

SKETCH OF THE GEOLOGY OF BIARRITZ.

Chiefly drawn from a Thesis by Monsieur Joseph Delbos.*

MONSIEUR DELBOS, after much research, has determined that the cliffs at Bidart consist of the cretaceous rocks, and that these cease going northward towards Biarritz, and are succeeded by beds of the Lower Eocene. The very lowest of these, however, does not appear on the coast, namely, that which he designates as "Marnes à Terebratules." The first, which is found to the north, beyond the chalk formation on the coast, is a calcareous rock, containing a species of *Serpula*. Mons. Delbos writes as follows :—

"I now propose definitely the following divisions for the nummulitic deposits of the basin of the Adour.

- "3rd. Upper Series { 1st. Operculine free-stones.
2nd. Limestones with *Eupatagus ornatus*.
- "2nd. Middle Series—Nummulitic limestone with *Serpula spirulæa*.
- "1st. Lower Series—Clays with *Terebratula*."

M. Delbos then gives an explanation of his section of the coast, starting from the point *a*, and going northward.

"North of the mass of siliceous limestone, of which I have already spoken, and which belongs incontestably to the chalk formation, there is an extensive depression, occupied by sands blown in from the shore, and which interrupts the continuity of the escarpment for the distance of rather more than a quarter of a mile. Beyond this depression the cliff recommences, and from the point where it first appears abundant specimens of fossils characteristic of the nummulitic formation may be collected from a large fragment which lies detached at the foot of the cliff. (*Nummulina*, *Serpula spirulæa*, *Vulsella falcata*, &c.)

"Starting from this fallen fragment, the cliff is formed of a yellow limestone, somewhat sandy in its texture, in which here and there softer bands occur. These beds dip E.N.E. Further on, these yellow beds alternate with blue ones of the same texture; presently, their inclination suddenly changes, and they dip south at an angle of 25°, and this continues to the end of this part of the cliff, where the blue argillaceous beds gain the predominance. The calcareous rock has been worked in several quarries which have been opened in this cliff, and it affords a sufficiently good stone for rough building-purposes. It is rich in fossils; among the species which it contains, I may mention *Guettardia Thiolati*, *Serpula spirulæa*, &c.

* Theses présentées à la Faculté des Sciences de Paris pour obtenir le grade de Docteur es Sciences Naturelles. Par M. Joseph Delbos, Préparateur d'Histoire Naturelle à la Faculté des Sciences à Bordeaux. Soutenues le 4 Décembre, 1854.

"Facing this cliff, there are some rocks which appear above the sands of the shore; at first the yellow sandy limestone but just discovers itself above the surface of the sand, and here it contains the same fossils as the escarpment itself; but further on, and distant about 120 yards from the cliff, there rises a large wedge-shaped mass, named 'La roche pointue,' composed of yellow sandy limestone, and of white limestone containing *Nummulina spissa* and *Serpula spirulea*.

"Another depression, traversed by the little stream which is designated 'Ruisseau du Moulin d'Estaigh,' again interrupts the continuity of the cliff. A sort of connexion between the two cliffs is kept up by a bluish argillaceous limestone containing many fossils,* and which appears here and there above the surface of the sand. * * *

"Continuing the examination of the cliff, beds of bluish clay are first observed, which dip at about 45° to the S.E.; these beds are alternated with narrow bands of limestone of the same colour, containing *Pygorhynchus sopitiamis*, &c. These beds soon become horizontal, and retain the same position to the end of the escarpment.

"The alternating beds of limestones are of a yellowish shade (see Sketch of cliff). These and the associated argillaceous beds become much disturbed and bent, then dip almost perpendicularly, and a little beyond the ophite rock, soon to be mentioned, entirely disappear under horizontal beds of alluvium.

