enables us to avoid the consideration of those changes in forces which are functions of the positions of their points of application, it is to be regarded rather as an ingenious device, unnecessary perhaps now that we have learned to distinguish power from work—that is, the fluxion from the fluent—but very useful when the ideas of power and work were confused together, as until lately they have been. At present it would perhaps be better to enunciate D'Alembert's principle as follows:—

"The algebraical sum of the powers of the external forces of a passive system is equal to the sum of the powers of the resultant forces." A *passive system*, for any motion, being defined as "one the sum of the powers of whose *internal* forces for that motion, is zero." F. GUTHRIE.

South African College, July 2.

"The Theorem of the Bride."

DR. ALLMAN would be doing a service if he could trace the *origin* of this term (see NATURE, July 25, p. 299). Its occurrence in the "Scholia" carries its use back to an early date but hardly far enough. R. T.

RECENT RESEARCHES INTO THE ORIGIN AND AGE OF THE HIGHLANDS OF SCOTLAND AND THE WEST OF IRELAND.[1]

II.

III.—*The Silurian Period.*

AFTER the long interval of time represented by the elevation of the red sandstones into dry land, and their entire removal from some places by denudation, the north-west of Scotland, and probably a large tract lying around it, sank under the sea. The depression seems to have been slow and gradual, and to have continued until the site of the Cambrian basins and of the surrounding region was covered with a considerable depth of clear open sea-water. The records of this subsidence are contained in a series of strata having a total thickness of somewhere about 2000 feet, and divisible into two chief groups—a Lower, composed of quartzites, grits, and thin conglomerate, about 500 feet in total depth, and an Upper, consisting almost wholly of limestone. Perhaps the most striking feature in this series of stratified rocks is the abundance of their organic remains. The quartzites are crowded with the tubes formed by sea-worms when the material existed as soft white sand on the sea-bottom. The limestones are made up of the remains of calcareous organisms, among which the most conspicuous that now remain are chambered shells and Gasteropods. Throughout these limestones, worm-casts are present almost everywhere, and in such abundance as to show, as Mr. Peach has pointed out, that "nearly every particle of the calcareous mud must have passed through the intestines of worms." A large collection of fossils has been made by the Geological Survey from these limestones, which, though not yet specifically determined, amply confirm the original generalization of Salter, made more than thirty years ago, that the aspect or facies of organic remains in the limestones of the north-west of Scotland resembles that of the older parts of the Lower Silurian formations of Canada rather than that of the corresponding rocks in Wales. So marked is the resemblance to the American type as to indicate that some shore-line must once have stretched across the North Atlantic, in order to afford a platform for the free migration of marine life between the two areas. The contrast with the Welsh type has been explained by the probable existence of some barrier that separated the sea-bed over the north-west of Scotland from that of Southern Scotland, England, and Wales. That such a barrier existed is tolerably certain, and I shall presently refer to some indications of its probable position. At the same time it may be open to question whether the Durness limestones can be properly correlated as homotaxial equivalents of any Lower Silurian rocks in Wales. My own impression is that they may be older than the oldest Arenig rocks, and may be equivalent to some part of the "Primordial Silurian" or Cambrian series. This, however, is a question that must remain unsettled until a thorough critical examination of the fossils has been completed.

The area within which these Silurian quartzites and limestones can be certainly recognized forms a narrow belt extending for about 110 miles along the north-west coast of Scotland, from the northern coast of Sutherland to the south of the Island of Skye. Throughout that extent of ground the rocks exhibit remarkable persistence in the character and thickness of their several subdivisions, whence the inference may legitimately be drawn that the area within which they are now visible forms but a small part of the region over which they were originally deposited.

It was claimed by Murchison, and generally conceded by geologists, that the quartzites and limestones of the north-west pass upward into a younger series of schists, representing metamorphosed sedimentary rocks. This order of succession appeared to be established by the evidence of many clear natural sections along the whole tract from Durness to Skye. It was first adopted and afterwards opposed by Nicol, who in his later papers maintained that the supposed younger schists were merely the old or Archæan gneiss brought up again by great faults, and pushed over the younger formations. But he failed to account for the striking difference in petrographical character between the old gneiss and the younger schists, and for the remarkable coincidence between the general dip of the latter and that of the Silurian stratified rocks on which they seemed to rest conformably. During the last ten years, various geologists have renewed the investigation of the question, among whom I may specially mention Dr. Hicks, Prof. Bonney, Dr. Callaway, Prof. Lapworth, and the members of the Geological Survey, particularly Messrs. Peach, Horne, and Clough. The result of their labours has been, in the first place, the discovery of one of the most complicated pieces of geological structure at present known in any country; in the second place, the abandonment of all further controversy, and the attainment of complete harmony regarding the order of geological succession in the North-West Highlands.

