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ORIGINAL ARTICLES.

I.—ON TRACES OF GLACIAL ACTION NEAR LLANDUDNO.

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(PLATE XII., Figs. 1 & 2.)

ANYONE accustomed to the peculiar outlines which ancient ice-action has produced in the Alps, cannot fail to be struck, at the first glance, by the contours of the upper parts of the Great Ormeshead and of the Carboniferous Limestone range which extends from near the village of Rhos to the Little Ormeshead; and a more minute examination only strengthens the conviction that, while the leading outlines of the hills are due somewhat to upheaval, but mainly to denudation—probably marine, the surface of the higher ground has in many cases been affected by ice.

The following notes were made during a brief visit to Llandudno in the month of April last. They refer chiefly to (a) the Great Ormeshead, (b) the Little Ormeshead, (c) the Coast section between the former and Conway. The bad weather and the shortness of my stay have made them less complete than I could have wished, but still they may be of use in calling attention to a neighbourhood at once so accessible and so interesting.

(a) The upper part of the Great Ormeshead is an undulating plateau of Carboniferous Limestone, in places almost bare of vegetation. Immediately on gaining this by the path which slopes up the steep south-western face of the hill, from above the ruins of Gogarth Abbey, one is struck with the general resemblance of the surface to that of some of the higher limestone districts in the Alps; for example, that between the Schwarenbad Inn and the Gemmi Pass. Large blocks of limestone are scattered about, especially in the neighbourhood of the north-western angle of the plateau. One remarkably fine mass (Plate XII., Fig. 2) is about 5ft. 7in. in height and 7ft. 2in. by 7ft. in breadth and thickness. It is very flat on the under side, and rests upon three or four projections of the rock below. Several of these blocks differ slightly in lithological character from the rock on which they lie; for they consist of a very hard kind of limestone, which, when broken by the hammer, does not exhibit the usual sharp and somewhat conchoidal fracture common in the Car-

boniferous limestones, but crumbles away more like indurated clay. It can be found *in situ* on a very slight eminence in the neighbourhood. I could not discover any distinct trace of moraines; which, indeed, could hardly be expected, owing to the absence of peaks. Probably in the glacial epoch the Great Ormeshead was a low island with its undulating icy cap (of no great thickness) broken here and there by a scarcely projecting ridge of rock.

The precipitous sides of the Great Ormeshead appear to me to bear distinct traces of the action of the sea in the form of steep lines of cliff with hollows and furrows at intervals. Its eastern face consists of two well-marked cliffs, separated by a sloping talus thinly covered by a reddish marly clay containing many angular fragments of limestone. The base of the lower cliff is washed by the sea; and it is instructive to compare the wave marks on it with those exposed some 200 feet or more above in the face of the upper cliff. Shells of *Patella vulgata* and *Littorina littorea* are not rare in the clay of the talus by the footpath near Pen-trwyn.

On the S.E. of the Great Ormeshead is a lower eminence called Pen-y-Dinas (on which are the remains of a British fort), separated from the main mass by a hollow, which opens out on the one side towards the town of Llandudno, on the south, and on the other to the sea, on the east. A deposit of reddish marly clay, with angular fragments of limestone, covers the lower parts of this, and is of considerable thickness in the neighbourhood of the sea. In the upper part of the hollow, near Gwydyf Farm, is a bed or pocket of light-buff sandy marl, mixed with fragments of chert, which has been described by Mr. Maw in an interesting paper in this Magazine (Vol. II. p. 200).

This is covered by the clay, which is here from two to three feet thick, and contains shells in considerable numbers. In a few minutes I collected many specimens of *Patella vulgata*, *Littorina littorea*, *Mytilus edulis*, with an *ostrea* (both valves), and three separate valves of *Tapes (pullastra?)*. This clay, both here and elsewhere, appears to have been deposited after the ground had pretty nearly assumed its present configuration, and to have not undergone much denudation during the process of upheaval.

Again, on the S.W. side of the Great Ormeshead, just beyond the house at present belonging to the Dean of Christchurch, we find, below the fine line of limestone precipices, a steep talus, the lower part of which has been destroyed by the sea, and a cliff of soil and clay thus formed. In the upper part of this cliff, beds of marine shells occur with partings of dark brown soil; as, however, I consider these to be kitchen-middens, I pass them by on the present occasion. Below these we have the following section: (1) reddish clay, with many angular fragments of limestone and rolled trap-pebbles—about 2ft.; (2) reddish sand, yellower in upper part, without pebbles—about 3ft.; (3) talus of fallen sand and clay—about 4ft.; (4) the pebbly shore. As the cliff is followed to the N.W., (1) is seen to thicken out rapidly and form a cliff some fifteen or twenty feet high, in which are many large angular limestone boulders.

