

to a Report on the Agricultural capability of New Brunswick, which he drew up during his recent stay in America, and which was brought out under the auspices of the local legislature. Not having yet seen that map, I am not aware to what extent, in the execution of the same plan, we have independently followed the same details; from the circumstances under which it was constructed, I presume it can give only a general outline of the distribution of soils in so large a district. That maps of the surface-geology of these Islands would be of great utility, must be obvious to every one who combines agricultural with geological knowledge, and who is aware of the extent to which our country is covered by the superficial deposits, whether we call them drifts, erratic tertiaries, or by any other name. Whatever may be the present fate of such maps, it may be safely predicted, that another generation will not pass away without seeing the construction of them firmly established as a recognised part of agricultural practice, and sedulously cultivated as an important branch of geological research.

4. *On the LIMESTONE QUARRY of LINKSFIELD, ELGIN, N.B.*
By Captain R. T. W. L. BRICKENDEN, F.G.S.

[This paper was withdrawn by the author with the permission of the Council.]

DECEMBER 4, 1850.

William Bennison, Esq., Thomas Rowlandson, Esq., and Henry William Taylor, Esq., were elected Fellows.

The following communications were read :—

1. *On the GEOLOGY of the UPPER PUNJAB and PESHAWR.* By
Major VICARY.

[Communicated by Sir R. I. Murchison, V.P.G.S.]

Introductory Remarks by Sir R. I. Murchison.—In communicating the enclosed letter from Major Vicary to myself, I beg to observe that he obtained his knowledge in an arduous campaign, which led the British forces into regions ordinarily inaccessible to geologists.

Independently of the description of an extensive range of those younger tertiary deposits in the Sewalik hills, with the contents of which we have been made acquainted through the letters of our associates Falconer and Cautley, Major Vicary now calls our attention to palæozoic fossils derived from the mountains which separate British India from Cabul. It appears that Dr. Falconer had previously obtained possession of fossils establishing this point, and I would now state that when I last visited Edinburgh, the Rev. Dr. Fleming showed me *Producti* and *Spiriferi* collected by his son Dr. A. Fleming, of the Company's Service, in the vicinity of the salt range at Musakhail

on the east bank of the Indus, which seemed to be identical with carboniferous forms well known in the British Isles. Being unaware at that time of any similar discovery, I urged my friend, the Rev. Dr. Fleming, to make his son's researches known to the scientific world, and to compare exactly the species collected in Western India with those of Scotland, with which he is so conversant.

Having since shown these fossils to M. de Verneuil, he has identified five out of eight or nine species with forms well known in rocks of this age in other parts of the world, viz.—

Productus Cora, *D'Orb.*

— *costatus*, *Sow.*

— *Flemingii*, *Sow.* = *P. lobatus*, *Sow.*

Orthis crenistria, *Phill.*

Terebratula Royssii, *L'Eveille*, and several other species of this genus.

Now these fossils have already been known to have an enormous geographical range; the *Productus Cora* occurring in Peru, Spitzbergen, Northern Europe, and the Sierra Morena of Spain; whilst two or three of the other species have an almost equally extensive distribution.

The observations of Major Vicary are thus augmented in value by the discoveries of Dr. A. Fleming; for they prove that the palæozoic rocks have a considerable range in the region of the Indus, a fact hitherto unknown to European geologists.

KAWREE PASS leads through a range of low hills rising in some places to about 800 or 1000 feet above the plain, and stretching in a north-easterly direction from Moong and Russoolpoor (near Julalpoor) towards Bhimber. The surface of these hills is barren and devoid of herbage, bearing only small and scattered trees. The formation is composed for the most part of yellow marly clays, with beds of a pale soft sandstone, the whole often capped with conglomerate. The boulders and gravel, disengaged from the latter, fill the water-courses, and are thence carried during floods some distance into the plain below. They are also scattered everywhere over the surface of the hills. I also noticed some thin beds of kunkur (travertine), but found no fossils during my hasty march through the Pass. I think that these clays, with kunkur, conglomerate, &c., will be found to belong to a tertiary formation noticed below.