Murchison's view that there is a regular upward passage from the quartzites and limestones into the upper schists is proved to be erroneous, while Nicol's contention that the old gneiss is brought up again above the Silurian rocks is found to be, so far, correct. But the structure is now seen to be infinitely more complex than Nicol imagined, while, on the other hand, Murchison's belief that the younger schists were evidence of a gigantic metamorphism later than Lower Silurian time is undoubtedly true, though in a sense very different from that in which he looked at the question.

Nowhere in the North-West Highlands can any rock be seen resting in its original and natural position above the limestones. The highest limestone of Durness is the youngest rock of that region about the geological position of which there is any certainty. At present we know absolutely nothing of other sedimentary strata which followed that limestone. That such strata continued to be deposited is certain, for the changes which the quartzites and limestones have undergone could not have taken place save under the pressure of a thick mass of overlying material. But this superincumbent mass has been entirely obliterated in the extraordinary series of terrestrial movements which I have now to describe.

[1] The Friday evening lecture delivered at the Royal Institution on June 7, by Dr. Archibald Geikie, F.R.S. Continued from p. 302.

IV.—*The Period of the Younger Schists.*

Without entering into details, which are only intelligible with the help of a large map and sections, and even with this aid involve much disquisition of a technical kind, I may briefly say that after the deposition of the limestone and of the missing strata, whatever these may have been, which covered them, the whole region was convulsed by a series of disturbances, to which there has since been no parallel within our borders. By a series of intermittent movements the terrestrial crust, for thousands of feet downward, over the North-West Highlands, was fissured and pushed bodily westward. The various geological formations of that district—Archæan, Cambrian, and Silurian—were disrupted and driven over each other. Thus masses of rock, not more than a few hundred feet thick, were piled up so as to appear multiplied tenfold. The youngest strata were doubled under the oldest, and large slices of the ancient Archæan gneiss were made to rest on the Silurian limestones.

Fortunately the strongly marked characters of the different members of the Silurian series, the striking contrast between them and the Cambrian sandstones and Archæan gneiss, and the manner in which all these rocks are now laid bare on coast cliffs and rugged hill-sides, have rendered possible the task of unravelling this labyrinthine structure. The large maps, on the scale of 6 inches to a mile, on which this structure has been worked out by the Geological Survey, are by far the most complicated which the Survey has yet produced; indeed, I am not aware that such mapping has ever before been attempted. [Some specimens of these maps were exhibited.]

On exposed rock-faces we see a thin group of strata repeated again and again by small reversed faults, the lower beds being made to rest on the higher till they occupy a great breadth of ground, and appear of considerable thickness. Further examination will generally show that they have been all pushed westwards, and that their truncated under ends rest upon a platform of undisturbed rock along which they have travelled. We may further observe them to be abruptly cut off at a higher level by a sharp line, on which perhaps stands another series of piled-up beds. This piling up and truncation of the rocks is followed by a still more gigantic displacement. Lower and lower portions of the geological series have been torn up and thrust westward until at last the Archæan platform has given way, and masses of it, many hundreds of feet in thickness and many miles in length, have been driven over the younger formations. The horizontal distance to which this removal has reached can sometimes be shown to have amounted to at least ten miles; perhaps it may have been sometimes even greater.

In studying this complicated system of dislocations we soon meet with evidence that the movements were not all effected at one time, but that on the contrary they took place at intervals, the earlier being disrupted by the later. The lines of maximum thrust override those of lesser size, and the most easterly of these lines passes successively across all the others till it rests directly on unmoved rocks. The period of terrestrial disturbance was probably a prolonged one, and this inference is strengthened by other evidence to be afterwards adduced.

