No. XXXIV.—RANDOM NOTES ON THE ENGLISH LAKE DISTRICT.

By JAMES WHITE.

[Read 11th October, 1883.]

WITHOUT attempting to discuss the question whether beauty is an objective or a subjective quality, whether resident in the mind of the observer or in the thing observed, it must be admitted that there are certain external objects which do command the general consent of mankind to possess that attribute—certain songs which we all and always like to hear; certain musical compositions which all admire; certain scenery which has a universal attraction.

It might be doubtful if there are many to whom these external objects present precisely the same aspect, or, if they could define their own emotions, would give exactly the same account of them. Of the thousands who every year flock to see the magnificent colonnades of Staffa, the motives in all their details might well-nigh be as varied as the individuals, an outing, to see what others have seen, something *outré*, while Edwin and Angelina must go somewhere, and so they go there. I rather fancy that those who look at such a spot from a geological point of view, whose minds care to realize its history, to conceive of it as a flow of burning lava before which no living thing could for a moment hold its own, or who endeavour to estimate those remarkable laws in virtue of which in cooling it has become broken up into the striking form in which we now see it, whose fancy cares to dwell on the reasons why, a mere fragment of what it has been, it is left rearing its head amidst the fierce western seas, are by far in the minority; and yet it is only those who get behind such scenes geologically, and who thus to a keener perception of the present add a vivid image of the past, who can be said to see them at all.

The English Lake District is one of those spots which yearly attracts its thousands of visitors, and a cursory review of some of its leading geological features, and how they have come about, forms the object of these random notes. It is only a rough sketch and a glance at its leading physical features. The district is extensive, is an exceedingly complicated one, and has proved as fertile a field for geological research as it is attractive to the tourist. I have beside me a printed list of 350 books or papers

all bearing more or less on the subject of its geology. In the midst of such a mass of literature, it would be very hard for a casual visitor to say anything that is new. It is rich in natural scenery, and has inspired many a glowing line ; it is rich in those inorganic products which minister to human wants—coal, copper, iron, zinc, lead, graphite, slate, lime are amongst them, and the principal. Its mineral ores have been worked for 2,000 years. But to our tale.

This district, then, occupies a corner in the extreme north-west of England, embracing part of the counties of Cumberland, Westmoreland, and Lancaster, and is somewhat in the form of an ellipse, whose longest diameter, north to south, is about fifty-one miles, and the shortest about thirty-seven. Within this area, which is distinctly marked off from the surrounding country, there are comprised sixteen of what may be called lakes, with an indefinite number of small "tarns." The largest sheet of water is Windermere, eleven miles in length. It is further of interest to notice that from the high ground, of which Helvellyn may be taken as the centre, though it is not the highest point, the long lakes radiate outwards in all directions like spokes from the nave of a wheel ; and this seems to supply us with a hint as to their common origin, whatever that may have been. The district consists fundamentally of a central dome of rocks, which may be classed roughly as of Lower Silurian age, flanked on every side by Carboniferous strata, which are succeeded by bands of Permian and patches of Secondary rocks. Of course this central dome has not been so long in the world without experiencing many of the vicissitudes to which rocks are everywhere exposed ; its top has been entirely removed, and numerous heights, which are greatly less elevated than the originals must have been, occupy its place, and many faults and flexures have added their quota to the disintegration of the locality. If we add a large share of those eruptive and metamorphic agencies which have everywhere played so important a part in the formation and modification of the crust of the earth, we come to have an exceedingly varied country, both above and below ground, which in its history and results has been the source of that great interest with which geologists have regarded it. The late Rev. Mr. Clifton Ward thus summarized the rocks of the district—Lower Silurians, about 10,000 feet, overlaid by volcanic rocks, about 12,000 feet, and Upper Silurians, about 14,000 feet.

Out of the many interesting topics of thought and observation which this district presents I select three, being those most attractive to my own mind—first, its elevation ; second, its denudation by ordinary atmospheric agencies ; and third, its glaciation.

First, Elevation.—That this was not accomplished all at once, but is the result of several movements extending through long geological time, is shown by Professor Sedgewick, Messrs. Hopkins, Clifton Ward, and others. Besides several minor unconformities amongst the Silurian rocks themselves, there are two principal ones, viz., the Carboniferous beds on its outermost border rest upon the upturned edges of the Silurian rocks, the Permian strata again resting upon and overlapping the inclined edges of the Carboniferous rocks ; so that we have several distinct epochs of upheaval, each separated from the other by an absolutely indefinite interval of time.

