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(1-28)

ADDITIONAL NOTES
ON THE
GROUPING OF THE ROCKS
OF
NORTH DEVON AND WEST SOMERSET:

With a Map and Section.

BY
J. BEETE JUKES, M.A., F.R.S.,
M.R.I.A., F.G.S., &c. &c. &c.

PRECEDED BY
AN INTRODUCTORY STATEMENT.

*Printed for circulation among the FELLOWS of the GEOLOGICAL
SOCIETY of LONDON.*

DUBLIN:
R. D. WEBB & SON, GREAT BRUNSWICK-STREET.

1867.

J. T. Campbell
March 30 1867.

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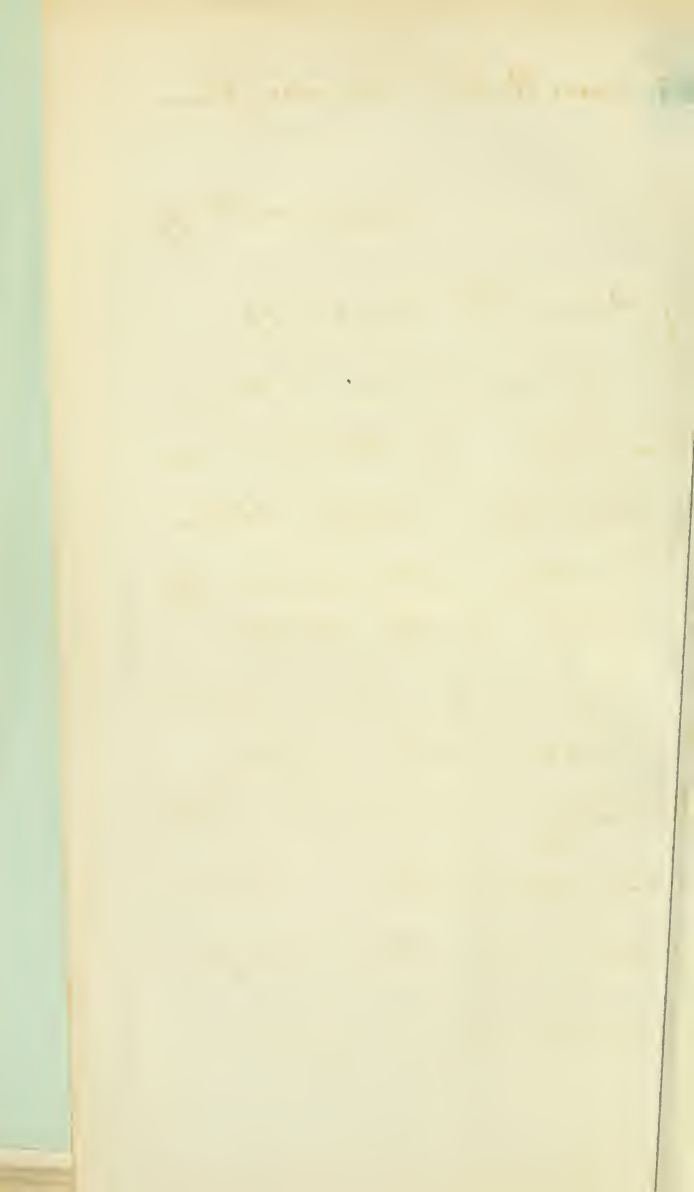
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1867.



Queens Hotel, Birmingham

GEOLOGICAL SURVEY OF IRELAND,

Office, 51, Stephen's Green, DUBLIN,

March 25th 1867

My dear Mr. Campbell

Your last long envelope followed me to Dudley where I think it rather astonished the waiters at the Hotel.

I found the temperature 130 yards under Hinley a good deal more agreeable than that at the surface among the snow

drifts. Lord Dudley
people have been
cutting across the
Boundary Fault and
certainly ~~that gentleman~~
(I don't mean Lord Dudley but the dislocation)
is of a very faulty
character indeed.

