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XL. *Classification of the Older Stratified Rocks of Devonshire and Cornwall.* By the Rev. Professor SEDGWICK, F.R.S. F.G.S., and RODERICK IMPEY MURCHISON, Esq., F.R.S. F.G.S.*

IT was the general belief of geologists, when we commenced our examination of Devonshire, in the summer of 1836, that the larger portion of its area was occupied by greywacke or transition rocks of high antiquity, from which the culm-bearing strata of Bideford, and many other places in the county, could not be separated. Having occupied ourselves for some years in deciphering the relative age of the older rocks of England and Wales, we were naturally anxious to apply to this county those principles of classification by which the successive subdivisions of the Silurian, and (though much more imperfectly) also of the Cambrian System, had been determined; for it seemed to us very anomalous, that the culm beds of Devonshire, though stated to resemble those of the coal field of Pembrokeshire, both in their mineral characters and in their associated fossil plants, should be interpolated among the most ancient greywacke rocks of the county. Mr. De la Beche had, however, in a communication to the Geological Society, stated that such was their position; and he completed an Ordnance geological map, in which all the culm rocks, as well as all the so called greywacke rocks of Devon, were represented under one uniform colour. This map we purchased many months before we commenced our examination of Devonshire. An outline of the results of this examination was laid before the British Association in the autumn of the same year; and we exhibited a section from the north coast to Dartmoor, (copied, though not quite correctly, in the

* Communicated by the Authors.

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Athenæum,) in which we pointed out an ascending series of ancient stratified rocks, the greater part then supposed to belong to the upper Cambrian, and a comparatively thin band to the lower Silurian strata: and we further showed that the culm measures of Devon, so far from being mere courses subordinate to these older rocks, constituted, in fact, a vast basin or trough of carbonaceous deposits, differing from the rocks on which they rested, in mineral character and in organic remains. We also exhibited a map in which the boundaries of this great carbonaceous trough were defined, with as much accuracy as the short period of our examination permitted; and we stated our belief, that at least all the upper part of it was the equivalent of the true coal measures. We further proved, that the granite of Dartmoor had been protruded after the consolidation of the culm or coal formation. Subsequently, we embodied these results with other details, not presented to the British Association, in a second memoir, read before the Geological Society (June, 1837), in which we gave a short account of the structure of South Devon; the different rocks of which we placed in parallel with their equivalents in North Devon, referring them, as well as we were able, to their types in other districts of Great Britain.

Adhering strictly to our first view, viz. that the great overlying culm-bearing trough is the equivalent of the carboniferous system; we proceed to point out the reasons which induce us to make a material change in the classification and equivalents of the older rocks of Devon and Cornwall.

North Devon.—In our previous communications we subdivided the part of Devon which lies between the north coast and the trough of culm deposits into five ascending mineral masses, closely linked to, or passing into one another. From its lithological character, from the ferruginous impressions of stems of *Encrinites*, and the resemblance of certain casts of shells (much distorted, however, by compression, and by lines of slaty cleavage) to fossils of the Caradoc sandstone, we placed the fifth group in the lower part of the Silurian system; consequently the four inferior groups (though different in many respects from anything we had ever seen among the older rocks of Wales or Cumberland) necessarily fell into the upper portion of the Cambrian system. Over all these groups came the culm measures, and certainly without the intervention of conglomerates or any manifest discordancy of position.

Since our memoirs were read, Mr. Weaver examined the neighbourhood of Barnstaple; and confirming our views as to the age of the culm-measures, reported them to be unconformable to the older rocks*. One of the authors, for the ex-

* Proceedings of the Geol. Soc. vol. ii. —.

press purpose, among others, of inquiring into this point, revisited the country last summer, but was not able to discover any discordance in the junction south of Barnstaple: on the contrary, the culmiferous deposits seemed rather to be a continuous uninterrupted series, following the older rocks. Now, if this be so, one of two things must follow. Either the culm measures must be older, or the rocks of North Devon younger, than we had at first supposed. The question then is this, what is the evidence given by the fossils? The fossil plants of the culm beds are undistinguishable from those of Pembrokeshire, the nearest coal field, while certain shells of the black limestone, subordinate to the lower culm strata, prove also to be undistinguishable from species which occur in the true carboniferous system; and thus we have on fossil evidence every ground for believing that our first view respecting the culm measures was correct, and that they are the true equivalents of the carboniferous system.

On re-examining, however, the collections of fossils we had made among the strata which lie beneath the northern edge of the culm field, we have seen reason to change our views respecting the age of these older rocks.

In the uppermost of the five groups into which we provisionally divided those rocks, we now find no unequivocal lower Silurian fossils: for though two distorted casts have much the appearance of shells of that date, there are other and better preserved specimens, which approach so near to species known in the carboniferous limestone, (*Spirifer cuspidatus* and *Spirifer attenuatus*) as to be almost undistinguishable from them; and with these are found *Leptæna*, having somewhat the character of upper Silurian fossils, and undescribed *Terebratulæ*, together with *Trilobites*, some of entirely new forms, and others approaching to upper Silurian types.