The range of hills distinguished by Mount Tilla (a high and conspicuous landmark) is north of this range about 30 miles, running nearly parallel to it, with the Jhilum river passing along the intervening valley. The broken and hilly country, however, stretching from Mount Tilla, reaches nearly to the bank of the river, at a point a short distance north-east of Julalpoor. The range of hills entered by the Rotas Pass is a prolongation of that from which Mount Tilla rises, and the mouth of the Pass is probably not more than twenty-five miles east of it; the road, *vid Rotas*, as far as the Bukkur-Alla Pass (or nearly to it), about forty miles, leads along the bed of the Kuhan river, the sands of which are washed for gold-dust. The outer and lower hills at once reminded me of those I had seen in Scinde, at

Avah, and other places; the same barrenness and yellowish rusty colour of surface, with the broken-up conglomerate scattered everywhere; and here too I found some of the boulders composed of nummulitic limestone.

The sections exhibited by the river show thick beds of yellow marly clay, sandstone (calcareous), and conglomerate. The beds for the first half-mile from the entrance to the Pass are nearly vertical; farther on they acquire a southerly dip, and at last become nearly horizontal; while farther on, near Rotas Fort, the dip is from 45° to 50° west. Near the Fort the clay beds become more developed, the upper beds being often conglomerate with a calcareous cement, from 3 to 10 feet in thickness; some of the boulders here are of nummulitic limestone. Beneath this, the clay beds and thin beds of sandstone alternate. Nodules of kunkur (travertine) are found in the clay. I found some broken pieces of fossil bone on the top of one of the hills near the Fort.

The same low hills and a similar formation are met with about a mile north-west of Bukkur-Alla village with a varying dip; at Udde-rana, about the thirteenth mile, it is nearly horizontal, and again at the village of Bukkur-Alla, dipping 35° to 45° west. The formation at this place assumes all the characters common to the Sewalik mountains at the base of the Himalayas, near Nahu. The upper bed usually is a calcareous sandstone 3 to 6 feet in thickness, partially covered by the remains of a calc-cemented conglomerate. Fossil bones are found in considerable abundance both in the sandstone and conglomerate, but I believe chiefly from the latter; they are found either in the water-courses, or even on the tops of the hills, detached by the action of the elements, or *in situ*. Beneath the sandstone there is a bed of marly clay with kunkur (travertine) nodules; in the lower part of the sandstone, and also in the upper part of the clay bed, I found numerous *Helices* (*Vitrinæ*?) and *Pupæ*, their interiors being filled with calc-spar. The bones I recognized belonged to the elephant or mastodon (too heavy to carry away), some large Ruminants, Saurians, and Chelonians.

Passing on in the direction of Tumiak, and at about one mile from Bukkur-Alla, the stratification becomes much confused; the sections exhibit deep-bedded, marly, yellow clays and conglomerate, possibly pliocene.

Hence to Bukkur-Alla Pass about five miles; the clays here have been denuded, and the beds which come to the surface are composed of red shale and clay, usually thick-bedded, sandstone and conglomerate, with a dip of from 60° to 90° to the north-east. The beds of red shale and clay being of a soft and incoherent nature, are easily acted upon by the weather, and, owing to degradation, have left the sandstone beds standing out like walls, with the upper margins indented in a grotesque, and often castellated manner. These beds are often of little thickness, and are occasionally surmounted by beds of conglomerate. This formation I believe to be eocene; it is found under various circumstances as far as Jianee-Sung, near the base of the Murgulle range of mountains, but always with considerable dip;

the edges of the beds occasionally showing themselves at the surface all the way.

The Bukkur-Alla Pass is about a mile from Tumiak, and the ascent may be about 500 feet. From this, towards the Murgulle range, a plain, apparently with a somewhat level outline in a general sense, but really an undulating and often broken country, intervenes; the whole distance being probably about sixty miles.

