were formed, not so much from conviction arising from close personal observation, as from a belief that they embodied the received and correct opinion, backed as it was by the authorities to which he referred.

Dr Davy is held by many as the great authority for this view of the matter; and all the greater, because he wrote professedly in the interests of science, and in his work devoted considerable attention to the rocks and soils of Ceylon. On referring to his work, therefore, it was a matter of surprise to find that it was entirely silent on the subject: not a single direct reference to cabook was to be found. An indirect reference to it was found at page 38 (the copy in the British Museum is here referred to), where, in discussing the soils of Ceylon, he writes,—“The best and most productive soils of Ceylon are a brown loam, resulting from the decomposition of gneiss or granite rock abounding in felspar, or a reddish loam, resulting from the decomposition of clay ironstone, called in Ceylon cabook stone.” It will be noticed that it is not cabook which Davy here asserts to be the result of the decomposition of gneiss or granite rock, but the brown loam to which he was referring; and that he assumes cabook to be as much an original formation as gneiss. This silence in such a work and on such a point is remarkable; and it would seem to imply that, unable to make up his mind as to what it was, he deferred the touching upon it to some future opportunity, when he might be able to pass a decided opinion.

Dr Macvicar, on the other hand, deals with cabook as nothing but disintegrated gneiss. He appears to have embraced the opinion that there is no trace of volcanic action in the island; and therefore he was shut up to this, the only reasonable solution of the matter left. Difficulties, however, are found at every step. If cabook is disintegrated gneiss, how is it that, instead of finding it along the banks of the rivers, and in the hollows of the plains, it is only found in the form of huge mounds or hills from 300 feet in height downwards? This and so many other difficulties rise up against his view, that he is compelled to admit that the idea of weathering is insufficient to explain the matter. He therefore falls back upon that of catalytic action *in situ*. If the transformation has thus taken place *in situ*, he fails to explain how it is that amongst the mountains of the interior (almost all gneiss) little if any cabook is to be found; that cabook only abounds at a distance from its presumed fountain heads; that it is not found in Europe and elsewhere where there is plenty of gneiss; and that, as we have noticed, it appears to be confined only to the line of a volcanic belt.

The traditions of the people, however, show that if there is

no volcano on the island, volcanic action on a terrible scale has visited it notwithstanding. According to these, large tracts of land, including many towns and villages, with hundreds of thousands of inhabitants, have been suddenly submerged by the sea. This, again, is corroborated by the antiquities of the island. There are scattered here and there ruins of large tanks, of massive irrigation works, and of what must have been extensive and populous cities. That population is not there now. Either it must have disappeared at the time to which these traditions refer, or some agent more destructive still must have caused it to do so since. If tradition is equal to hand down the one calamity, it is equally fit to hand down any other which could have occurred equal to the destruction of such a population. It has not done so. The presumption is that none such has occurred; that, therefore, the disappearance of the population dates from the time of these traditions; that at that time volcanic action showed itself to such an extent as to cause the population to fear, not the destruction of their cities only, but that of the whole island; and that they therefore fled from it. It is from this time that, at any rate, the most recent of the cabook hills may be dated.

There are also signs that the island even yet is not beyond the influence of volcanic action. The existence of hot springs is undoubtedly a proof of this. Another proof is that at particular parts of the coast—Colombo and Negombo, for instance—the sea has at different times made strange inroads. Nor are these freaks confined to Ceylon. They extend, as might be expected, to India. At Cochin, on the Malabar coast, the sea appears in 1867 to have played some extraordinary freaks. A local paper, after describing the puzzling inroads it had for some time been making, referred to a change in its procedure in these words:—"This change is both hard to account for, and dangerous to rely upon. Breakers appear far out at sea, and wiseacres say that the work of restitution is beginning." It then went on to describe how a jetty which used to stand in ten feet of water was, at the time of writing, high and dry at some distance from the sea. Such freaks of the sea, when they are not caused by any particular storm or exceptional high tide, and when thus continued for months, undoubtedly mark a slight local subsidence, or otherwise, of the land; and they are often the only means by which such can be discerned and gauged.

There thus appears to be undoubted evidence not only that the island of Ceylon is even now within the influence of volcanic action, but that, at a time not long past, it has been so acted upon to a very violent extent. If, therefore, anything is to be found in the island for which the action of the usual laws of nature fails to afford a satisfactory explanation, we are surely

justified in closely scrutinising whatever suggests, in connection with it, the idea of volcanic action.

Turn now to cabook, and consider it. It is just such a thing as has been referred to: the action of the usual laws of nature, so far as they come under our observation, fails to explain its presence. We have seen the difficulties which militate against the idea of its being disintegrated gneiss. As such, we expect to find it forming the soil of the plains, but we do not. Instead of occupying the low ground, we find it in the form of, huge mounds, 300 feet in height. To explain this, we are told that it has been metamorphised *in situ* in its original beds. We therefore expect that the great bulk of it will be found at its fountain heads, the mountains of gneiss in the interior. When we go there we find none at all! To all these, and a number of other objections, the theory of disintegration affords no explanation whatever.

If, however, we deal with cabook as a clay lava, thrust up on to the surface of the paddy-fields by a series of mud-volcanoes, all such difficulties vanish. Not only so, but a number of little facts meet us almost at every turn, which favour the idea in a very remarkable manner.