(b) The undulating outlines of the chain of the Little Ormeshead are also strongly suggestive of glacial action, and upon that hill are two shallow but well-marked valleys, whose contours can, I think, be due to no other cause. One of these is on its western face, and is clearly seen from the neighbourhood of Llandudno (Plate XII. Fig. 1). It is enclosed by two low ridges; one of these falls rapidly down to the conspicuous gap which isolates the Little Ormeshead from the rest of the range; the other, descending seawards, ultimately forms a broken face of rock. The peculiar curves of these ridges and of their inner slopes, with the form of the bed of the valley, which in the upper part is scarcely masked by a thin turf, can only be explained by the action of a glacier. Nor is this all: about the lower third of the hill is covered by drift, the rock disappearing under a sloping bed of it, which sweeps gently down towards the west. The sea has eaten away a large portion of the northern side of this, and formed cliffs which, in places, cannot be less than 50 feet high. If we proceed along the shore to the place where this drift rests upon the limestone, we find that the latter forms a steep cliff or rapid broken descent, which still preserves the rounded contour indicative of ice-action. In the upper part of the clay cliff, a bed of large angular boulders, all apparently of limestone, is now exposed a few feet below the surface of the ground. This thins out on each side, and appears to be thickest in the part nearest to the middle line of the above-named valley. It was quite impossible to reach this bed, but its greatest thickness cannot be less than seven feet, and it bears a very close resemblance to a moraine. The clay below also contains many chert fragments, and boulders most of which are limestone, the rest trap and various metamorphic rocks from the district west of the Conway. One good sized trap boulder was resting in the clay, a dozen feet or so above the shore, almost in contact with the limestone rock. The land slips have made it difficult to examine the lower part of this cliff, but a little further on to the west a good section is exposed, which exhibits below the surface soil: (1) red clay, with but few pebbles or boulders; (2) a rather darker clay, containing large limestone boulders, but slightly water-worn, and many pebbles and boulders of limestone, trap, and metamorphic rocks; (3) a bluer clay, containing many small pebbles of slaty rocks. In many places the lime in (2) has cemented it into a hard conglomerate. Measurements were impossible owing to the steepness and wetness of the cliff. I did not find shells in any of these clays.¹ Again, on the southern face of the Little Ormeshead, a valley may be seen, which descends towards the marshy valley leading to Colwyn Bay, with contours, if possible, more suggestive of glacier action, and apparently with a similar clay in its lower part. A valley of the same kind may also be observed in the north-western part of the range, from the road between Rhos and Llandudno; and the new road from

¹ It may be worth mentioning that the great curving joints which seam the northern cliffs of the Little Ormeshead and contribute largely to their graceful outlines, present remarkably fine instances of slickensides. They can be examined from the shore when the tide is out.

the former place to Castell Diganwy Hotel cuts, on the northern slope of the Diganwy hill, through a regular 'subalpine' drift.

(c) We come lastly to the shore section in Conway Bay. Going from Llandudno, we pass a line of dunes of blown sand, and meet with the clay at Tremlyd Point. This is the extremity of a deposit which forms a slightly rising tract on the north-western face of the Diganwy hills, and appears to be connected with that described above, and to have once overspread the whole, or the greater part of, the level Morfa Rhianedd. Here it forms cliffs about 30 feet in greatest height, and extends along the shore for a distance of about 370 yards. It is capped by a sandy soil from 6 inches to 4 feet in thickness, which was deposited, after the clay had been reduced by denudation to its present form—a bank with gentle slopes north and south. On each of these we find (1) a red marly clay, with but few pebbles, which rises to the surface and disappears towards the middle part of the cliff. The upper part of this, immediately under the surface soil, is of a yellowish tinge, but the state of the cliffs prevented me from ascertaining whether this change in colour indicated a distinct deposit or not. Under this is (2) a bluish-brown clay, containing many boulders of trap and metamorphic rocks from the neighbourhood of Penmaenmawr; perhaps 25 feet in greatest thickness. Many of these blocks contain 20 or 30 cubic feet, or even more; and scratches, apparently the result of ice-action, may be observed on some. They are scattered over the shore for a considerable distance seawards. Below this is (3) a bed of tenacious dark blue clay, full of small pebbles of a dark slaty rock; it only rises one or two feet above the shore, but it may be traced for some distance below high water mark. On the south slope the red clay in like manner replaces (2) and then disappears under the sand; in which, on both sides of the clay, are seams of *Mytilus edulis*, beds of which occur at intervals along the coast-section; but, as these deposits are obviously of an age different from that of the Glacial drifts, I abstain from entering into particulars concerning them. A furlong or so beyond, the clay (1) rises from the shore, and here also is capped by sand, containing beds of *Mytilus edulis* and other shells; and we again find it, after another interval of sand-cliff, near the Castell Diganwy Hotel. I did not find shells in any of these deposits. They seemed to have a general correspondence with those bearing the same numbers in the Little Ormeshead Section.