Tumiak is situated on a pliocene formation, which, with many intervals, is traceable into Peshaur and even into the Khyber Pass, and I think it probable that the low range of hills stretching along the left bank of the Jhilum, from near Julalpoor towards Bhimber, belongs to the same formation. Near Tumiak, on the left bank of the Suhan River, a good section of this formation is exposed, showing a depth of about 400 feet. It here consists of deep beds of yellow, marly clay, with travertine nodules, and exhibiting near the base of the whole some unconnected beds of a pale soft sandstone. The clay beds are separated by thin beds of boulders, in some places cemented into conglomerate; the lowest of these beds is about 10 feet thick, and composed of large boulders. In several places the rain-water has found its way through the clay beds down to this bed, and, from its sapping action on the clay, has formed many somewhat circular deep funnel-shaped pits, some of considerable size, but particularly so near the escarpment. The whole of this formation is nearly horizontal, and, whether in Peshaur or at other intervening places, is in a rapid state of degradation. In a few years, geologically speaking, it will disappear. During every fall of rain, large quantities of debris are carried into the water-courses and rivers, the finer portion of which, I have no doubt, contributes to the elevation of the country near Mooltaun and the banks of the Indus.

Hence to Pukkaderace 14·3 miles. The pliocene is here cut into deep ravines, showing perpendicular sections, particularly at the Seraee.

Twelve miles and a half farther on to Munikyala, chiefly over the pliocene clays, but the edges of underlying red shales and sandstones occasionally come to the surface. The country round Munikyala is undulating: on looking over the surface, it appears like an extensive plain, but it is much broken and cut up into ravines.

Hence to Hoormuk, on the left bank of the Sewan river, ten miles, partly over the same pliocene; near an old Serace, and about the sixth mile, the conglomerate beds, sandstone, and red shale are pushed above the general level, the sandstone and conglomerate forming walls more than 100 feet in height, with a strike north-east and south-west, the dip from 85° to 90° south. The red shales and clays form the thickest beds; and here too, from the action of the elements, they have been degraded into troughs, and even ravines, leaving the harder sandstone and conglomerate to form either walls above the general level, or sharp precipitous escarpments to the ravines. However, in this neighbourhood, and indeed to the Bukkur-Alla Pass, the upturned edges of these beds have a tolerably equal elevation. Looking over the plain east and west, the country ap-

pears ridged with slightly elevated lines and intervening hollows. These hollows are many of them still filled with the pliocene clays to a level with the upturned edges of the sandstone, &c. The pliocene is deep-bedded on both banks of the Sewan river; the conglomerate on the right bank, deep-bedded and held together by a calcareous cement, caps the yellow marl, and is nearly horizontal.

Crossing the Sewan to Rawul-Pindee, about ten miles: at about the third mile, and in the deeply-excavated bed of a branch (or tributary) of the Sewan, I again found the upturned edges of the red shale, clay, sandstone, and conglomerate, which are here nearly vertical; the dip slight and southerly; the strike east by north and west by south.

In a thin bed of conglomerate, with red shale above and below it, I found part of a large tusk, which belonged either to a mastodon or elephant; this broken specimen, *in situ*, was about 2 feet in length, 4 or 5 inches in diameter, and strongly curved. I shattered it to pieces in an attempt to dislodge it. The cement of the conglomerate is very hard and tinged with the red colour of the shale, as was also the fossil.

I noticed here that thin beds of conglomerate and sandstone often alternated. The higher land forming the banks of the river at this place are capped with conglomerate resting on yellow marls, the whole resting on the edges of the red shale, &c.

I found *Pupæ* and *Helices* in the clay. Farther on, in the direction of Rawul-Pindee, there are sections of thin clay 200 feet in height. From these I collected numerous *Melania*, *Helix* (or *Vitrina*), *Pupæ*, and other terrestrial or lacustrine shells.