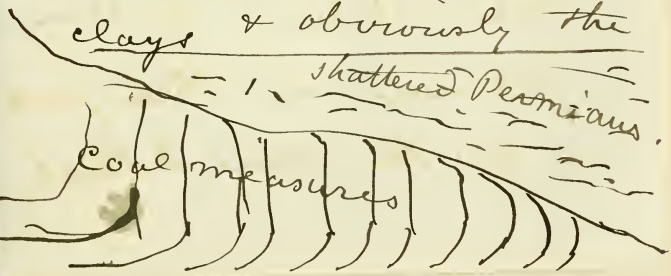
I am going to get
a regular mining section
of it drawn for the
new edition of my
Memoir on these parts
- for the more I think

of it the less I understand it.

The Thick Coal tilts up being upright & all the other measures under it, & seem even to be bent back along the fault, which one could understand if it

were an upthrow, but on the other side the fault are red rocks & these seem to be shattered

Permian sandstones and clays & obviously the



fault must be a big
downthrow, as the
country is all Permian
& New Red on other side
of it.

I breakfast in Dublin
tomorrow & hope to find
a better sample of weather
there. Thanks for your
note about the accounts. I
'll send in a new bill
& also charge arrears
of several nights 6s worth
if I can find my old accounts

Yours very truly
J. Beete Jukes.

TO THE FELLOWS
OF THE
GEOLOGICAL SOCIETY OF LONDON.



Gentlemen,

As I intend to forward by post a copy of this pamphlet to the address of each of you, as given in the last list of our Society, a few words in explanation of that proceeding may be necessary.

Those of you who read our Journal may have seen in the 89th number of it, the title of this paper printed without any paper following it, and the absence of the paper may have been attributed by some of you to some fault or neglect of mine. I naturally wish to shew you that this was not the case.

Others among you, who may not have noticed the matter, or may not even be in the habit of seeing the Journal, may still feel anxious that our science may be freed, as far as possible, from those small entanglements of error which are the inevitable accompaniments of the growth of all human knowledge. As I believe I am able to correct such an error, I think I am bound by duty to the science which I have made my profession to take all legitimate means of doing so. All I ask is that my reasons for believing it to be an error should be allowed a full hearing and a due consideration. If they are weak, they will make no impression and require no refutation. If, as I believe, they have that strength which is inherent in all simple truth, it is incumbent on me to take care that they do not perish from suppression.

I am,

Your obedient servant,

J. BEETE JUKES.

DUBLIN, *February 17th*, 1867.

INTRODUCTORY STATEMENT.

The Action of the Council of the Geological Society of London.

ABOUT the period of the foundation of the Geological Society of London, the science of Geology was almost the peculiar property of gentlemen of fortune. As the three qualities of the orator were said to be "*Actio*," "*Actio*," "*Actio*," so the three necessities of the Geologist are "Travel," "Travel," "Travel," and as travelling in those days was far more difficult and expensive than it is now, it followed that only men of fortune could afford to be Geologists.

Hence the governing body, or Council, of the Geological Society of London had what Sydney Smith designated as a very "*landed manner*," and received their less opulent brethren of the hammer in somewhat of a patronising spirit. Even the Professors of Geology in Oxford and Cambridge, as I have heard my revered old master Professor Sedgwick laughingly remark, were at first admitted rather condescendingly on the Council of the Society.

There naturally sprang up then in the minds of the gentlemen composing that body a feeling that to them, as to the Roman Dictators of old, it was given to care "*ne quid damnum Respublica capiat*;" and for "*Respublica*" they read indifferently "*Societas*," or "*Scientia*," as if the two things were equivalent.

Now in the early days of the Society there really was much truth in the latter supposition, and even down to the present day the Geological Society of London may confidently challenge the world to show any Society that has done so much as it has for the science of Geology.

The papers which were published in the early Transactions, accordingly, were carefully examined and often modified by the President and Council, and even in the years 1842-1843, Mr. Warburton, then President of the Society for the second time, was so far guided by the old dictatorial spirit, as not only to manipulate the papers of Professor Sedgwick on North Wales at his own discretion, but even to refuse to allow the author to see a proof of the papers so altered before publication. This was done on his Presidential authority, and notwithstanding the fact that he had taken upon himself to remodel Professor Sedgwick's nomenclature to *what he thought it ought to be* so as to correspond with the then unpublished nomenclature of Sir Roderick R. I. Murchison (*See Professor Sedgwick's Introduction to Synopsis of Classification of Pal. Rocks, page XLIX, etc.*).