The direction of movement has been on the whole from the east-south-east. Bordering the west coast of Sutherland and Ross there is a strip of ground about 10 or 15 miles broad and some 90 miles long, in which the rocks have not been displaced. East of that strip, along a belt of dislocation varying up to five or six miles in breadth, the disturbances become increasingly numerous and powerful towards the interior, until at last a gigantic thrust-plane is encountered, above and beyond which the rocks have been so crushed and altered, that it is for the most part no longer possible to tell what their original character has been. They are now flaggy schists—the younger "quartzose and gneissose flagstones" of Murchison, "the Moine schists" of the Geological Survey.

The enormous amount of fracturing, displacing, and crushing caused by these terrestrial disturbances has resulted in the development of regional metamorphism on an extensive scale. Every stage can be traced from a sandstone or conglomerate into a perfect schist, and from the most typical coarse Archæan gneiss into a fine laminated slate.

Where the feeblest amount of alteration has taken place, the rock has been merely somewhat crushed, its larger crystals or pebbles have been fractured, and the separated portions have been re-cemented. A further stage is shown where the fine material of the rock has been more comminuted and has been drawn out round the flattened and elongated crystals or pebbles. The latter give way in proportion to their power of resistance. The felspars and hornblendes are first left as "eyes," and then crushed down till they disappear in the general matrix. The harder quartz-pebbles of the conglomerates have resisted longer; but they too, in the planes of great movement, are found to be pulled out to twice or four times their length, or to be flattened out into mere thin plates like pennies. One of the most singular proofs of this internal movement of the component particles of even so obdurate a rock as quartzite is shown by the deformation of the worm-tubes. As these tubes come within the influence of the movement their vertical position changes into an inclined one, and they become gradually flatter and more drawn out, till at last, before they cease to be traceable, they appear as mere long ribbons on the surface of the rock, which then becomes a quartz-schist. Along the planes of intense crushing the original structure of a rock is entirely effaced, its crystals or grains are ground into fragments, and it acquires a streaked laminated structure like a shale or slate.

But for the most part, concomitant with the mechanical destruction of the various rocks, there has been a chemical and mineralogical re-arrangement of their particles. Out of their broken-down materials new minerals have crystallized, and this process of reconstruction has, in the most thoroughly altered masses, proceeded so far that the whole new structure is now crystalline. In this manner, mica, quartz, felspar, hornblende, and other minerals, have been developed, and have arranged themselves along the lines of movement in the crushed rock. These lines, approximating to the surfaces of the great thrust-planes, may be utterly discordant from the structure-lines, such as those of foliation or bedding, in the original mass. Rocks of this character are true schists, and I know of no internal or external signs by which, apart from field-evidence, they are to be distinguished from Archæan schists, as to the derivation of which we can only guess, and which, therefore, must in the meantime be considered as original rocks.

By the aid of the microscope, much assistance is obtained in tracing out the mineral transformations which have taken place in the course of this regional metamorphism. To show the larger features of the change, so far as they can be judged of in hand-specimens, I exhibit on the table a series of pieces of the crushed gneiss, quartzite, and conglomerate; and to illustrate the internal changes I show a selection of slides on the screen, photographed from thin slices of the rocks as seen under the microscope.

The importance of the discovery of this belt of extreme complication in the North-West Highlands can hardly be over-estimated. It gives us the key to the geological structure, not only of the Highlands, but of all the areas of younger crystalline schists in our own area, and will doubtless be found to explain much in the geological

structure of Scandinavia. The lines of maximum thrust-planes can be followed for 100 miles, from the north of Sutherland into Skye; but this is only a small part of their extent. They can be picked up again in the west of Mayo and Donegal, a total distance of some 400 miles. That similar lines of movement have affected Scandinavia and produced the distinctive strike of the rocks there can hardly be doubted, so that the total length of disturbed country in North-Western Europe probably exceeds 1600 miles, trending in a general north-north east direction.

How far the influence of the great terrestrial movements extended eastwards from what now appears as the belt of maximum disturbance, and what effect it had upon the configuration of the surface, are questions to which as yet no satisfactory answer can be given. It is difficult to suppose that such colossal displacements and fractures of the crust should not have powerfully affected the superficial topography of the time. They may have produced a high mountain range, or a succession of parallel ranges, extending along the north-west of Europe. The existence of some such mass of land is needed to account for the vast piles of sediment of which the Palæozoic, Secondary, and Tertiary formations have been built up. So great, however, is the antiquity of these terrestrial movements, so continual and gigantic has been the denudation, and so repeated have been the oscillations of level, that the upheaved land has been reduced to the fragments that now form the Highlands and Islands of the west of Ireland, of Scotland, and of Scandinavia.