Below these slaty and calcareous strata near Barnstaple, a part of which we first mistook, as above stated, for Caradoc sandstone*, are the sandstones of Baggy Point, Marwood, and Sloley, which we have elsewhere described in detail. In the line of these are found certain fossil plants, specimens of which were first sent to us by Major Harding, and others were laid before the Geological Society by the Rev. D. Williams: some of them are considered by Mr. Williams and Mr. De la Beche, on the authority of Dr. Lindley, to be undistinguishable from

* The strong resemblance of the *Caradoc sandstone*, in consequence of mineral character and the circular marks of erinoidal stems, to the sandstones of the lower shale of the *Carboniferous limestone*, and the probability that this resemblance would lead to mistakes, has already been pointed out by one of the authors. (*Silurian System*, pp. 384, 453.)

plants of the carboniferous system. On the same line are ferruginous bands, with casts of shells, communicated by Major Harding, which strongly reminded us of forms in the old red sandstone; one indeed being, as Mr. Sowerby thinks, identical with the *Bellerophon globatus* of that system*.

In the next underlying groups of Morte Bay and Ilfracombe, we have few well-preserved mollusca, but among them is a very wide *Spirifer* and a spined *Productus*, approaching to the carboniferous type, but unlike anything we know in the Silurian or Cambrian rocks. Corals occur in parts of these Ilfracombe groups, and among them is the *Favosites polymorpha*, a species most abundant in the upper Silurian rocks, but not found in the lower.

Lastly, in the lowest group we perceived certain large heart-shaped forms, quite unlike anything we had ever seen until we afterwards detected the same in the collection of Mr. Hennah, from the Plymouth limestone: and in the very lowest fossil beds near Linton, we still perceived some of the same specific forms that occur near Barnstaple; which, though undescribed, may be pointed out as of characters intermediate between those of the Silurian and carboniferous fossils, the balance of evidence inclining rather to the younger of the two types; there being few if any traces of the genus *Orthis* so eminently characteristic of the Silurian system. These evidences all tend one way, and (confirmed as they are by the passage of the bottom culm-measures) force us to believe that the oldest rocks of North Devon are much younger than we at first supposed: and coupling these with other proofs still more cogent from South Devon, we arrived at the conclusion which we shall presently explain.

South Devon.—In the communication of 1837 to the Geological Society, we described several sections from the granite of Dartmoor to the south coast of Devon, and (omitting the altered slates) we divided the older stratified rocks into three groups; the lowest, composed of slates, containing subordinate bands of the Ashburton limestone, and ending in ascending order with the Plymouth and Torbay limestones, which we considered to be identical; the second, composed of red sandstone, with occasional subordinate beds of shale, &c.; the third of soft non-fossiliferous schists, extending almost to Start Point. These we considered (and we believe correctly) of the same age with the groups of North Devon; and we attempted (without the aid of fossils) to bring them into close comparison, by identifying the great deposits of *red sandstone* of the two districts. This identification of the separate groups we considered as merely provisional, “to be con-

* Murchison's Silurian System, Pl. 3, 15.

firmed or rejected," to use our own words, "by the examination of the organic remains of the several groups."

And here we may briefly allude to visits made by one of the authors to different parts of this region, both before and after the Bristol Meeting of the British Association, and subsequent to the reading of our second memoir in London. During the autumn of 1836, he traced the calcareous system of South Devon into Cornwall, and followed it continuously through the north of the Lizard into Mount's Bay, and at Looe, Fowey, and other places, found numerous organic remains (not however yet described): in a former year, 1828, he had traced the fossil slates of Tintagel into Padstow Bay, but had then no time to carry his observations further south. Before the autumn of 1836, Mr. De la Beche had worked out the structure of the north side of Cornwall in great detail: and one of us, informed by him of the existence of many other fossil localities, examined the north Cornish coast; and concluded, in a paper read at Cambridge in the winter of 1836-37, *that the fossiliferous system on both sides of Cornwall was the same*, and therefore of the age, or nearly so, of the calcareous rocks of South Devon. The same view was re-stated by us in the paper read to the Geological Society. We still believe this view to be correct, and hesitate not to class the calcareous rocks of South Devon, and the fossiliferous slates of both coasts of Cornwall, together.

Last summer (1838), one of us paid a visit to Devon and the neighbourhood of Launceston, for the purpose of ascertaining the following points:

1. Whether the limestones of Newton Bushell could be classed with the carboniferous or mountain limestone, an opinion advanced by our friend Mr. Austen*, who drew that conclusion from the forms of the numerous fossils he had brought to light.
2. Whether the true culm-measures pass under the Ashburton or Chudleigh limestone.
3. To ascertain (especially after Mr. Weaver's memoir) whether there was any general discordancy of position between the culm-bearing beds and the Cornish slates near Launceston. To each of these questions his observations gave a negative. He was confirmed in the views first stated by the authors in 1837, concerning the relations of the limestone of Torbay to that of Plymouth; and notwithstanding the many fossils of the Newton Bushell limestone resembling those of the carboniferous system, its beds formed clearly a part of the group subordinate to the great southern slate deposit. He saw no good reason for thinking that the culm-measures pass under any

* See Proceedings of Geological Society.

part of the limestones and slates of South Devon : and lastly, he found near South Petherwin what appeared an *unequivocal passage* between the fossiliferous slates and the overlying culm series. From these facts it follows ; 1st, that the fossiliferous slates of Barnstaple, on the north side of the great culm trough, must be nearly of the same age as those of South Petherwin on its southern side ; for certainly the inferior strata of the culm series are the same, or very nearly the same, at the two localities ; 2nd, either that the culm series was older, or the fossiliferous slate of North Cornwall newer than we had supposed in our memoir of June 1837. Under these circumstances, it became doubly important to examine large suites of fossils, before we could arrive at a correct conclusion as to the true place of the older Devonian strata in the geological series*.