Whatever hypothesis we may adopt as to the condition of the interior of the globe, whether we regard it as gaseous, liquid, or solid, one thing is very evident, that its crust is extremely mobile, developing itself in numerous instances in bosses and domes of varying altitudes and areas, and sometimes running in long anticlinal ridges for hundreds of miles. Hills of this sort are easily distinguished by the dip of the strata from those which are formed by the denudation of the softer surrounding masses, and also from those which are formed by the piling up of volcanic ejectamenta at the mouth of an orifice, all of such agencies having played their part in diversifying the surface of the earth and giving those varieties of climate and soil which are so powerful agents in modifying the living forms which inhabit it.

The causes of those subterranean movements which result in the elevation of great masses of strata have long engaged the attention of physicists, and are by them ascribed to the very simple one of the hard outer shell, crust or rind of the globe, being compelled to adapt itself to a gradually decreasing interior, decreasing by loss of heat ; in fact a larger sphere being forced to occupy the place of a smaller one—irregularities of contour, flexures, and fractures being, of course, the result.

These are things which in our little rambles or excursions to the country, either as individuals or as a society, we have few opportunities of observing. It is summer-time, and Nature with her soil-clad and verdure-clad hills and dales, seems quite disposed to

cover up and conceal her little faults and failings from the eyes of too prying geologists, and then the sections we see, either natural or artificial, are so shallow that we must just have recourse to the experience and observation of those whose opportunities are better than our own to verify the conclusions to which this theory points. In the Swiss Alps the flexuring and displacement of rocks are seen to great advantage, and therefore most text-books are furnished with drawings of some of those phenomena. I quote one example from a review in *The Geological Magazine* for 1879 of a work on the formation of mountains by Professor Heim, of Zurich, in which he describes one of those flexures or inversions of strata which he had traced over an area of 464 square miles, or something like the following :—If a mass of strata about twenty miles broad were lifted at Glasgow and folded over so as to reach Rothesay, with the axis of the fold at Greenock, we would then have an inversion of strata of fully 400 square miles, or less than the one Professor Heim has actually traced out.

Dr. Archibald Geikie in his new geological text-book, quoting from the above-named author, states that the horizontal compression of the whole Alpine chain amounts to about 74 miles—that is to say, that two points on the opposite sides of the chain have, by the folding of the crust that produced the Alps, been brought 74 miles nearer to each other than they were before the movement. An example on a smaller scale of this displacement of rocks by horizontal compression occurs in our own neighbourhood, in the small coalfield of Quarrelton near Johnstone, where, in sinking vertically, the beds are found to be repeated, and lie folded upon each other three times like a widely extended letter Z.

Such are examples of the disturbances which sometimes go on amongst the quiet everlasting hills, quiet indeed with us so far as the memory of the oldest inhabitant is concerned or even that of the race itself, but other regions of the world have of late been furnishing proofs of how grossly inappropriate such epithets are as applied to them. I am sure every one in this room has read with the most profound and painful interest the accounts which have come to hand of the terrible eruptions which occurred last August in the Sunda Straits, where, amongst many other details, it is mentioned that in the Island of Java the entire chain of the Kandang mountains, which extended along the coast in a semi-circle for about 65 miles, sank beneath the sea in a single night.

However awful such events may be, and however productive of human suffering and destructive to human life and property, yet every geologist knows that they are merely the result of natural laws which have been in unvarying operation ever since the thinnest film of a crust was formed on the surface of the globe, and which must continue to operate so long as there is a single cavity within its mass.