In the bed of a small water-course, about a mile south-east of Rawul-Pindee, I again came upon the red shales and conglomerate, with the strike and dip noted above. The conglomerate and sandstone here have an intensely hard cement, and the pebbles in the former are small. Firmly imbedded in the weathered surface of these beds I detected numerous fossil bones; I was hurried at the time (on the line of march), and could only disengage a few broken fragments.

From Rawul-Pindee to Jianee-Sung, thirteen miles and a half: over the pliocene for the greater portion of distance: in many places I remarked large masses, or rather irregular rocks of travertine, partly or altogether disengaged from the yellow pliocene clays; and in some sections near Jianee-Sung I observed this travertine forming distinct beds in the yellow marl, having its upper portion soft and porous, but becoming hard and solid downwards.

From Jianee-Sung one mile and a half to the Murgullee Pass, and the range of hills through which it leads; the land gradually rises; the surface is everywhere covered with loose rounded boulders, many of which are nummulitic limestone. Sections obtained near the base of the Hill-range exhibited the same conglomerates and thick-bedded yellow marls previously noticed. I was unable to obtain any particular name for this range of mountains; I shall therefore call it the "Murgullee Range," from the name of the Pass. Their direction coincides with the strike, viz. east by north and west by south;

the dip southerly, the angle varying much at the different points examined.

Near the base of the southerly side I noticed some beds of a coarse hard limestone of a reddish tint, containing an abundance of broken shells, all tinged with a bright red colour: higher up the hills, which are limestone, and particularly on the northern face, I noticed some beds abounding in *Nummulites*, but I detected scarcely any other fossils in my hurried visit: a *Pectunculus* and some *Polyparia* were however found.

The part of these hills visited is about a mile east of the Murgullee Pass, and I imagine about 1500 feet above Jianee-Sung. The base of the range here is little more than a mile and a half across, but further to the eastward the base expands, and the mountains attain an elevation of 2000 to 3000 feet above the country beneath. I was informed also that, in the same direction, sulphur-mines have been worked.

The pliocene clays and conglomerates are again found covering the northern base of these mountains and filling the depression between the Murgullee hills and Hussun-Abdal. The latter place is situated at the foot of some hills, attaining an elevation of 1500 feet above the plain. I was unable to examine the hills, but judging from what I saw, they are limestone: round their base and on the banks of the river (a branch of the Aroo river) are scattered numbers of water-worn boulders, many of which are granite, brought here in all probability from the mountains to the eastward. The gravel of the Indus, at Attock, also contains many granitic boulders, which have been brought down the stream from the same direction.

From Hussun-Abdal to Attock, about thirty-five miles, for the most part over the pliocene formation; it is much broken and cut into ravines, some of which widen even into broad valleys, now under cultivation. At other points, where disturbing causes have not affected it, elevated plains of considerable extent remain unbroken and with a pretty level outline. The sections bounding these elevated plains are usually abrupt, but particularly so near Boorin, the height above the denudation being from 200 to 300 feet. These sections often exhibit beds of travertine, which, when sand is in excess, passes into a pale, soft, calcareous sandstone. A fine *Pupa*, now existing plentifully from the Jhilum to the Khyber Pass, is found abundantly in this formation along with others mentioned above.

The Fort of Attock is situated on the northern base of a range of slate mountains, to the age of which I could obtain no clue. The slate beds near the foot of the hills are very dark-coloured; higher up the rock becomes paler and of a blue tint, and is easily split; at one place I noticed men at work splitting it into slabs for headstones for the graves of the Moosulmauns. The pliocene formation is found round the base of these hills, resting horizontally on the edges of the slate. To the eastward the action of the Indus seems to have destroyed it for a considerable distance inland from both banks.

East and north-east from Attock there is an extensive alluvial plain, covered at the time I passed (March) with fine crops of grain.

The river, on reaching Attock, has to force its way through a narrow gorge between the slate mountains which rise on both banks, and it is only necessary to imagine this gorge closed, to form extensive lakes over much of the country where I have noted the existence of pliocene deposits.