The most extensive collection of fossils which had been made in South Devon, were from the Plymouth limestone by the Rev. R. Hennah, and from the limestones of the neighbourhood of Newton Bushell by Mr. Austen. The latter was sent to the Geological Society to illustrate a memoir by that gentleman ; and the inspection of its contents convinced Mr. Lonsdale, that few, if any, of the organic remains could be strictly identified with species of the carboniferous limestone to which Mr. Austen compared them ; for although there were some which had a close resemblance, still there were many which bore the impress of a distinct type, while others, particularly the corals, seemed to approach to certain forms of the upper Silurian group ; and hence Mr. Lonsdale was

* The fossils of South Petherwin, from the first, presented a great difficulty. One or two of them very nearly resembled mountain lime fossils ; and as a group they were *not* identical with any series we had before examined. This induced one of the authors to join Mr. Austen (in July, 1837) in an excursion to that neighbourhood ; thinking it possible that the South Petherwin limestone *might* form a part of the base of the culm-measures. An unseasonable interruption compelled them, after two or three days, to leave the country : but they ascertained, 1st, that the limestone in question did not form a part of the culm series ; and 2nd, that the fossils of South Petherwin, &c., were, as a group, nearly the same with the fossils of South Devon ; thus confirming a previous conclusion (drawn from less perfect evidence), that the fossiliferous systems of South Devon and of Cornwall were the same. They also found one junction (since visited and sketched by Mr. De la Beche, Report, &c. p. 107.) in which the culm beds appeared to rest unconformably on the older slates. This kind of junction seems to form the exception and not the rule ; and does not, we think, invalidate the statement made above. Many such junctions might indeed be found in the very heart of the culm-measures, where the beds are all of one age. Such an appearance of want of conformity does not therefore invalidate the fact of a true *passage* from the Petherwin slates into the culm-measures.

induced to suggest to us (now more than a year ago), that the South Devon rocks would be found to occupy an intermediate place between the carboniferous and the Silurian systems. The collection of Mr. Hennah was unfortunately mis-sent to Cambridge, and was only unpacked very recently: but upon its examination (within these few weeks) by one of the authors, in company with Professor Phillips and Mr. James Sowerby, the same general results were arrived at; namely, the existence of some fossils undistinguishable from certain forms of the carboniferous limestone, and others from those of the upper Silurian rocks, while many were entirely new. Again, the corals of this limestone being examined by Mr. Lonsdale, gave nearly the same results as those of Mr. Austen.

After again examining our own collections, and looking to the fossils of North Devon, South Devon and Cornwall as a whole, we distinctly perceived that Mr. Lonsdale was right, and that they must all belong to a system intermediate between the two great systems (Silurian and Carboniferous) which had so recently been shown to be entirely separated from each other, both by their order of superposition and their imbedded organic remains.

The publication, indeed, of the Silurian system and its numerous fossils affords us a fixed term in the series of the older rocks; and the previous labours of Professor Phillips and others having made us acquainted with the organic remains of the carboniferous system, we have now, for the first time, the means of placing the Devonian groups in their true order.

Without entering, on this occasion, into specific details, we may state that the zoological groups of the Devonian rocks are all of characters intermediate between those which mark the Carboniferous and Silurian epochs. Thus, for example, among the Cephalopoda, *Goniatites* have hitherto been considered as typical of the carboniferous system, while the researches of one of the authors have shown that they never occur in the Silurian system. They do, however, appear in some of the older Devonian rocks; and, just as we should expect, they are associated with analogues of an entirely new type, the *Endosiphonites**.

Again, there are many large and broad *Spirifers* in these Devonian rocks, which closely approach to the forms of that genus, so abundant in the carboniferous system. But this genus is feebly developed in the Silurian system, and the few species that do occur are entirely unlike the large typical *Spirifers* of the carboniferous æra; while the *Orthis*, or real Silurian

* See Trans. of the Cambridge Phil. Soc., vol. vi.

Spirifer, is rarely if ever seen in Devonshire. The large round spinose *Producti* are among the best-marked fossils of the carboniferous system. Now, the closest researches have not hitherto brought to light the existence of one species having this character in the Silurian system; while in Devonshire we find several associated with other species, which are analogous both to the Silurian and carboniferous types. On the other hand, the families and genera which predominate so much more in the Silurian than in any other system, viz. *Trilobites* and *Orthoceratites*, are here just of the intermediate character which ought to be detected in deposits connecting that system with the carboniferous. Some of them approach very closely to upper Silurian species, if indeed there be not some undistinguishable; while others, particularly some of the *Trilobites*, are of forms entirely different from any species hitherto found, either in the Silurian or Carboniferous systems*.

In regard to the corals, Mr. Lonsdale informs us, that the few which he can identify with published species (the most abundant and certain being *Favosites polymorpha*, *Porites pyramorphis*, and *Stromatopora concentrica*), belong to the upper Silurian rocks; while there are several which are new and undescribed. Again, the chain coral (*Catenipora escharoides*), and many of the most remarkable Silurian types, are entirely absent, nor has a single species common to the carboniferous limestone been yet detected among the numerous polypifers of South Devon.