The cabook hills are just what one would expect hills of clay lava to be, after they had cooled down and solidified. They dot the paddy-fields like islands, or run into them like little peninsulas. They are all formed of one homogeneous mass, are all of an irregular form, and are all of a rounded tumular outline. They range in height from 300 feet downwards. There is little or no rock to be seen connected with them until you cut into the roots, when you come upon what may be said to form the shell of the island, gneiss, riven up at all manner of angles. This is just what should be; for, after bursting up through the gneiss, it would flow over, and hide it completely from sight. Rock is often enough seen in connection with the hills on the line of coast, but that is because the sea has laid the rock bare. In the case of wells sunk on cabook hills, after cutting down through some 30 feet of solid homogeneous cabook, the riven gneiss has been come upon. There was then no blending of the one into the other, an appearance which is now and then found, but the outline of both was sharp and defined. It suggested but the one idea: that the cabook had flowed over the gneiss before either had been exposed to the action of weathering or anything equivalent thereto. The word "equivalent" is here used, because, in the case of a semi-fluid mass rolling over the ground, as the cabook must of course have done, there could be no time for the action of weathering to take place. On the surface of the mass, however, where it would get cooled down, and broken and crushed as it rolled on, something equivalent to it must

have taken place. If, therefore, you suppose such to have rolled over a mass of gneiss very much weathered and rotten on the surface, you can easily understand how, in after years, each would appear to blend into the other. If the gneiss were also exposed to severe heat, it would be disintegrated still deeper. This would enable the surface drainage from the cabook above to percolate down into the mass of gneiss beneath, staining the latter at the same time in proportion as it was disintegrated. This gradual shading of colour would render the appearance of blending, or changing the one into the other, more puzzling than ever.

Another thing which might be expected in cabook, on the supposition of its having been a clay lava or semi-fluid, would be a striated appearance in the mass indicating the direction in which it had flowed, as well as a honeycomb look when viewed in cross section. In many cases both these appearances are very distinct. In old cabook walls, for instance, where the surface has become exposed, the different angles of the striation in the different blocks is often very marked; also in many gutter sides, when these have been cut through hard cabook. It was otherwise very marked at various places about Colombo. At a part of the small pass-road, the flow had evidently been at right angles to the present line of road, so that the sides of the cutting have here a honeycomb look. At the Colombo Railway Station, where there is a cutting from the station to the Marandhan road, the striation of the cabook on the east side of the cutting and at the end nearest the station, or towards the heart of the hill, is nearly vertical. Care must be taken not to confound this with the striation on the sides of the cutting caused by the rain, which is vertical also. Nor must it be looked for on the surface, as that is weathered and disintegrated for a considerable distance down. The striation to which reference is made, will be best seen about the level of the roadway of the cutting; but the mamotie must be used and a clean smooth surface exposed. Immediately north of the station, and between it and the then (1868) offices of the Public Works Department, appeared to be the very heart of the hill. The striation of the cabook was here all vertical. About fifty yards still further east, beds of gneiss, as fine as granite, appeared. It was riven up at an angle of from  $80^{\circ}$  to  $90^{\circ}$ , and on it rested beds of cabook 20 feet or more in thickness. Here, however, the striation of the cabook, instead of being vertical, was horizontal, and two flows, one over the other, could undoubtedly be traced. Still further east, where were the railway workshops, there were beds of river sand 15 feet or more in depth.

But the idea of cabook being a clay lava is forced irresistibly on the mind at a portion of the Colombo beach called the "Galle

Buck." The immediate spot referred to will be found about 30 or 40 feet from the foundation of the wall of the commissariat stores. A pathway ran thereabouts over the cabook referred to, which cannot be seen from the path. To see the cabook one must go down to the beach and among the rocks. Conglomerate and very coarse sand will then be found cemented to the gneiss and masses of cabook. But the actual beach at that part is that to which attention should be more particularly given. At ordinary times it is covered to the depth of three or four feet with sand washed up by the breakers, and which sand covers it for four or five months during each monsoon. At the change of the monsoons, or after some heavy gales, the sand may get washed away from it for a time. The beach is then exposed, and the cabook may be seen running between and around rocks and sea-worn boulders, and holding within its embrace these, smaller boulders, and stones and sea-worn shells, just as a plum-pudding holds plums, raisins, and currants. The stratification of the boulders, which are thus partly imbedded in it, is at all angles. A flow of cabook has thus undoubtedly rolled over this part of the beach at no very far past date, but of course long after the formation of the present coast-line. Another part of the beach for local geologists to examine, is that portion immediately north of the Fort, towards the Pettah. The beach is there formed of cabook. At this part will be seen what from the road looks like the ruins of some old wall running into the sea. On examination, however, it will be found to be a natural dyke, composed of a fine black sand cemented into a hard compact mass.

Should these remarks reach any local geologist, and encourage him to continue a close and minute examination of the matter, much additional and valuable light may, at no distant date, be yet thrown on the point in question.

---

*Thursday, 16th February 1871.*

GEORGE LYON, Esq., Treasurer, in the Chair.

The following Gentleman was elected a Fellow of the Society:—

ROBERT PATERSON, Architect, Edinburgh.

The following Communication was read:—

*Notes on the Coal-fields at Falkirk; illustrated with Drawings, and Specimens of Antholithes and its Fruit, Halonia, and other fossil Plants from that locality.* By CHARLES W. PEACH, A.L.S., Associate.