Crossing the Indus and *viâ* Geedur-gullee Pass to Akhora, about eleven miles;—the Pass nearly half the distance leads through a formation, chiefly slate, occasionally showing thin beds of an altered limestone and veins of quartz. The beds are usually nearly vertical; the dip to the south, with an east and west strike. I saw no fossils; indeed in both going and returning I was obliged to move on quickly.

Disengaged from the Geedur-gullee, at about the fifth mile, and near the village of Nuwazeerun, I again noticed the pliocene formation; the Caubul river has here cut its way through it. On the left bank it appears to be elevated and to form some low hills, rising 300 or 400 feet above the river. I was unable to cross and verify this observation, but obtained sections on the right bank down to the slate rocks. First, in descending order, there is a thick bed of yellow marl with numerous individuals of *Melania*, *Pupa*, *Helix*, and *Unio*, all in a state of decay, usually crumbling to pieces on being taken out. Beneath this travertine (kunkur) there is a bed of conglomerate, included in which I found some pieces of pottery. Next came yellow marl with *Septaria*; below this a thick bed of conglomerate with a calcareous cement, beneath which the yellow marls were again repeated. In the lower conglomerate I found the rib of some large animal (Camel?); it was so firmly held by the cement that I could not free it without fracture; the cancellated structure of the bone was not entirely filled up, and its mineral state would at once refer it to the most recent geological period.

From Geedur-gullee the slate hills recede southerly from the Caubul river, forming the southern boundary of the Peshaur valley (or rather basin). As far as the eye could reach I traced the pliocene formation along their base, deeply cut into ravines by water-courses, and perhaps from other causes; but, although so broken, the surface-outline holds nearly the same level throughout, except near the base of the mountains, towards which there is a slight and gradual rise. Near Akhora I noticed many huge masses of an igneous rock scattered along the banks of the river, but could not discover whence they came. Sections nearer to the town of Peshaur showed beds of the gravel and conglomerate thicker, but in other respects similar. Near Jumrood, and along the base of the Khyber mountains, the pliocene clays are replaced by boulder and gravel, derived chiefly from the Khyber range. The pliocene, however, is found even in the mouth of the Khyber Pass, and the cave dwellings of the Khyberees are excavated in it.

Owing to the intractable and savage nature of these people, it was impossible to examine the Hill country*; I was obliged to content

* Dr. Bow of my regiment, eager to aid me, mounted his horse, and rode to the foot of the nearest hills with the intention of bringing away specimens of the rock: he had scarcely got there when he found himself suddenly in the midst of

myself with the most angular and freshly detached boulders obtained from the water-courses leading from the mountains. In some of these (limestone) I detected a small *Spirifer*, *Orthis* in abundance, a *Terebratula*?, and some *Polyparia*. But I fear some time will elapse before more conclusive information with respect to the geological history of the Khyber mountains can be obtained*.

For these notes which were made on the roadside, during the pursuit of the flying Seiks by the division under General Gilbert, and eventually to the Khyber Pass, in pursuit of Dost Mahommed and his Afghauns, I have to crave some apology. I could only record whatever came under my observation on the line of march, and was unable to devote the time and attention which strict geological investigation demands. I believe, however, that I have been able to bring to notice the existence of a deep-bedded and extensive pliocene formation, extending, with intervals, from the Jhilum river to the Khyber Pass. The formation, holding a westerly dip near Rotas and the village of Bukkur-Alla in which fossil bones were observed, I should approximate to the age of the Sewalik range of hills flanking the base of the Himalayas, and which have been so ably illustrated by the labours of Dr. H. Falconer and Captain Cautley. Dr. A. Fleming, who visited Pind-Dadun-Khan and the salt-mines, appears to have met with the same formation near Baghauwala and Mount Tilla†. I stated above that the Rotas hills were a prolongation from the base of Mount Tilla to the eastward.