Whether, in the sequel, we shall present to the public a suite of engravings of all the undescribed Devonian and Cornish fossils which we have collected, or which have been lent to us, or shall consign them to Professor Phillips, to complete a task for which he is so eminently qualified, and for which purpose he is, we are glad to learn, to be employed by the Government, is of little moment: but after such evidences, we have no hesitation in putting forth our present classification, and in accepting, in the broadest form, the conclusions to which the general view of these organic remains lead us, viz. *that the oldest slaty and arenaceous rocks of Devon and Cornwall are the equivalents of the old red sandstone.* We also place, in the same parallel, the older rocks of North Devon; being now fortified in our conclusions by the evidence of the fossils, by the sections, and by the order of superposition; which indicates, on both sides of the great carbonaceous trough, a passage downwards from the carboniferous system (the horizon of which

* Our friend M. de Verneuil acquaints us, that having examined a collection of South Devon fossils sent to him by Mr. Austen, he is of opinion that seven or eight of these shells are undistinguishable from fossils of the Eifel, which he refers to the Silurian system.

we consider as fixed,) into the Devonian equivalents of the old red sandstone.

Under this view, the supposed difficulty arising out of the existence of certain species of fossil plants, both in the carboniferous system and "undisputed greywacke rocks*," is at once obviated: for the hard brown and greenish-grey micaceous sandstones between Ilfracombe and Barnstaple, in which these plants were discovered †, are now placed in the upper part of the old red sandstone, in which all true analogy would impel us to look for the presence of some of the species of plants common to the carboniferous epoch: and we are strengthened in this conviction by the evidence of the shells on the same line with these plants, among which is a species, as before stated, of *Bellerophon*, identical, as far as casts can prove it, with a shell figured from the old red sandstone. In regard to the organic remains of the old red sandstone, one of the authors has indeed already published those forms which mark its passage into the Silurian system. Aware of the enormous thickness of this arenaceous series in the British Isles, and having ascertained, to a certain extent, the peculiarity of its fossils, particularly of its fishes, he proposed that it should be considered "*a system*," intermediate between the Carboniferous and Silurian systems ‡.

Whilst, however, he indicated the existence of certain shells connecting the old red and Silurian systems, as well as fossil fishes of very peculiar types in the former, he knew too well that the greater mass of this vast system, particularly all its upper members, contained no organic remains in the countries which he illustrated. In stating that "the strata (Carboniferous and Silurian), so broadly distinguished by their organic remains, are separated by accumulations of enormous thickness, and that the vast time occupied in their deposit accounts satisfactorily for an almost entire change in the forms of animal life;" he also thus declared his anticipation concerning the old red system: "We are yet unprovided with zoological links to connect the *whole series*, though I have no doubt that such proofs will be hereafter discovered, and that we shall then see in them as perfect evidences of a transition between the old red and carboniferous rocks, as we now trace from the Cambrian, through the Silurian into the old red system §."

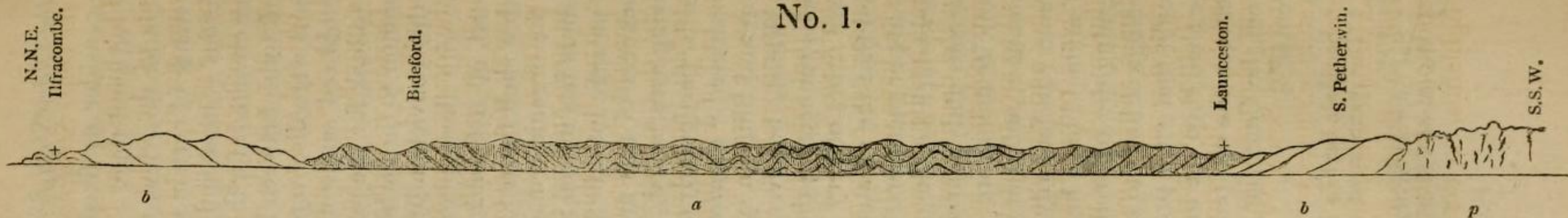
* See De la Beche's Report, p. 132, *et seq.*

† The plants were first observed by Major Harding and the Rev. D. Williams.

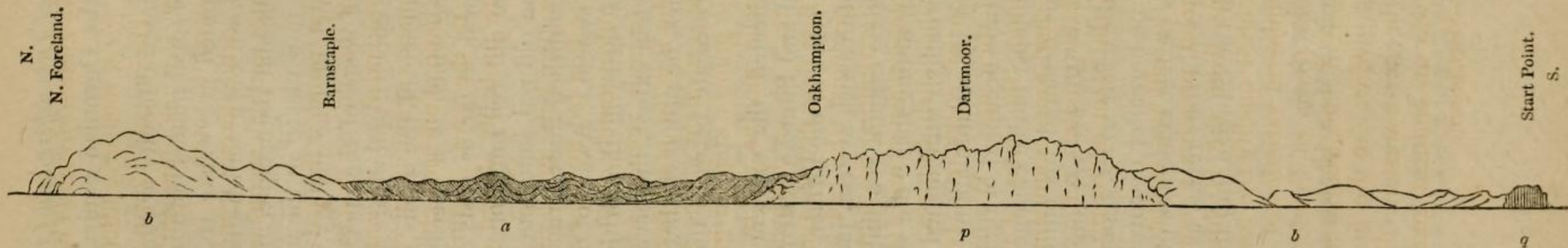
‡ See Silurian System and Map.

§ Murchison's Silurian System, p. 585.

No. 1.



No. 2.



a. Culmiferous Rocks = Carboniferous System.
b. Slaty Rocks, Sandstone and Limestone = Old Red System.

p. Granite.

q. Metamorphic Rocks?