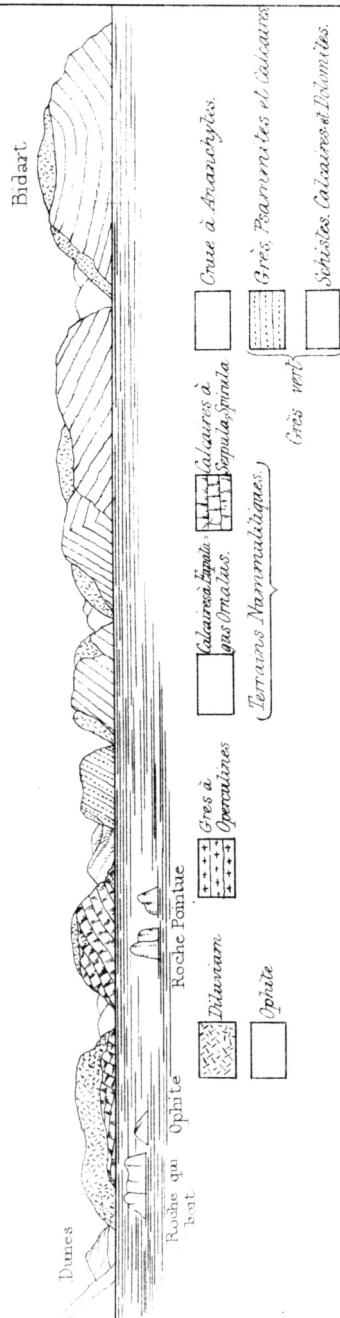
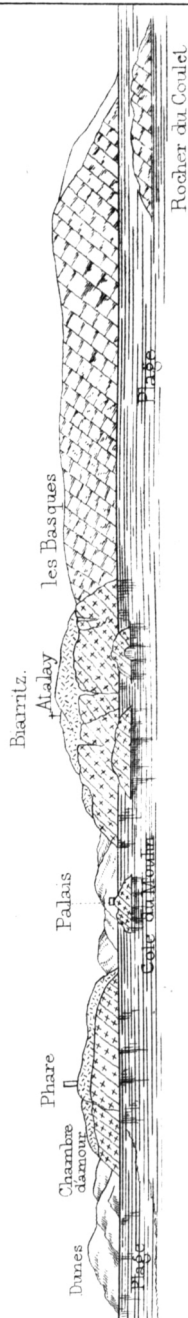
"It is precisely opposite this cliff that the large rock stands which is called 'La roche qui boit:' it is an enormous block, ten or eleven yards high, of extremely hard limestone, very white, and slightly saccharoid. The action of the waves has partially polished its surface; it contains an immense quantity of altered nummulites (*N. spissa*). The colour and the quality of this limestone, so unlike the rocks of the cliff, are due unquestionably to the influence of the ophite which appears about thirty-five yards south of the 'Roche qui boit,' under the form of a little rock, visible only at low water. This ophite is of a beautiful green colour, and has gained a fairly good polish under the action of the waves charged with sand, which beat against it perpetually. It is girdled at the distance of about twelve yards by a sort of semicircular belt of magnesian limestone, notched at its upper edge, blackish, and in some part red (also of a lovely grey), traversed by thread-like veins of sulphate of lime, hard enough to be partially polished. The seashore sand prevents the establishment of the connexion which exists between the ruptured beds of calcareous rock and the ophite."

Here M. Delbos omits entirely to mention that the remainder of this escarpment, till it sinks like the previous one, beneath drifted sand-hills, is composed of horizontal beds of modern deposit, from thirty to forty feet in elevation, and rich in vegetable matter. He continues thus—

"Beyond the last-mentioned interruption in the continuity of the

* Among others, I have found here remains of a crustacean resembling a crab.
—A. D. A.

SECTION ALONG THE COAST NEAR BIARRITZ.



cliff begins a long rectilineal escarpment, which extends to the 'Port des Basques,' marked out with great regularity to the N.N.E., for the distance of rather more than a mile. Opposite the point where this cliff begins, there rises in the sea a rock much more considerable than those we have hitherto met with, and which is designated by M. Thorent the 'Rocher du Goulet;' it is formed of grey-blue limestone, tolerably hard, and worked as building-stone; it dips to the N.N.E., and encloses a great quantity of fossils." (This rock has been so much worked for building that it is below high-water mark, 1861.) "The cliff itself, throughout its whole extent, presents a very uniform appearance. It consists exclusively of alternate beds of bluish clay and soft limestone of the same colour, dipping regularly to the N.E. at an angle of about 40° or 45°. The only fossil found there is the *Serpula spirulæa*." (As you approach the Port des Basques, the beds become richer. On the shore, imbedded in the rock, I have found several varieties of shells, and also a good deal of wood.) "This long clay cliff terminates abruptly at the Port des Basques against the promontory of Biarritz.