To conclude. It would appear, from the above remarks that, after the limestone hills of the district had acquired their leading forms by upheaval and marine denudation, the whole district was depressed. The summits of the low rocky islets thus formed became capped with ice-fields, which, in places, descended in glaciers into the sea. At times, very probably, they were united to the mainland by pack or coast ice. The section on the Conway shore seems to favour the idea that, at this period, there were oscillations of level, during which the two lower beds were subjected to slight denudation. After the deposition of the uppermost bed of clay there must have been considerable denudation, either from the action of the re-

treating sea or of currents in shallow water. To this must have succeeded a period of depression, during which the mussel beds were formed, and then the whole was gradually upheaved above the sea, probably—at any rate in the case of the Great Ormeshead—not quite uniformly.

II.—NOTES ON A COLLECTION OF RECENT SHELLS DISCOVERED AMONG THE RUINS OF POMPEII, AND PRESERVED IN THE MUSEO BORRONICO AT NAPLES.

By ROBERT DAMON, F.G.S.

AMONG the many singular discoveries made in the ruins of Pompeii, and deposited in that most interesting of Museums, the *Museo Borbonico*, in the city of Naples, are a variety of shells, principally species now found in the Mediterranean Sea, and so far of interest as an illustration of the persistency of certain known species within the historic period, no difference whatever being observable between the disinterred and living specimens. On a close examination I observed, besides those from the neighbouring seas, species from distant countries, for example:—*Conus textilis*, *Triton femorale*, *Meleagrina margaritifera* (Pearl Oyster), species only found in the Indian and Eastern seas. I think, therefore, that this may be regarded as part of a Natural History collection. Assuming the truth of this conjecture, its antiquity is without a precedent. Did the original proprietor form one of a Natural History Society of Pompeii, of which the distinguished Naturalist Pliny, who perished at Pompeii, was a member? It would also be curious, in these days of research for priority of names, to know how they were described. Such a discovery might disturb existing nomenclature, and increase the perplexity already felt in naming collections. But laying aside fanciful conjectures, the collection is further instructive from the condition and perfect preservation in which the specimens are found, after an interment of nearly 1,800 years. Besides the collection in the Museo Borbonico, there is still standing in a villa at Pompeii, a fountain decorated with shells of the Mediterranean, one species of which, viz. *Murex Brandaris*, retains its colour and general freshness and is not to be distinguished from living examples; while the same species, from the Italian Tertiaries, are colourless and in that friable condition characteristic of shells even of the most recent geological period, pointing, like other discoveries, to the great antiquity of the most modern Tertiary deposits as compared with the era of the human race.

The following is a list of the species which I was able to identify in the Museo Borbonico:—

Triton nodiferum, Lam.
 „ *corrugatum*, Lam.
 „ *femorale*, Lin. sp.
Murex Brandaris, Lin.
 „ *trunculus*, Lin.
Dolium oleare, Lin.
Cypræa pantherina, Solan.
 „ *lurida*, Lin.
Turbo rugosus, Lin.
Conus textilis, Lin.
Pecten Jacobæus, Lin.

Pectunculus siculus, Reeve *P. glycimoris*
 var Lam.
 „ *violascens*, Lam.
Meleagrina margaritifera, Lin.
Tapes pullastra, Forbes & Hanley.
Lutraria elliptica, Lam.
Cardium echinatum, Lam.
 „ *rusticum*, Lin.
Helix pomatia and other *Helices* of the
 district.

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