This hiatus is at last, in a great measure, filled up by the fossils of the older rocks of Devon and Cornwall; and believing our views to be correct, we thus represent Devonshire in two general sections from north to south.

In the higher of these the carboniferous trough is seen to repose at each side on the slates and calcareous sandstones of the old red system.

In the lower section the culm trough is flanked on the north side only by the slaty rocks of the old red system, the granite of Dartmoor having been protruded on its southern edge; while the old red system reappears again in the southern part of the county, terminated by a band of micaceo-chloritic schists, which are perfectly parallel to the great disturbing axis of Cornwall and Devon, and are probably altered or metamorphic strata.

In propounding these views, we have no desire to conceal the error into which we were first led by trusting too much to mineral characters. We unfortunately never gave, till very lately, that attention to the organic remains which is indispensable; but having been the first to point out, that nearly one half of Devonshire is the equivalent of the carboniferous rocks, we have no hesitation in going a step further, guided by a closer inspection of the organic remains, and by the apparent fact, that this carboniferous tract passes downwards into the older system. It is not the first time that we (and we believe we may say every practical geologist who has examined old rocks) have been deceived in attributing too high antiquity to strata having an antique lithological aspect and a slaty cleavage: but the day is now passed, when such features, still less the mere colour or composition of rocks, can be allowed to lead to any true estimate of their age. We have red sandstones and conglomerates among the slates of the Cambrian system; red and variegated sandstones abundant in the lower Silurian rocks, as well as in the greatest red systems of our islands, the one underlying, the other overlying, the carboniferous deposits.

If it be contended that the old red sandstone of Great-Britain, as hitherto understood, presents a more or less uniform character in its range from the Highlands of Scotland into South Wales, we must qualify the assertion. The system assumes very great mineral varieties of aspect in different regions: in some tracts (parts of Scotland and Cumberland) it is usually composed of thick, coarse conglomerates, while in others such masses give way to the finest laminated sandstone and shale. In the north-western districts of the Highlands, so completely was an eminent geologist* misled

* Dr. MacCulloch.

by its lithological structure, that he classed a large portion of it as *primary sandstone*,—an opinion which was afterwards corrected by an examination of that region by ourselves*. Again, it has fallen to us to show, that the black bituminous schists of Caithness and the Orkneys form an integral part of the old red sandstone: and what trace of lithological resemblance, we would ask, is there between such rocks as these, which occupy the north-eastern extremity of our island, and the great masses of the same deposit which prevail in the form of the variegated marls and concretionary limestones of Herefordshire and Brecknockshire? Passing from the latter district into Pembrokeshire, we perceive the old red sandstone rapidly changing its aspect and composition. The concretionary limestones disappear; and a hard, brownish-red, schistose rock replaces the soft marls, and large tracts are occupied by yellow and grey, hard, siliceous sandstones.

As, therefore, such great lithological changes actually occur in continuous strata within such a limited area, why may we not believe (particularly when we have strong collateral reasons for doing so depending both on fossils and sections,) that the older fossiliferous rocks of Devonshire and Cornwall are the equivalents of the old red sandstone? They have indeed, to a great extent, assumed a new mineral type—we say to a great extent; for we ourselves, in both our previous memoirs, have described many of the rocks in question as *much resembling* the old red sandstone.

Various causes may have co-operated in producing the peculiar mineral character of the Devonian and Cornish strata. Among these, igneous action is the most apparent, and the country it is well known bristles with rocks of igneous origin, many of which are well described by Mr. De la Beche: and if (as we believe) he is correct in supposing that many of these rocks were formed contemporaneously with the strata among which they appear, we are furnished with one of the conditions under which the mineral character of a part of this region of the old red system has been greatly modified. But, independently of any supposed igneous action, what is there among the analogies of sedimentary deposits which should not lead us to embrace the view, that formations of the same epoch may have completely distinct mineral types? Has it not been over and over again demonstrated that the limestones of any particular series are often represented by siliceous sandstones, even at the opposite extremities of our island, though the order in which the organic remains occur is precisely the same in these different rocks? The sandy and shaly strata of the coast of

* See Geol. Trans., vol. ii. p. 125.

Yorkshire and the hard siliceous fossil grits of Brora, proved to be of the same age as the Oxfordshire oolites, are among the many striking illustrations of a phænomenon, of the prevalence of which, indeed, no stronger proof can be given, than that geologically and zoologically considered, the massive clays of the London basin are the same as the white limestones and hard siliceous grits of Paris.

In applying, therefore, these analogies to Devonshire we should say, that if the true mountain limestone (under its ordinary aspect) thins out and is no longer traceable, we ought to look for its equivalent in sandstone and shale: and in accounting for the great development of many marine animals which appear in the Devonian limestones, we have, *à priori*, reason to expect the appearance of large stratified masses of calcareous matter.

If these views be confirmed by our best fossil conchologists (of which we have little doubt), then will they have a most important bearing upon the classification of the ancient rocks of foreign countries, and we believe also of Ireland. In large tracts of Europe, the first great series under consideration, (to which one of us applied the word "system,") is supposed to be wanting: but if this supposed absence be founded chiefly on mineral characters, the representative of the system may still be discovered by its typical organic remains, though enveloped in rocks like these of Devon and Cornwall, or in strata still further removed from what we have been in the habit of regarding as the general type*.

