was delivered before the above Society by Dr. P. P. Carpenter (late of Warrington, near Manchester), "On the Cuttle-fishes and their allies." Dr. Carpenter included in his interesting lecture descriptions of both fossil as well as recent forms, and exhibited illustrations of the several genera. The President (Dr. Smallwood) on behalf of the Society returned thanks to Dr. Philip Carpenter for his valuable and instructive lecture.—*Montreal Gazette*, February 13, 1866.

CORRESPONDENCE.

ATMOSPHERIC *V.* MARINE DENUDATION.

To the Editor of the GEOLOGICAL MAGAZINE.

SIR,—Having publicly advocated atmospheric action as the power by which the present "form of the ground" has been produced, I would wish to say a word or two on the clever articles you are publishing by Mr. D. Mackintosh, in which the sea is treated as the chief agent.

I am glad to see that Mr. Mackintosh does not allude to the action of internal force as having any *direct* effect on the external features of the ground. So long as we were hoodwinked by the *hocus-pocus* of "grand convulsions," and believed it possible for mountain chains to jump out of the interior of the earth like so many "jacks in the box," no advance in real knowledge was possible.

It may be taken for granted, then, that all the external features of the ground (except of course volcanic cones and craters) are the direct result of external agencies (Presidential Address to Section C. British Association, Cambridge, 1862). It may also be taken for granted that as all lands have risen out of the ocean, marine denudation has done something towards the production of their present form, and that during the time they have stood as dry land atmospheric agencies have also done something towards it. The problem is to apportion to the marine and atmospheric agencies the amount of work each has performed.

In reading Mr. Mackintosh's articles I recognise ideas which a few years ago I held as stoutly as he does now, and I believe therefore that he is following the same path which I did towards a fuller appreciation of the precise operation of these natural agencies. I think I was hardly aware of the change which had taken place in my own convictions, as the result of constant observation in the field, till I hit upon the solution of a problem that had long puzzled me, namely, the precise mode of production of the river valleys of the South of Ireland. (See Quart. Jour. Geol. Soc., London, vol. xviii.)

This solution requires that the rivers should never have ceased to run through the ravines, by which they traverse isolated hills between their sources and the sea, during the denudation of the plains by which those hills are surrounded. Had the sea ever marched across the country, and worn it down to form those plains, it must

have obliterated all the old features which formerly existed over the areas where the plains are now; and the subsequently formed rivers would never have regained their channels in those ravines, which would have been left as shallow passes through the hills at a greater or less height above the plains. The plains have many broad openings to the sea, without the intervention of any hills, and these would have been the natural outlets of the rivers, if the "form of the ground" had been made for them by the sea.

The reason why the rivers choose to run through the hills by deep ravines, instead of by much easier routes which are now open to them, is that when they began to run these hills did not exist. The hills were then buried, as it were, in much higher ground, by which they were surrounded, and over which the rivers originally ran. The rivers choosing, of course, the lowest ground they could find in their course to the sea, happened here and there to cross the parts where these hills subsequently became disclosed by the waste and erosion of the rock which surrounded them. The rivers, however, having once cut channels for themselves, have ever since kept those channels open, and it is through those channels that the waste of the interior has been carried off. Although, then, the interior was worn down into a plain, while the hill ground resisted that action and was left standing as a hill, the river channel, through that hill, was always cut lower than any part of the plain, for it was only in consequence of the deepening of that channel that the waste could be carried off and the erosion of the surface of the plain continued.

In Ireland the rock that was thus wasted in the interior was Carboniferous Limestone, the ground that stood as a hill was Old Red Sandstone or some other siliceous rock.

The calcareous rock was acted on both by mechanical erosion and chemical solution, the siliceous rock only by mechanical erosion. The siliceous rock therefore resisted the atmospheric action far more than the calcareous rock did, but it would not have thus resisted the sea, which would have cut into Old Red Sandstone just as easily as into Carboniferous Limestone.

This alone is an argument in favour of atmospheric action, but the great argument is the continued running of the rivers during the denudation. Rivers only run over the land, therefore the denudation took place upon the land.

This conclusion, to which I found myself unconsciously and almost reluctantly brought, acted on me like a sudden revelation. It connected together and explained to me all that had been mysterious in the "form of ground" in Wales and England, and other parts of the world, during my observations of the last thirty years, including many of the localities mentioned by Mr. Mackintosh. I saw how it could be applied to the Weald, as my colleagues Professor Ramsay and Dr. Foster and Mr. Topley have since applied it; and, in fact, that its application was universal.

There are, doubtless, several difficulties to be got over in many cases. Some of those instanced by Mr. Mackintosh are easily

removable; the rest will yield to patient investigation, if only we do not assume that there is nothing to be investigated.

In the meantime I confidently rely on two conclusions, which in our islands are specially applicable to Palæozoic districts, but apply *mutatis mutandis* to rocks of all ages. These are—

1st. The sea has removed vast masses of rock, and left undulating surfaces, the highest points of which ultimately become the summits of mountains.