The red shales and clays, sandstone and conglomerate beds beneath, to which I have ventured to apply the term Eocene, are, I have reason to think, the same formation so productive of salt near Pind-Dadun-Khan. It is true that, with the exception of fossil bones, I found nothing in these beds to enable me to identify them; but Dr. Fleming's account of the salt-yielding shales‡ leads me to this conclusion. Further, I believe that the red shales near Subathoo belong to the same series; and this observation gathers weight when we remember that salt§ is obtained from the red shales of the Mundee district, on the right bank of the Sutlege, within fourteen miles of Belaspoor and hardly fifty miles N.N.W. of Subathoo. Dr. H. Falconer in a letter to me states that he found these red shales, &c. between Nahu and the Choor mountain, about sixty or seventy miles south-west of this (Subathoo), and also mentions his suspicion that they correspond in age with the red shales and limestones noticed by him in the salt range of the Upper Punjab.

I continued my exploration of Subathoo and its vicinity during the last cold season, and can now with certainty state that fossil

armed Khyberes; they fired at him, and during his hasty flight, the horse refusing a leap, he was thrown; fortunately, however, he again caught his horse, and escaped without injury.

* Dr. Falconer obtained specimens of *Spirifer*, *Orthis*, and other palæozoic forms, from these mountains some years ago.

† *Vide* Calc. Journ. As. Soc., No. 205. p. 673.

‡ *loc. cit.*

§ This salt is called Goomba; it is very dark-coloured and impure; much fine gravel is often diffused through its substance, some of the grains of which have an organic appearance (*Foraminifera*?).

bones, but particularly saurian, are to be found over an area of ten miles; I have found them in the red shale, in a bluish pale-coloured shale, and in the limestone beds. The bluish shale passes gradually into the limestone beds, and the fossils are similar; they are, however, very ill preserved in the shale and often recognised with difficulty.

I hope at a future time to be able to give a more minute account of my present locality, Subathoo.

2. *On the SILURIAN ROCKS of DUMFRIESSHIRE and KIRKCUDBRIGHTSHIRE.* By R. HARKNESS, Esq. *Communicated by J. C. Moore, Esq., Secretary G.S.*

IN addition to the detrital, superficial deposits of sand, gravel, and clay, the geological formations of the county of Dumfries consist, in descending order, of a red sandstone, the age of which is not yet determined, of coal-fields and carboniferous limestone, and of Silurian rocks.

The greater part of the county (excepting always many masses of trap rock) is indeed exclusively occupied by rocks which I consider to be of Silurian age, and which cover an area more than twice the size of that possessed by the other formations conjointly. The Silurian formation is exhibited in few natural sections, the country over which it prevails consisting in a great measure of comparatively low undulating hills, covered with soil and debris. The course of the rivers, moreover, which drain the district being in a great measure through valleys filled with the newer deposits, it is chiefly in the smaller brooks that such natural sections can be obtained, as afford an insight into the constituents of the Silurian rocks. These and the cuttings of the railways, combined with a few small quarries, are the principal means by which the rocks are exposed; and consequently it requires a considerable extent of country to be traversed, and a number of brook-courses to be examined, before any idea can be formed on the nature and relation of these deposits.

The term *greywacke*, as it is generally used, well expresses the mineral nature of the rocks which compose the Silurians of Dumfriesshire, whether these rocks assume a schistose or a granular character; but the term *slate* is totally inapplicable, inasmuch as no true slaty cleavage has hitherto been discovered amongst them. Greywacke is not, however, the exclusive composition of the mineral masses; for in some localities soft shale, resembling in every respect the shales of the coal formations, is found. Besides this soft shale, beds of anthracite occur; and so intimate is the connection between the latter and the soft shales, that the one is a constant concomitant of the other.

Anthracite and Graptolite Schists.

First Band.—Commencing near the mountain of Hartfell, one of the highest in the south of Scotland, and near the junction of Dum-