It is quite clear that during the disturbances in the north-west region the main thrust came from the eastward. It will be interesting to discover how far towards the east these disturbances affected the structure of the rocks beneath. That it reached across the whole breadth of the Scottish Highlands—that is, for a distance of 100 to 130 miles—can be conclusively proved. That it extended much further, and embraced within its area the whole of the Silurian regions of the three kingdoms can, I think, be shown to be highly probable.

To understand this part of the problem it is necessary to consider the structure of the ground immediately to the east of the belt of extreme complication in the North-West Highlands. I have said that the displacements and metamorphism increased in intensity from west to east, until at last, by a final gigantic thrust, a series of reconstructed schists has been driven over rocks whose origin can still be determined. Among these eastern schists it is occasionally possible to detect more or less reliable traces of the original rocks out of the crushing down of which they have been formed. Thus we find in the northern part of the area slices of Archæan and eruptive rocks, and in the south an increasing amount of material which has been derived from the destruction of the red Cambrian sandstones. It is tolerably evident that in the broad band of country which extends from the belt of complication eastwards to the Moray Firth and the line of the Great Glen, and embraces the mountainous tracts of Sutherland, Ross, Western Inverness-shire, and North-Western Argyllshire, the lower parts of the geological record are repeated again and again. It is mainly the Archæan platform, with its covering of Cambrian sandstones, and possibly the lower parts of the Silurian series, which have been broken up, plicated, crushed, and converted into the series of crystalline schists that form the picturesque heights of Ben Hope and Ben Klibric southward to the Moidart and Morven. Nevertheless, when this wild tract of country comes to be mapped out in detail, there will probably be found intercalated bands of higher formations which have here and there been caught in folds of the lower rocks.

But when we pass eastwards from the Great Glen into the mountains of Eastern Inverness-shire, Perthshire, and the South-Western Highlands, we encounter a totally different series of rocks. Though greatly plicated, dislocated, crushed, and metamorphosed, these rocks can be recognized as unquestionably, in the main, of sedimentary origin. They must be many thousands of feet in thickness, including among their members such rocks as conglomerate, pebbly grit, quartzite, black slate, andalusite slate, phyllite, mica-schist, fine flaggy gneiss, and limestone, together with intrusive sheets and bosses of various eruptive rocks. Some of the groups of this series can be followed and mapped for long distances with nearly as much ease as the members of a succession of unaltered Palæozoic or Secondary formations. There is a belt of limestone, for example, which has been traced by the Geological Survey almost continuously from the coast of Banffshire to the west of Argyllshire, through the very heart of the Highlands—a total distance of not much less than 200 miles. These limestones have for the most part become so thoroughly crystalline, that fossils can hardly be expected to be found in them, though there are occasional less altered portions of rock which may eventually prove to be fossiliferous. The limestones are associated with quartzites and schists, as unaltered limestones are with sandstones aud shales. I cannot myself doubt that they have been formed by the aggregation of the remains of calcareous organisms. The same rocks are prolonged into the north of Ireland, where one of the dark limestones at Culdaff has lately yielded certain bodies which some palæontologists have declared to be the remains of a coral (*Favosites*). The black slates which so closely resemble the dark Carbonaceous shales of the Lower Silurian region of South Scotland have afforded in Donegal some curious pyritous markings, strongly suggestive of Graptolites.

Out of this enormous mass of metamorphosed sedimentary strata the Scottish Highlands east of the Great Glen are built up, as well as the region which extends southwards across the north-west of Ireland as far as the centre of County Galway. The first question that requires an answer with regard to it has reference to its relation to the fossiliferous quartzites and limestones of the north-west. Murchison, who led the way in the investigation of the stratigraphy of the Highlands, believed that the quartzites and limestones of the Central Highlands lay towards the base of the whole series of post-Cambrian rocks, and were the south-eastward extensions of those of Sutherland. But recent investigations throw some doubt on this view, which at the time it was promulgated seemed so natural and simple. We know that the quartzites and limestones of the Central Highlands, so far from being near the bottom of the vast series of schists, are underlain by many thousand feet of other metamorphosed sedimentary strata, and that the actual base is nowhere reached in that region.