The generalization first indicated by Dana of the permanency of our continents and of the great ocean beds, and now accepted by many leading geologists as a sound doctrine, seems but an extension of this idea or observation. Whilst this acceptance is by no means universal, yet the facts and arguments in its favour seem to be of very great weight, and some of these may be here enumerated. 1st. On the universally accepted hypothesis that the earth is a cooling and contracting body, the corrugations on its surface would naturally continue to deepen in the same lines on which they were originally formed, as we see always to be the case in any body where we have a soft interior and a less yielding exterior, for example, in dried fruits. 2nd. It is now known that the islands of the great oceans are not the remains of previously existing land formed of sedimentary strata in those regions, but are simply volcanic peaks often capped with coral reefs. 3rd. The zones most favourable for the development of life in the sea are not the deepest parts, but those of more moderate depth, as those of moderate height on land, so that our limestones, by far the greater portions of which are merely organic accumulations, do not represent the deepest parts of the sea, but those of moderate depth only. 4th. The great mass of the derivative rocks which form the crust of the earth are of an arenaceous or argillaceous character and therefore littoral in their origin, shore deposits often exhibiting such features as sun-cracks, footprints of wading birds or reptiles, worm-tracks or casts, ripple-marks, rain-drops, etc., all of which features are certain indications of shore conditions. Then there are other deposits of deltal or estuarine origin, as is shown by the mixing together of marine and freshwater fossils, and by their often containing the remains of land animals and plants. Add to this that the wash of the sea is always towards the land. Such seem to be the principal data on which the generalization rests, but when the leaders of the science, those who, with a special training fitting them for such pursuits, have spent their lives in its

prosecution, are at variance, it would be foolhardy in those who are mere dabblers to give any very decided opinion. Yet I think the above-named facts must be held to be of very great weight, and that this generalization must be regarded as one of the most interesting of recent years, for by limiting the area of life it seems to afford more hope to the palæontologist of being able ultimately to fill up many of those life-breaks which now mark his series, while to trace out the history of life on the globe must ever be held the profoundest aim, as its completion would be the greatest triumph, of geological science.

Second, Denudation.—Notwithstanding the great disturbances to which this district has been subjected, the present “beautiful forms of its mountains and valleys are entirely due to sub-aërial agents” acting on masses of unequal powers of resistance. This will be clear if we consider the immense amount of material which has been removed from its surface since these disturbances took place.

The late Rev. Mr. Clifton Ward, whose experience and intimate knowledge of the district render his observations reliable, shows that from large portions of the area the whole of the Upper Silurian strata, 14,000 feet thick, has been removed, besides 12,000 feet of volcanic rocks, an amount so great that “an Etna in size may once have stood where now are the resting-places of quiet lakes,” besides a large portion of the Lower Silurians.

It is worth notice in passing that Professor Heim points out the same thing in regard to the Alps, probably the most disturbed known region in the world. “Denudation,” he says, “has absolutely destroyed the original shapes which would correspond to the internal structure of the mountains. The valleys of the Alps are entirely due to erosion. If fissures or syncline lines have in the first place fixed the direction, these must have been far above the present peaks and actual crests, and in strata which have long since disappeared.” So much for the action of trivial but insidious agents *plus* indefinite time.

Third, Glaciation.—The evidences of ice-action are very abundant in the Lake country. It was one of the localities visited by M. Agassiz in 1840, and the observations made during his visit may be said to have established the glacial theory. It is wonderful how easy it is to see these glacial features now, and how difficult it was to do so before. The question now is not where

can one go to find them, but where can we go to avoid them? They meet you at every turn—*roches moutonnées*—smoothed and grooved surfaces, mammillated hills, huge boulders, moraines, and last but not least, that irrepressible Boulder-clay. It is of amusing interest to look over the literature of forty or fifty years ago and note the progress of thought and observation since then. Debacles, floods, convulsions, cataclysms, waves of translation, the great Mosaic deluge, etc., etc., were all called into play to account for superficial phenomena, which, it is now seen, are so much better accounted for without them; and accounted for, moreover, by causes which, it is known from other sources, were actually at work. So the debacles, with their attendant train, advocates and all, peacefully take their exit, as ogres, ghosts, and monsters generally have done, and we are left in quietness to reason from what we know to what is more obscure, and not to perfect our knowledge by calling in data the existence of which is more difficult to account for than the phenomena which they are called on to explain.