"Here begins a new system of deposits, harder than those which we have hitherto described, and to this circumstance is due the singular aspect of the whole of this mass of rock, fantastically worn by the sea. * * * It is composed of yellow arenaceous limestones towards the south, intermingled with beds of arenaceous limestone of a bluish shade, which, advancing northward, become more and more abundant. These limestones enclose an enormous quantity of small nummulites (*N. intermedia*), which of themselves almost form small beds; the *Eupatagus ornatus* is also sufficiently plentiful; finally, round the 'roche percée,' the *Scutella subtetragona* is frequently met with; this fossil has, no doubt erroneously, been stated to be found in the Dax beds. * * *

"In the regular strata, rolled pebbles of hard grey subsaccharoid limestone, and also of black flint, may be frequently observed; they are the *débris* of the siliceous limestone of the chalk period, similar to those in the escarpment of Bidart, and which must have existed as rocks on the shore of the sea in which the nummulitic beds were in process of formation.

"The whole strata which form the mass of the rock at Biarritz are overlaid by a very modern deposit of yellow sand, which on the Attalay attains the thickness of at least fifteen or twenty yards. (This modern deposit beyond the Attalay, beneath the Empress's chapel, contains wood and great masses of vegetable matter.)

"Beyond the point of Biarritz begins the 'Côte du Moulin,' bordered at first by little escarpments, surmounted by some sand-hills. These escarpments are formed of a very sandy bluish limestone, with some yellowish bands containing an abundance of the *Nummulina Biarritziana*, also the *Eupatagus ornatus*, the *Schizaster rimosus*, &c. Low sand-hills occupy the space beyond, for a distance of 600 or 650 yards, after which follows a steep cliff, twenty-five or thirty yards high, composed of bluish sandy limestones, with some yellow bands, con-

taining but few fossils (*Pecten*, *Ostrea gigantea*), and dipping to the N.E. at an angle of 25° or 30°.

"Below the lighthouse a very hard fine-grained limestone, or rather a calcareous freestone, presents itself intermingled with the other beds, and containing *Cytherea Verneuilii*, &c. Some deposits containing pebbles, ten or twelve yards thick, overlie the whole of these beds.

"Beyond the Point St. Martin begin the cliffs of the 'Chambre d'Amour.' They are formed of somewhat soft sandy limestones, with *Operculina*, *Ostrea gigantea*, and *Venus transversa*; here also may be observed the same beds of hard bluish calcareous freestone with *Scalaria*, &c., as those beneath the lighthouse. At the extremity north of the little bay, the hard freestone is scattered, as it were, through the softer sandy rock in the form of flattened detached nodules, disposed in somewhat regular beds. Advancing from the lighthouse, these nodules increase in volume and become blended together in more continuous masses, till at last they entirely replace the more friable rock, in which at first, beneath the lighthouse, they only partially appeared.

"The preceding description leads naturally to the following conclusions :—

"1st. The nummulitic strata of the cliffs of Biarritz dip regularly to the N.N.E., except for a short space where their inclination is in a reverse direction, opposite the ophite rock. Consequently, in following the coast-line from the commencement of the nummulitic cliff to the point north of the Chambre d'Amour, the strata are in regular sequence from the older to the more modern deposits.

"2ndly. From the commencement of the nummulitic cliff to the Port des Basques, there is a vast system of calcareous deposits, first arenaceous, afterwards argillaceous, and characterized principally by the *Guettardia Thiolati*, *Num. spissa*, *N. complanata*, *Serpula spirulæa*, &c. At the Port des Basques these beds disappear beneath the following deposits.

"3rdly. From the Port des Basques to the St. Martin lighthouse, that is to say, through the whole mass of the point of Biarritz, and a part of the Côte du Moulin, yellow or blue sandy calcareous deposits, with rolled pebbles of flint or limestone, follow the strata previously described. The fossils of the former beds are no longer found. Their place is taken by the *Eupatagus ornatus* and the *Nummulina intermedia*, which appear for the first time.

"4thly. Finally, from the lighthouse to the extremity at the Chambre d'Amour, a system of hard, fine-grained, calcareous freestone is developed, associated with *Operculina* sands. These rocks no longer contain the *Eupatagus ornatus*, nor the *Serpula spirulæa*, but they present a certain number of fossils, for the greater part identical with the species found in the Paris basin, and unquestionably characteristic of the Tertiary period. The *Operculines* seem here to replace the *Nummulites*."

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The work from which I have quoted contains an elaborate account

of all the formations of the valley of the Adour ; but I do not wish to extract details beyond those which relate to Biarritz.

With regard to the rich beds of well-preserved shells found near Dax, and in some other parts of the Landes, the same author places them in the upper beds of the Miocene.