During the last two years, in concert with some of my colleagues of the Geological Survey, I have devoted some time to the task of endeavouring to find the bottom of these crystalline schists of Scotland and Ireland, as a necessary foundation for placing them on their true geological horizon, and at length, this spring, our efforts have been successful beyond our expectations. Last year, in the north-west of the Island of Islay, I found a group of scarcely altered shales, grits, and thin limestones emerging from beneath the black slates which underlie the schists, limestones, and quartzites of that region. So little have these strata suffered from the metamorphism which has affected the rocks lying above and to the east of them, that I quite anticipate that fossils will be found in them. This year, in company with Mr. C. T. Clough, I came upon a somewhat similar group of little-metamorphosed black slates and grits at the north-east end of the Island of Iona. I am hopeful that these strata will yield fossils; I myself found in them some short black limes, which at once recalled the form and condition of the fragments of the central rods of Graptolites so com-

monly met with in the black shales of the Southern Uplands of Scotland. The discovery of recognizable fossils in these strata would fix the geological age of the rocks of the Central Highlands and of the north-west of Ireland.

An interesting feature about these slates of Iona is that they lie at the very bottom of the series of younger schists. Immediately under them are a coarse grit (arkose) and conglomerate, formed out of the Archæan gneiss, which comes out in great force from underneath them, and forms the main part of the island.[1] The uprise of an axis of the old gneiss so far to the east of the line of great complication, and at the base of the vast sedimentary masses of the Central Highlands, is a fact of great importance. We seem to find here a fragment of the old barrier which separated the American province in which the Durness limestones were deposited, from the area of Western and Central Europe in which the other Silurian formations of Britain were laid down. Prolongations of the same ridge towards the north-east are possibly to be traced even as far as the mountains between the head of the Rivers Nairn and Findhorn, where some of my colleagues think that there is probably another core of the Archæan gneiss.

The search for a base to the same great series of schists as they are developed in the north-west of Ireland has been equally successful. Along the west of County Mayo, Archæan gneiss has been recognized by us,[2] exhibiting the typical characters of the same rock in the north-west of Scotland. In Achill Island we found the base of the quartzite and schist series in the form of a coarse quartz-conglomerate resting on the gneiss. But all these rocks have come within the influence of the intense regional metamorphism. The conglomerate in particular has had its quartz-pebbles pulled out in the direction of movement, and its paste has been converted into a fine kind of gneiss.

Having thus traced an original westward boundary to the younger crystalline schists of Ireland and Scotland, I saw that it would be important to follow their eastern boundary as far as it had not been concealed by later formations. In Galway we found that the quartzites, limestones, and schists are succeeded to the south by the large area of Archæan gneiss already referred to. But the boundary between the two groups of rock is one of extreme complication, somewhat like that of the North-West Highlands. Along a line running east and west through the heart of this county from Mannin Bay to Lough Corrib, the two groups have been so dislocated and so thrust between and over each other that much time and patience, with the use of large-scale maps, would be required to map out their respective areas. But the important fact is readily perceptible that in Galway the uprise of a large Archæan area gives us a southern limit for the basin in which the younger schists of the north-west of Ireland were deposited.

To the east and north-east of the Galway area the country has been overspread with Old Red Sandstone and Carboniferous strata, so that for a long space the older rocks are concealed. Far to the north-east, in Tyrone, on the southern borders of the great area of crystalline schists, a mass of dark hornblendic rocks was mapped some years ago by Mr. Nolan, of the Geological Survey of Ireland, and referred doubtfully to a pre-Cambrian age. A more recent examination of this mass, with the experience gained over so wide a region among the older crystalline rocks, has enabled us to identify it without hesitation as a characteristic portion of the Archæan gneiss. It rises as a long north-east ridge along the south-eastern margin of the chloritic schists of Londonderry which were deposited against and over it. We discovered, moreover, that these schists have at their base, resting on the old gneiss, a thick volcanic series consisting of amygdaloidal basic lavas, tuffs, and coarse volcanic agglomerates. The green chloritic material of the schists, not improbably represents the original magnesian silicates in the finer volcanic dust that mingled with the ordinary sediment of the sea-bottom.

From the evidence now adduced, it is, I think, manifest that the crystalline schists of the Scottish Highlands east of the Great Glen, as well as their continuation into the north-west of Ireland, cannot be regarded as merely the equivalents of the quartzites and limestones of Sutherland and Ross. They are enormously thicker and more varied in their component members than those north-western strata. Whether even any part of them represents the sedimentary rocks of the north-west seems to me open to serious doubt. My own impression is that they are probably younger than these rocks, and that they once stretched far to the north-west, and covered them to a depth of many thousands of feet. That the fossiliferous strata of the North-West Highlands were originally buried under a thick pile of other sediments I have already shown.