Conclusion.—We had no intention a few weeks ago of writing upon this subject. It is true that we had been gradually changing some of our views respecting the age of the oldest rocks of Devon and Cornwall (since the suggestion of our friend Mr. Lonsdale before alluded to); and we should soon have placed our opinion upon record before the Geological Society. The publication, however, of the Report upon the Geology of Devon and Cornwall, seen by one of the authors for the first time within these few days, compels us, in justice to our character †, (for it is now not merely a scientific, but also

* We are led to believe, from the data already before us in the works of foreign authors, that the old red system will be found in the provinces of Russia and the Scandinavian countries, as well as in Poland and Germany. M. Elie de Beaumont has recently written to one of the authors, and approving of the establishment of the old red sandstone as a separate "System", he says that he has no doubt it will be largely found on the continent.

† At the conclusion of a note affixed to p. 130 of Mr. De la Beche's Report on the Geology of Cornwall and Devon occur the following words: "He," the Rev. D. Williams, "observes, that he stated the fact of the car-

a moral question) to state immediately and concisely what our views have been and what they now are; in order that our scientific brethren (with whom our statement cannot fail to produce its proper effect,) may have it in their power to draw a just conclusion as to the part we have taken in the new classification of the rocks of Devonshire and Cornwall. If any one should think that there is somewhat of a polemic spirit either in this page or those which follow, we request him to bear in mind, that the determination of the great *culm trough of Devon* and the settlement of its true geological position, is the key to the whole structure of the two counties; and that no one was in possession of this key, until in 1836, we offered it to the British Association at Bristol.

We pass over the circumstance alluded to in the note below, trusting that Mr. De la Beche is incapable of insinuating that which he knows to be incorrect; and we shall conclude this sketch with a short statement of facts in relation to his operations and our own. We have already stated, that before we entered upon an examination of Devonshire, Mr. De la Beche had exhibited a map to the Geological Society which he said was complete, and which was afterwards on sale for some months. It contained many excellent details, the result of the labours of former years, and on the whole was justly considered to be of great value: but it made no separation of the culm-bearing or carbonaceous strata from the older rocks. Before our visit to Devon, this author had, in fact, neither

bonaceous recks occurring in a trough, bounded by the ridge of Exmoor on the north, and the granite of Dartmoor and slates of Foerabury and Boscastle on the south, at the Meeting of the British Association held at Dublin, in 1835. (Report of the Proceedings of the British Association, Oct. 7, 1837.)" We are compelled to give an unequivocal contradiction to this statement. We were both present at Dublin when the paper alluded to was read, and we took part in the short discussion by which it was followed; and we assert that the author, the Rev. D. Williams, considered the fossil plants he exhibited from Devonshire, as derived from the oldest grey-wacke rocks of the district, and yet identical with those of the true coal-field of Pembroke. He described no section, and made no allusion whatever to the existence of any overlying carbonaceous trough. This assertion is perhaps superfluous on our part, for we have only to appeal to all the geologists who were present at the Dublin Meeting, and to refer others who were not there, to the abstract prepared by Professor Phillips from Mr. Williams's *short notice*, for such it really was. An assertion of Mr. Williams, made in the autumn of 1837, and which till this time we never saw, is put forth to establish his pretension to a discovery said to have been announced to the British Association in 1835; while neither the official records of the Association, nor, as far as we can learn, any journal of that year, make the slightest allusion to such a circumstance! The facts speak for themselves. We are the first persons who pointed out the existence of the carbonaceous trough; and we never received the smallest hint of the sort from Mr. D. Williams.

separated the culm measures as a distinct formation, nor had he ascertained their place in the general section; for he had so far mistaken their relations, on their northern limits, as to place them *not over* (as he now does after our example), but *under* the first three groups of the *older* system; and their southern limits he had never ascertained. In short, to work out this point it was necessary he should do what he had *not* done—to separate the black or culm limestones from the other limestones of Devon; for without this it was impossible for any one to take the first step. As soon as our new views were announced, he suppressed the map as originally coloured, and revisited Devonshire to make himself acquainted with the fresh data, which he had now no difficulty in doing. Major Harding had, indeed, pointed out to one of us the existence of the culm limestone even as long ago as 1835, at the time when Mr. De la Beche's map was first exhibited. Great therefore was our surprise when we perceived that no distinctions were drawn in the ordnance geological map between this very remarkable flat-bedded limestone, and those limestones of a slaty character which predominate in other parts of Devon; the more so as the fossils of the one are entirely distinct from those of the other. So palpable, however, is the line of demarcation between the rocks containing the black or culm limestone and those containing the slaty limestone, that Major Harding, though then very slightly acquainted with geological phenomena, had traced the boundaries of the two classes of deposit from Barnstaple by Swimbridge and Venn before we entered Devonshire, calling the one *mountain* and the other *transition limestone*, and had thus prepared an excellent point of departure for our examination. On the south side of the trough (as we afterwards showed it to be), Mr. De la Beche referred the inferior part of the culm series to the oldest system of Devon and Cornwall; because it alternated, like the Cornish killas, with certain contemporaneous trap rocks. We pointed out to him the imperfection of this reasoning, because similar alternations take place among rocks of many ages, and therefore by themselves prove nothing. Now, in 1839, Mr. De la Beche publishes his Report, accompanied by an index map, in both of which he adopts our view respecting the right mapping of the culm measures as a distinct formation, which he calls “carbonaceous rocks:” and although before our visit he had always insisted on these rocks forming an integral part of the greywacke series, he now gives valid reasons for their separation, yet without acknowledgement, and with no other indication that we were the agents who produced this change in his

views, except the announcement, in a few words, of what occurred at Bristol, from the perusal of which no one could deduce any correct inference as to what we really had done. A single sentence, a mere parenthesis (*if to the point*) would have satisfied us; and would not merely have been right, but would have been prudent.