He writes on this point as follows :—

“The shelly deposits of the Upper Miocene of the basin of the Adour are represented at three points—one is in the Commune of St. Paul, near Dax. * * *

“At St. Paul, the yellow sandy beds contain an enormous quantity of fossils, and crop out at a great number of points from beneath the sands of the landes.” * * *

In the Upper Miocene of this region there appears to be one limited deposit, but a well-defined one, of fresh-water origin.

“Upper group, Sand of the Landes.” This he places decidedly as the Upper Tertiary, or Pliocene.

He says, “This formation, which plays so important a part in the valley of the Adour, is, except towards the south, most uniform in its composition. It covers all the Marensin with a thick mantle, reappears at the tops of all the hills, and on the central plateau of La Chalosse, and traverses the river-bed (*Gaul*), disappearing finally under the form of ‘molasse and macigno,’ beneath the diluvial deposits, from which it is often difficult to distinguish it.”

Mons. Delbos’ account of the diluvial drifts is very brief, and he makes no mention of the modern deposits, rich in vegetable remains, south of Biarritz. Near the ophite rock they form a cliff from thirty to forty feet high at least. They lie perfectly horizontal, and are composed of alternate beds of sand and gravel, the stratum of vegetable matter appearing at its base, just above the seashore sands.

Further on in his thesis, M. Delbos speaks of the Ophite. He says that in general fibrous gypsum is found near it, but that this does not appear to be the case at Biarritz.

Probably when M. Delbos examined this coast the seashore sands were rather higher opposite the Ophite rock than they are at present. Under the cliff, at about thirty yards from the Ophite rock, I found a very good example of the fibrous gypsum. It lay—as he states it generally does—“dans des argiles rouges.” At the point where I saw it, the gypsum, not much more than an inch thick, lay imbedded like a wedge in clays of the most beautiful colours, veined grey, red, and yellow, and of the texture of stiff paste.

In conclusion, there seems to be little or no question that the Nummulitic rocks belong to the Lower Eocene period ; that is to say, to the Lowest Tertiary, and that in general they repose directly on the Chalk.

The researches of geologists seem to have established that the Nummulitic rock exists very extensively in Southern Europe. Mont Perdu, in the Pyrenees, is composed of it, and also La Montagne Noire de Corbières. On the south of the Pyrenees it extends from Vittoria

into the valley of the Ebro. Again, in Languedoc and Dauphiné. Near Nice, in the Maritime Alps, and in Lombardy. In Switzerland, in Sicily, and in Turkey. Not to speak of Egypt, where this rock has long been known to exist.

A. D. ACWORTH.

NOTES ON THE GLACIAL PHENOMENA OF WASTDALE, CUMBERLAND.

By EDW. HULL, B.A., F.G.S.

DEAR SIR,—I had hoped this year to have been able to extend over the Northern portions of the Cumbrian mountains some observations on Glacial Vestiges which I made in 1859 over the southern slopes of the same range, and communicated to the *Edinburgh New Philosophical Journal*.* I have only, however, been permitted to investigate a very small tract along the western slopes; but though limited to this, the following notes may not be without value, as there are few observations as yet recorded of the evidences of extinct glaciers in the English Highlands.

I may preface my remarks by observing that the first notices of glacial phenomena in the Lake district were made by Agassiz and Buckland in their general survey of the evidences of extinct glaciers in the British Islands; but they were accompanied by very few special examples. It is not, however, from any want of striking instances that till lately they have been passed by almost without notice. Every valley which descends from the central watershed, presents the features of a glacier-channel, and is well furnished with *roches montonnées*, perched blocks, moraines, and striated rock-surfaces. Even the lakes, which are the special feature of this region, are in many instances due to the presence of terminal moraines, which have acted as embankments to the waters. In addition to the instances which I have already enumerated, I may now add that of Wast Water, "the wildest, the deepest, the most impressive of all our lakes, over whose surface the winter's frost cannot spread a crust."

Wastdale leads up from the undulating tract of New Red Sandstone which lines the coast into the very heart of the highest mountains. At its head stands Great Gable, an elevation conspicuous for its pyramidal outline as seen from the west. On the right of this rises Scafell, the culminating point of England, 3166 feet, throwing out some limbs, like great buttresses, with very gracefully curved

* Vol. xi. Glacial striæ have also been observed by Professor Phillips on the limestone of the southern coast, and by Mr. Bryce, near Kendal. In a letter to the author in 1860, Mr. W. Longman states how much he was struck by the glacial phenomena in several localities in the Lake district,