The last question on which I propose to touch is the geological date of the extraordinary terrestrial disturbances to which the crystalline schists of the Highlands of Scotland and the north-west of Ireland owe their characteristic structures. The limit of its antiquity is easily fixed. As these disturbances involve rocks containing fossils of Lower Silurian age, they must obviously have taken place after some part at least of the Lower Silurian period. In Scotland their chronological limit in the other direction is determined by the fact that the conglomerates of the Lower Old Red Sandstone are largely composed of the crystalline schists of the Highlands. They must consequently have occurred before the deposition of some part at least of the Lower Old Red Sandstone. Here, then, is a long geological interval within which the gigantic upthrusts and metamorphism began and ended.

But the evidence obtained in Ireland enables us to fill up this interval with a little more definiteness. In Southern Mayo and Northern Galway, as Prof. Hull has pointed out, the Upper Silurian rocks rest upon and contain abundant fragments of the younger crystalline schists which stretch into these counties from Donegal. And the inference has naturally been drawn that the great terrestrial disturbances and metamorphism occurred before the Upper Silurian period But a recent more critical examination of the ground has satisfied me that this inference, though to a certain extent correct, does not embrace the whole truth.

Those who have visited Connemara may remember the singular group of mountains which hem in the Killary fjords, and rise in Mweelrêa and its neighbouring ridges to a height of more than 2600 feet above the sea that frets their base. These massive buttresses of rock owe their distinctive forms to the thick beds of coarse grit and conglomerate of which they are in great measure built up. An abundant series of fossils proves that this mass of deposits is of Upper Silurian age. It is the base of these exceedingly coarse sediments which along their southern margin can be seen to rest upon the upturned edges of the crystalline schists, and to be there largely made up of fragments derived from that metamorphic platform. The numerous bands of coarse conglomerate upon successive horizons serve to indicate considerable terrestrial disturbance during their deposition. That the commotion continued after that time is further shown by the remarkable way in which the rocks have been dislocated. These Upper Silurian sediments have been broken up into large mountainous blocks which have been thrown on end or actually pushed over each other. So violent

[1] The existence of a slight displacement at the actual junction does not obscure the evidence of the true relation of the rocks.

[2] In my recent traverses in the west of Ireland I had the advantage of the company and assistance of my colleagues, Mr. Peach, Mr. McHenry, and Dr. Hyland.

has the movement been along certain lines, that the bands of greywacke and shale have been intensely crumpled and puckered, and have actually been converted locally into fine micaceous schists.

Hence it seems tolerably certain that though in the west of Ireland the chief plications, fractures, and metamorphism were completed before Upper Silurian time, and though a vast interval must have elapsed during which the progress of denudation laid bare the younger schists, and thereby provided materials for the Upper Silurian conglomerates, the terrestrial disturbances nevertheless continued during the deposition of these conglomerates, and were renewed with increased vigour afterwards.

If we compare the geological structure of the Silurian tracts of England, Wales, and the south of Scotland, and the east of Ireland, with that of the areas of the younger crystalline schists, many points of resemblance will be seen to occur between them. Towards the north and north-west we find that the Archæan, Cambrian, and oldest Silurian rocks, now exposed there by the progess of denudation, have been subjected to the intensest mechanical deformation, and have assumed the most completely schistose structures. Coming southward, we trace the younger crystalline schists of the Central Highlands and of Donegal thrown into innumerable north-east and south-west folds, and becoming less and less metamorphosed as they are followed towards the lower grounds. Still further south the Lower and Upper Silurian rocks, plicated, crumpled, and dislocated, repeat the familiar structure of the Southern Highlands, but with only partial and feeble metamorphism. I am disposed to look upon the whole of these structures as the result of one great succession of terrestrial movements which began and reached their maximum of intensity during some part of Lower Silurian time, but which continued to repeat themselves at intervals with greater or less vigour through a long series of geological ages, down to the early part of the Old Red Sandstone period.