Whatever may be, even the small merit of our labours in Devonshire, this at least we affirm, *that they are perfectly original*. In passing from the north coast to the south, across the whole county, we were astonished at the novelty and unexpected nature of the phænomena that successively rose before us, contrasted with every thing we had before understood from those who had examined Devonshire. We were amazed when, after having ascertained the separation of the culm-measures from the underlying slaty rocks, we stood upon the cliffs of Clovelly, and found ourselves compelled by the evidence before us to sketch them in as the highly inclined masses of a *coal-field*, dipping away from the more ancient strata of North Devon: and still greater was our surprise when, following those cliffs by Bude we found the same carbonaceous or culmiferous system still rolling over in countless striking flexures, till passing into North Cornwall it rises up against and rests upon the older slates of that county. Nor again were we less surprised on finding the same system lifted up, penetrated, and altered by the granite of Dartmoor. So far from any attempt having been previously made to effect this great separation, the position even of the several limestone bands in North Devon had been mistaken by Mr. De la Beche, and considered by him as the repetition of the *same calcareous group* by successive undulations. The truth is, that no one can make a correct section among slaty rocks till he learns to distinguish cleavage from stratification; and it is astonishing how very few geologists are even at this time masters of the subject. This is we believe the explanation of some of Mr. De la Beche's early difficulties, and may be the reason why he did not first separate the culmiferous deposits (as he now does) from the *greywacke* of Devonshire.

Should any one ask what we effected in Devon, we reply,—

1. That we were the first to give anything resembling a correct section of the mineral masses between the N. and S. coasts of Devon; and till such a step was taken, it was impossible to commence any classification of the subordinate groups.
2. That we determined the relative place and succession of the distinct calcareous and fossiliferous groups.
3. That we proved the existence of the culm limestones on

both sides of a great trough, and included the hitherto anomalous limestones of Holcombe Rogus in the same carboniferous system.

4. That we ascertained the subdivisions of the culm series, and laid down, for the first time, on a map, its extent (with one limited and perhaps doubtful exception at its south-eastern extremity near Ashburton), thus converting the supposed *ancient greywacke* rocks of nearly one-half of the large county of Devon into equivalents of the carboniferous system, as it is already represented in two published geological maps*.

In attempting to classify the oldest rocks of Devon we fell into some false conclusions from imperfect data. These we have corrected, and the whole series of Devonshire and Cornwall is now, we trust, exhibited in harmony; the lower sandstones and slates being the equivalents of the old red sandstone, the next natural group beneath the great coal-bearing strata of the British Isles, and the whole being exhibited under peculiar mineral types.

In asserting that the older stratified rocks of Devonshire and Cornwall are upon a broad scale the equivalents of the *carboniferous and old red systems*, we do not however deny that in some tracts the lowest members of these rocks may represent the *upper division of the Silurian System*: for although we have as yet found few if any of the fossils most typical of that system, we admit that when the sediments of a given epoch have been accumulated under peculiar conditions, we must expect to find considerable variations in the forms of animal life. Again, we know that the older rocks of this region have undergone great changes in assuming their present hard and slaty character; and under such circumstances the difficulty of precisely limiting the boundary line of any given portion of them is prodigiously increased. In tracing, for example, the Silurian System from its typical region into the sea-cliffs of Pembrokeshire (where its place in the series is so precisely marked in Broad Sound) we perceive *its ordi-*

* See small map of England, in the corner of the large map of the Silurian region. See also Phillips's General Geological Map of the British Isles. In the latter it has been inaccurately stated (in acknowledging the sources from which the author drew) that Devonshire is coloured from Mr. De la Beche. Professor Phillips has promised to correct this error in the new edition of his map which is about to appear, as he is fully aware, together with every geologist who was present at the meeting of the British Association, that we first proposed this great change: and even now, though Mr. De la Beche has followed us in separating the carbonaceous rocks from the greywacke, and represents them under a distinct colour, he does not admit them to be the equivalents of the carboniferous system of England.

nary lithological aspect almost entirely obliterated; the rocks which occupy the place of the soft mudstones and argillaceous limestones of Salop and Hereford, &c. have become hard, siliceous sandstones, with a slaty cleavage; and affording no evidences of clear subdivisions, they can be divided into broad groups by the help alone of a *very few* of the same fossils which teem in the great area of the Silurian region. As Pembrokeshire, lying as it does between the Silurian region and Devonshire, prepares us, by the peculiar structure of its coal or culm-field, to recognize an almost perfect analogy of structure in the culm-field of Devon; so do the great changes which the underlying old red and Silurian systems have there undergone, predispose us to believe that the strata which support the culm-field in Devon may present themselves also under a peculiar mineral aspect. Notwithstanding, however, this caution as to the possibility of some lower members of the Devonian and Cornish strata representing Silurian rocks, we adhere to the conviction, that the great mass of the strata which support and appear to pass upwards into the culm-field are the equivalents of the old red system properly so called.