2nd. When those undulating surfaces are raised high into the air they are attacked by the atmospheric agencies, and hills, valleys, and plains gradually carved out of the rock-mass below their particular features depending on original varieties in the nature of that mass, and variations in the action of the atmospheric agencies. The latter depend largely on variations of temperature, by which water is made to assume the different forms of vapour, water, snow, and ice.

It must be recollected that the forms of our Palæozoic grounds are of very ancient date, anterior to the period of the New Red Sandstone, and that the great denudation of the Older Palæozoic Rocks took place even before the deposition of the Old Red Sandstone. The time, then, during which the atmospheric agencies have been modelling the minor features is inconceivably great. The recent temporary depression beneath the waters of the glacial sea did little or nothing in the way of denudation, the principal effect then, being the transport of blocks, or the washing about of materials, already loose on the surface.

Much instruction as to the amount of atmospheric action may be gained by comparing volcanic cones with each other. I observed in Java that small volcanic cones of recent origin had their sides quite smooth and even, while others of older date, as was shown by the young trees growing on them, began to show gullies widening and deepening on all sides. The flanks of the great volcanic mountains were a mere series of deep glens, separated by sharp knife-edged crests, radiating like the spokes of a half-shut umbrella, as described by Dr. Junghuhn. (See Lyell's Elements, 6th ed., p. 620.)

Still older volcanos, as those in the South Pacific, described by Dana, have merely narrow vertical walls, radiating from the central mass, between flat-bottomed valleys, which gradually contracting towards the interior where at the head of each may be seen a little rill of water leaping from crag to crag, still going on with the work it has performed, and to which it seems at first so utterly inadequate.

It has sometimes occurred to me to ask how long grass has existed? and especially those grasses which make our matted turf? Conclusions as to the rate of atmospheric erosion drawn from our turf-covered downs would be apt to lead us astray if applied to hills not so covered. In many parts of Australia, for instance, where you come to ride over a hill that looks quite green in the distance you find you can see the ground between the roots of the grass, very much as if you were riding through young wheat. The rain, when it does come down in a torrent, must exert much more effect on such ground than where there is matted turf.

Supposing no grass at all to exist, the rate of erosion will be still more rapid, as on the recent volcanic cones mentioned above, or as may be seen on a new railway embankment or cutting where one or two years' storms produce perfect models of mountain glens and ravines in miniature. J. BEETE JUKES.

DUBLIN, April 6th, 1866.

ORIGIN OF VALLEYS.

To the Editor of the GEOLOGICAL MAGAZINE.

SIR,—As I have commenced a line of investigation among the valleys, gorges, and drifts of Central Wales, which will require for its completion a series of observations on the sea-coast of Cardiganshire, I shall not take up your valuable space with a concluding article on the *Origin of Valleys* for several months to come. Meantime permit me to add a few lines to my last article.[1] The combes behind Malvern Wells are much deeper than they would seem from the woodcut on page 157. The one behind the Holy Well (right side of the woodcut) embraces nearly three-fourths of a circle, and is exceedingly smooth and regular in its outline. All the three combes referred to have been cut back beyond the axial ridge of the Malverns. The rocks in which they have been scooped out would, by Dr. Holl, be classified as Hornblendic and Micaceous Gneiss, with Quartzo-Felspathic and Granitic veins. In reference to the denudation of the Longmynd Valleys, locally called "gutters," Mr. R. Wilding, of Church Stretton, reminds me of a cwm (English combe) to the north of Carding Mill valley, with no regular stream flowing through it; and this cwm must have been excavated by the same cause as that to which the valleys owe their origin. Mr. Wilding is convinced that the streams have only *furrowed* the bottoms of the valleys of the Longmynd.

I now write from the heart of Siluria; and on entering this hallowed region, I was struck with its richness, not only in underground relics of the past, but in the most striking indications of the various modes in which the surface of the earth has been denuded. This is the land, not only of trilobites, but of escarpments, cliffs, cwms, gorges, and all kinds of drifts. Geological tourists, during the coming season, would do well to devote particular attention to the stupendous accumulations of tumultuously-distributed clay, earth, and sand, with enormous rounded boulders, which may now be seen exposed in cuttings on the line of railway running between Hereford and Llanidloes. The successive tiers of inland sea-cliffs, half wrecked by the weather, but still retaining in sheltered situations their smoothed, grooved, pitted, and caverned forms, near Abereddw, are likewise worthy of minute inspection. Neither ought the tourist to pass by the deep and rocky ravines of the "Great Desert" of Central Wales, to the west and south of Rhyader.—Yours truly,

BUILTH, BRECONSHIRE. D. MACKINTOSH.

[1] GEOL. MAG., April, 1866. At page 160, line 25, for "indication," *read* "induction."