As the consequence of this prolonged disturbance, the Archæan and older Palæozoic rocks have been thrown into those north-east and south-west folds, which have in large part determined the trend of the land in the north-west of Europe. The shaping of our mountains into their present forms has been brought about by ages of subsequent sculpture, in which the agencies employed by Nature have operated mainly on the surface, but the carving of their features has been guided by the internal structures developed by those subterranean movements which we have been considering.

THE ENTIRE SKELETON OF AN ENGLISH DINOSAUR.

SOME years ago an article appeared in the columns of this journal (vol. xxviii. p. 439), in which a notice was given of the marvellously preserved skeletons of *Iguanodon* from the Wealden deposits of Bernissart, in Belgium, some of which are now exhibited in the Brussels Museum of Natural History. In that article the author very properly insisted upon the extreme importance of those specimens from an anatomical point of view, as exhibiting the whole of the bones of the skeleton in their natural juxtaposition. He was, however, probably then unaware (as the undermentioned specimen was not at that time exhibited to the public) that the British Museum possessed the skeleton of an English Dinosaur, which, although of smaller size than the Bernissart Iguanodons, belongs to the same sub-ordinal group, and exhibits equally clearly the mutual relations of the component bones. The English skeleton is, indeed, in some respects much more satisfactory than the Belgian specimens, inasmuch as its bones have not been flattened and crushed in the manner which so sadly disfigures those of the latter. Further, the English Dinosaur has an additional interest in that it is one of quite the earlier members of the group, its geological horizon being the Lower Lias of Dorsetshire.

This specimen, as being the only known example of the almost entire skeleton of a Dinosaur from English deposits, is so remarkable as to deserve especial attention from all those interested in the former inhabitants of our islands. In the first place, the history of its discovery is somewhat curious. Thus, some time previously to 1861, Mr. J. Harrison, of Charmouth, obtained from the Lower Lias of that neighbourhood portions of the hind-limb of a comparatively large Dinosaur, and, later on, a skull, lacking only the extremity of the muzzle. In the year mentioned, these specimens were described by Sir Richard Owen in the publications of the Palæontographical Society, under the name of *Scelidosaurus harrisoni;* the portions of the limb being taken as the type of the genus, and the skull referred to a smaller individual of the same species. Stimulated by the extreme interest aroused by the discovery of this skull, Mr. Harrison continued his excavations on the spot where the latter had been obtained, and was rewarded by finding the whole of the remainder of the skeleton, with the unfortunate exception of most of the vertebræ of the neck. The skeleton was extracted in several blocks, and these, after careful "development" of the bones, were fitted together so as to enable the whole skeleton to be exhibited.

Until the completion of the Natural History Museum at South Kensington, this magnificent skeleton was, however, from want of space, never exhibited to public view; and it was not until some three years ago that it was properly mounted and placed in its present position, where, in a handsome glass case which permits a view of both sides, it forms one of the chief treasures of the unrivalled gallery of fossil reptiles in that Museum. The bones being all firmly cemented together by matrix, and also more or less dislocated out of their normal places, it was, however, of course impossible to mount the skeleton in its natural position—which was probably a semi-erect one; and it is accordingly now placed with the axis of the vertebral column in a horizontal position. As thus mounted, the specimen is about 11 feet in length, but the absence of the cervical vertebræ renders it impossible to ascertain its true dimensions, the head being now placed much too near to the shoulder-girdle. The skeleton has been somewhat dislocated, and twisted over to the right side, so that the neural arches and spines of the vertebræ of the back and loins are seen on the right, and the under surface of their bodies, or centra, on the left side of the specimen. Both hind-limbs are entire, although the left one is thrust up by the twist, and has become placed near the tail. The haunch-bones (ilia) of the pelvis still nearly retain their normal position; and on the left side of the specimen we see the lower extremities of the left pubis and ischium lying crossed over the lower ends of the corresponding bones of the right side. A portion of that part of the pubis which lies in advance of the acetabulum is visible; and the post-acetabular portions of both the pubis and ischium lie in the original parallel position which is so characteristic of this group of Dinosaurs and of the Struthious birds. The left side of the shoulder-girdle is well preserved, and has the humerus and portions of the bones of the fore-arm in their original position; but the bones of the hands are wanting. The dermal scutes, with which the body and tail were protected, are seen arranged in longitudinal rows, which have, however, been somewhat thrown out from their original position. We would especially call the attention of those who may think it worth their while to visit the Museum, in order to study this unique specimen, to the marvellous preservation of the hind-limbs, which permits even the smallest bones of the toes to be