Writing forty years ago, Dr. Buckland called attention to the great masses of moraine detritus which exist in front of the great vomitories through which the waters of these lakes were discharged, [and the first thing which strikes an observer as he enters the district from Penrith on the east is the great masses of gravelly detritus through which the railway cuts. As you get further on you observe the rounded, flowing form of the hills, a form which is at once attributed to the action of ice, and your impressions are confirmed when you reach the top of some of them, as I did to the top of Skiddaw and Helvellyn, both over 3,000 feet high, and observe that on the summit this smoothing goes right across the upturned edges of highly inclined strata. Look up the glens such as Borrowdale, and every projecting crag and knoll are sharply defined and seem to frown at you, but turn and look down, and immediately they are rounded off, transformed into the finest examples of *roches moutonnées*. The little islands on Lake Windermere, where not covered by vegetation, also frequently show the same features. Having an hour to spare till train time, I sauntered into the quiet little churchyard at Windermere, and there, projecting amid the tombstones, memorials of the human past, were two memorials of the great ice age, beautiful examples of *roches moutonnées*, rounded, smoothed, and

furrowed from the north, the south end terminating quite abruptly. But it is useless to multiply examples—the whole district is teeming with them. Mr. M'Intosh, in a paper printed in the *Quarterly Journal* of the Geological Society, vol. 30, describes the volume of ice as being so great as to travel *across* the hills, ignoring, in its onward progress, valleys 900 feet in depth. Rev. Mr. Clifton Ward also writes on the same subject in great detail.

Thus we see some of the deep-seated and remote causes of the beauty of the Lake District. If it had not been elevated it never could have been denuded; if it had not been denuded we never could have had those deep glens with their picturesque waterfalls, affording food and shelter to so rich a flora, which are but the further developed forms of those “glancing torrents which scour the mountain side with streaks of glistening sheen,” and which, by the striking contrast they exhibit to the hard, bare, busy scenes of every-day life, are welcomed by all dwellers in towns, by all toilers, whether with hand or brain, whether artizan or merchant, as a most merciful relief; nor those mountain-tops, which one has such a strong fancy to ascend and so to seem to take possession of, nor those rich and fertile meadows which yield us freely that which we need for our support, suggesting ideas of comfort and abundance, and which again afford such a pleasing contrast to the less productive if more striking portions of this remarkable region. If it had not been glaciated, its hills and valleys would have wanted much of that softness and sweetness of contour which characterize them; they would have been all grim and fierce and angry. Both agencies are apparent, and the blending of the two gives that variety which is one of its attractions.

Without glaciation we should have had none of those lakes at all, but merely so many tiny rivulets threading their devious and rugged paths to the sea :—

“ No check, no stay these streamlets fear,
How merrily they go ;
They'll murmur on a thousand years,
And flow as now they flow.”

Rock-bound basins they all are, and their formation is clearly the work of that grim agent. Nor those innumerable “tarns” which

dimple the hills in every direction, and, like so many little mirrors, reflect the glitter of the summer sun. And do not these erratics even add to the beauty as they certainly do to the interest of the scene? Wanderers often far from home, with their parentage doubtful or wholly unknown, perched no matter where, they are at once the relics and the evidences of a time when certainly there were none to admire them, or to care either for what they were or from whence they came.

NO. XXXV.—ON THE GEOLOGY OF ARDROSSAN AND WEST
KILBRIDE. BY DUGALD BELL, *V.P.* WITH A SECTION.

[Read 12th April, 1884.]

FROM Port-Glasgow to Ardrossan, the eastern shore of the Firth of Clyde is generally of a bold and rocky character, bounded by a range of hills in which the well-marked old coast-line, that forms so picturesque a feature of our seaboard, has been cut out at no great distance from the present shore. But between Ardrossan and the Heads of Ayr, the country assumes a more open and level aspect; the hills retreat further into the interior, and a considerable plain, or tract of gently sloping ground, extends outwards from them towards the sea, terminating along the shore in a broad margin of yellow sand. This low-shelving part of the coast marks the seaward extension of the Ayrshire coalfield. It forms, in fact, a great bay scooped out of the softer Carboniferous strata between the points where the Calciferous sandstones and associated igneous rocks emerge from beneath them on either hand. This great bay is divided by two or three projecting points into so many smaller bays, as at Ardrossan, Saltcoats, and Troon. Such points on a coast are always worthy of notice, as indicating rocks which from their superior hardness have more successfully resisted the abrading action of the sea. If they be igneous or eruptive rocks, there is a likelihood that the neighbouring strata will be seen to advantage either protected by them from disintegration or disturbed and uptilted alongside of them.

At Saltcoats and Ardrossan, for example, we find that both these projecting points, of which advantage has been taken to form the