

## III.—MODERN DENUDATION IN NORTH WALES.

By J. R. DAKYNS.

THE subject of denudation is so important that I propose giving a few instances of denudation and of the transport of material that have actually come under my own observation or that of my friends. Where one sees the same familiar crags and pinnacles year after year, apparently quite unchanged, one may perchance fancy that denudation is at a standstill; but anyone who, in scrambling across the scree that clothe many a steep hillside, finds them moving beneath his feet, or perhaps has clattering about his ears a shower of stones dislodged by some wandering sheep, will at once perceive that it is not so: for it is obvious that if the mere tread of such a small beast as a sheep, shepherd or other pedestrian, can set scree rolling downhill, it must be in a very unstable state, and may be expected to move in a conspicuous manner under more potent forces than the tread of animals. Observation shows that this is the case. Not a year passes without some conspicuous fall of scree or of solid rock, owing chiefly to great downpours of rain. Leaving general statements, I will now give actual instances of the fall of rock or movement of scree that have recently taken place in the Snowdon district.

In the Summer of 1897 a large mass of earth and rock débris was washed by heavy rain down the hillside overlooking the east end of Llyn Llydaw, leaving a conspicuous scar which is still quite distinct. A similar scar close by, which is actually marked on the Ordnance six-inch map, was doubtless formed in a similar manner. Later on, in August, under another downpour of rain, a similar scar was formed on the Glyder near the head of Llanberis Pass.

In June, 1898, after a great deal of wet weather, while the summits were still enveloped in mist, I was scrambling along the slope of Lliwedd, above Cwm Llan, when I was startled at hearing from the side of Snowdon a noise like that of an explosion, followed by the sound of falling rocks. Turning quickly round, I saw issuing from the mist a quantity of earth and stones rushing down the mountain-side, and leaving long trails ploughed out of the loose material clothing the steep slope. Going up next day I found that a large mass of rock, weighing several hundred tons, had slipped down the hillside. The landslide was evidently due to a tiny rill having been swollen by the recent rains and having washed away some material supporting the highly weathered rocks, whose points of support then gave way with snaps like explosions of gunpowder. I once saw a somewhat similar fall of rocks in Norway caused by a thunder-shower. In August, 1899, during heavy rain, a long conspicuous scar was formed in scree on the side of Yr Aran. On November 3rd, the day of the great gale, when from fifteen to twenty streams were tearing down the mountain-sides, where usually there are only two or three, the high-level footpath to Snowdon was in three places either completely washed away or obliterated by being overwhelmed with stuff washed down the side

of Crib y Ddysgl. A few days after this, on going to seek shelter from rain in an old adit level, where I had often sheltered two years ago, I found it completely covered with scree, which had either come down in a similar manner previously or had gradually accumulated during the last two years. Another old level, which was open when I was a boy, has long since been quite covered by scree.

A long red scar is to be seen on the hillside between Lliwedd and Galt y Wenallt: this was formed in March some years ago by an avalanche caused by the sudden melting of the winter's snow under heavy rain. A friend of mine saw and heard it come down with a roar like thunder.

Another cause of the fall of rocks is lightning. I often see freshly broken rocks that look as if they must have been broken by lightning: such a one I noticed the other day below Crib Goch, which had probably been struck by lightning during the thunderstorm that occurred on the 20th of July, 1899; but it is not often that we actually know as a fact that such and such a rock has been struck by lightning. During the great thunderstorm that occurred in North Wales in the middle of August, 1898, a mass of rock was broken and thrown down near Llyn Teyrn. This is known to have been done by lightning, as it was not there till after the storm. It is still quite distinct.

It will thus be seen that scree is perpetually moving down to a quite conspicuous extent under the influence of water, and that large landslips and falls of rock are also caused by heavy rain and by lightning. I have not had an opportunity of observing in Wales the transport of stones by ordinary mountain torrents; but doubtless such torrents behave in Wales as similar streams do in Yorkshire, about which I happen to know something. I once lived at Kettlewell in Craven, in a room overlooking a mountain torrent. I had not been there very long before there was a deal of heavy rain; and one night, after all the village folk had gone to bed, I heard a bumping noise as if a heavy cart were jolting over a rough road; so, being surprised that anyone should be driving a cart at dead of night, I opened the window and looked out, and I then discovered that the noise was caused by boulders bumping against one another as they were swept down by the beck that flowed under my window. Whenever there was heavy rain on the hills, that bumping noise was heard. The beck, when in spate, which it often was, invariably rolled great stones down to the river Wharfe. No doubt mountain streams in Wales and in other hilly countries do likewise. I may here remark that this transport of stones may go on in clear water. In such a country as the volcanic parts of Cumberland and Westmorland, where there is no shale, very little peat, and all the rocks are hard, a stream, even when in spate, will run quite clear, but it is hurrying stones on along its bottom all the same. The effect of this may be seen in many places in the great spreads of gravel that occur where a mountain stream enters a river valley, as for instance where such a stream enters the valley of the

Aire from the hills above Kildwick and Conouley. I have given the above-mentioned observations to prove that there is now going on a steady transport of material, but the same conclusion is manifest to the reason, for there are places on the mountains where the rock is conspicuously bare, naked, and fresh-looking, being free from asperities and from vegetable growth; such spots, reason tells us, are the places where there is a perpetual or oft repeated fall of stones from above. There is such a naked rock on Clogwyn y Garnedd, under the summit of Snowdon; and though I have not actually seen stones falling there, I am as sure that the naked appearance of the rock is due to falling stones as if I had seen them fall. Such bare places on the mountain-sides are very conspicuous in some parts of Norway; and the natives tell you that they are due to 'stane scree.'

Another sign that a rock is now wasting away is this: if the ground beneath a cliff is thickly strewn with blocks of the same rock as that of which the cliff is composed, you may be quite sure that the cliff is now wasting away. A geologist must be careful how he hammers such a cliff at its foot, for even a slight blow of his hammer may bring down a mass of rock on to his head. Again, the spiky character of a serrated ridge is proof that the ridge is wasting away. Such wasting away is mainly due to frost; and I have noticed that in the Spring the mountain-sides are in a more crumbly and unstable state than at any other time of the year. This is doubtless due to the winter frosts. I have now said enough to show that denudation is steadily going on, though its amount may be small in comparison with the size of the hills.

#### IV.—ON SANDSTONE PIPES IN THE CARBONIFEROUS LIMESTONE AT DWLBAN POINT, EAST ANGLESEY.

By EDWARD GREENLY, F.G.S.

THE low, but rocky headland of Dwlban Point forms the western corner of Red Wharf Bay, on the east coast of Anglesey;<sup>2</sup> and is on the coastline of the principal tract of Carboniferous rocks in the island, not very far from the boundary fault which runs out to sea beneath the sands of the bay. The Carboniferous Limestone near the Point is for the most part a light-grey, crystalline rock, with abundant crinoids, corals, and other marine fossils. There are, however, four beds of sandstone, varying from 2 to 9 feet thick, and some of the Limestone itself also contains scattered grains of quartz. The sandstones are clean white rocks, generally fine, but with occasional thin seams of small pebbles.

Now the foreshore at Dwlban Point is composed of a massive bed of light-grey, crystalline Limestone. The surface of this bed, at a little creek close to the headland, is pierced by a large number of

<sup>1</sup> Abstracts of this and of the succeeding paper were read before the British Association, Dover, 1899.

<sup>2</sup> During the first examination and the mapping of this ground I was accompanied by my friend Mr. J. R. Dakyns. I should like to add also that most of the phenomena here described were noticed more than twenty years ago by Mr. G. H. Morton, F.G.S.