Instead of thinking ourselves rash and hasty in making the generalization above given, we would rather accuse ourselves of being tardy and over-cautious; and we are now surprised (notwithstanding the imperfection of our evidence) that we so long retained the older rocks of Devon and Cornwall in the place where we classed them on our return from these counties in the autumn of 1836. For our conclusions, excepting their generality, are not entirely new. Some of the red sandstone groups, at least, of South Devon, have often been called *old red sandstone*; and they are so regarded by Mr. Austen; who also considers the Torbay limestone as the equivalent of the *mountain limestone*. Mr. Greenough, many years since, pointed out the extreme difficulty of separating the Plymouth limestone from the *mountain limestone*; and Mr. Lonsdale, a considerable time since, believed that the system of South Devon would at length be proved only a peculiar development of the *old red sandstone*; and he freely stated this opinion to Mr. De la Beche as well as to ourselves. The present opinions of Mr. De la Beche are before the public, and we have no right, perhaps, to be his interpreters. He puts forth several hypotheses, without positively adopting one of them. He must, however, (after the recent publication of such large groups of Silurian fossils) before long perceive that the formations of South Devon not merely contain fossils approaching those of the *mountain limestone* (a fact long known), but that their whole suite of fossils is intermediate between those

of the Silurian and Carboniferous Systems; a fact which at once defines their true place in the sequence of British rocks. The hypothesis he seems most inclined to adopt is the following:—That the calcareous and slaty system of South Devon is the newest, being above the carbonaceous system; and that the carbonaceous system is newer than the greywacke north of Barnstaple. In this way the calciferous band, “extending from Torbay, &c., into South Cornwall, would be in a higher part of the greywacke series, and might be even equivalent to the beds known as the old red sandstone.”—(*Report, &c.* p. 149.)

We agree with the concluding remark; but not for the reason hypothetically stated, viz.: that South Devon is in a higher part of the greywacke series; for we place the North and South Devon groups on the same parallel, and consider the culm-measures as unequivocally superior to them both.

So long as we were unprovided with a typical suite of fossils from the older system of Devon, it was impossible to propose for it any name; but now, having discovered a great many of its fossils, and that too in regions wherein the red arenaceous character gives way to the slaty impress, and a very different mineral aspect; the necessity of adopting a new name becomes apparent, and we propose the term “Devonian System” as that of all the great intermediate deposits between the Silurian and Carboniferous Systems. The “Devonian System” is so far unexceptionable, that it may be applied, without any contradiction of terms, to rocks of every variety of mineral structure which contain the characteristic series of organic remains.

When these organic remains are described, we shall then have a regular descending order of the older fossiliferous strata in the three great lower systems which pass into each other, the *Carboniferous*, *Devonian*, and *Silurian*. Whether the still lower slaty rocks to which one of us applied the term *Cambrian*, may or may not contain, in their inferior parts, distinct typical fossils, is a problem not yet solved, though as far as our labours have gone, we know that many of the shells which characterize the lower Silurian group, exist also (even at considerable depths) in the great upper Cambrian group, and therefore the line we have provisionally drawn between the Silurian and Cambrian Systems may, eventually, be fixed by some natural grouping of fossils at a different level.

We proposed the use of the terms Silurian and Cambrian because we believed that their adoption, (*L. & E. Phil. Mag.*, vol. vii. pp. 46, 483,) when applied to well-defined mineral masses, might tend to clear away the obscurity which we were per-

sueded would hang over the older rocks as long as they were all considered to belong to the dark and undefined æra of "Grauwacke;" and we trust that we have, in this memoir, shown strong additional grounds why this mineralogical term should be disused by geologists, as a term of classification, applied as it has been to rocks of such very different ages; thus serving as a shelter for ignorance, and paralyzing every effort for determining the succession of strata upon true principles. If its lovers wish still to cling to it, let them use it as an adjective and tell us of *Carboniferous*, *Devonian*, *Silurian*, and *Cambrian* "Grauwacke," and then, at least, the term will do no mischief. The continuance of the use of this term to represent different epochs in the history of the earth would be as absurd as to retain the old "flötz" formations of Werner, after it has been shown that such rocks are often as highly inclined as the most ancient strata; but we trust that any wrangling about this barbarous word is nearly at an end; for already some of the best foreign geologists have discarded its application to the upper systems of transition rocks, and now restrict its use as a term of classification to the lowest slaty or Cambrian rocks.

March 25, 1839.

[A Postscript to this paper will be found at p. 317 of the present Number.]

XLI. *On a very particular and curious Account of the Comet of 1472, from a contemporary MS. Chronicle in Peterhouse Library.* By J. O. HALLIWELL, Esq., F.S.A., of Jesus College, Cambridge.

To the Editors of the *Philosophical Magazine and Journal*.

GENTLEMEN,

THE following minute description of the comet of 1472 is taken from an autograph chronicle of English affairs by John Warkworth, master of St. Peter's College, Cambridge, still preserved in the library of that institution. I am preparing the whole for publication for the Camden Society.

"And in same xi yere of the kyng, in the begynnyng of Januarii, there apperyd the moste mervelous blasynge sterre that hade bene seyn. It arose in the Southe-Este at ij of the cloke at mydnyght, and so contynued a xij nyghtes, and it arose ester and ester till it arose full este and rather. And so when it roose playn Est, it rose at x of cloke in the nyght, and kept his cours flamynge Westward overe Englonde; and it hade a white flaume of fyre fervently brennyng, and it flamed endlonges fro the Est to the Weste, and noght vp-