The system of "Paternal Government," which circumstances

thus introduced into the Council of the Society, lingers apparently with the same tenacity of vitality that paternal governments are apt to exhibit in more elevated spheres. Among several smaller indications of the fact, I presume this to be the case from an account given by Mr. Searles V. Wood, Jun. of the Council's treatment of his paper "On the Drift of the Eastern Counties of England" in the year 1865. Mr. Searles V. Wood has privately printed and distributed this paper, in order to show the groundlessness of the charge brought against it by the Council, that the views contained in it were for the most part an unacknowledged appropriation of those of the late Mr. Trimmer. He shows, on the contrary, that the views were as diverse as those of two observers are possible to be, except "they transgress the accepted principles of Geology."

This was just one of the mistakes that paternal governments are so apt to fall into, very often to their own excessive astonishment; and sometimes to their no slight mortification and dismay. They are all animated by the very best and most benevolent intentions, and if they only had the trifling addition of omniscience, with an occasional loan of the faculty of omnipotence, nobody would have any occasion to find fault with them. So long, however, as poor imperfect human nature carries on this system of government, the benevolence is apt to end very often in getting itself into a mess, and the good intentions are all broken up by the hammers of circumstance into road-metal for certain dreary regions, where none of us wish to have the opportunity of walking on it.

I don't profess to be perfectly acquainted with the mysteries of the system of government adopted by our Council, but from my own experience I believe the following to be a pretty correct outline of that part of it which relates to the reception and publication of papers.

Papers must be sent in with all illustrations complete, to be laid before the President and Council, at least as early as the Council meeting before the day on which the papers are to be read. If ordered to be read, they are so by one of the Secretaries at the meeting, or by leave of the President the author himself reads the paper, or gives such a condensed *viva voce* account of its contents as shall suffice for the purposes of discussing the principal points in it.

The paper is, at the next meeting of the Council, referred to some Fellow of the Society, who is supposed to have special knowledge of the subjects treated of, and he is requested to answer a printed list of questions which are sent with it. These questions, as well as I can recollect them, inquire whether there is anything personally offensive in the paper; whether there is anything superfluous, or absurd, or manifestly contrary to the principles of the science in it; whether it should be published *in extenso*, or only in abstract; whether it should be accompanied with the illustrations, or whether any or all of the latter can be dispensed with; and generally, in fact, what is to be done with the paper.

If the referee have the requisite knowledge, and acts with judgment and impartiality, and takes sufficient trouble to master the paper, of course the system would act in practice as well as it was meant to do theoretically.

But it must often happen that the man who knows most about a particular subject is the man who has himself published opinions upon it, and if any of the statements or opinions in the paper contradict those previously published by himself, he, of course quite conscientiously, thinks them wrong, or absurd, and that it would only be doing an injury to science to allow them to be published. He reports accordingly to the Council, who are then either to accept the report of the referee and act upon it; or else to discredit the judgment of the man whom they had previously selected as the best qualified to judge, (in the majority of cases, one of themselves) and refer the paper to somebody else whom they at first thought not so well qualified to judge; or to act in contravention of the report of their own referee.

I have two or three times acted as referee, and the plan I adopted was to treat it very much as a matter of form, just to look over the paper to see if there was anything in it personally offensive or disrespectful to any one; any obvious *lapsus calami* which the author would wish to have his attention called to; or anything manifestly childish, such as attempts to reconcile Geology with the Mosaic cosmogony; and, if not, to recommend that it be printed as a matter of course.

If the paper contained the results of honest work so far as it went, even if I did know, or believed I knew, that some of the statements were not correct, or some of the conclusions imperfect or erroneous, I considered that that was not my affair, but the author's. He had just as much a right to be heard, or read, as I had, if I chose to write a paper to contradict or refute him; and certainly I had no right to give him a kick in the dark, and then run away, which is the action that appears to me most analogous to that of secretly reporting against his paper to the Council.

If the Council, moreover, are to sit in judgment on the scientific accuracy or completeness of an author's paper, why do they shirk the responsibility of doing so, and insert in each number of the Journal a notice "that the authors alone are responsible for the facts and opinions contained in their respective papers"?

As an instance of the paternal care exercised by the Council, I may adduce a small fact with respect to my own paper, published in vol. XXII. of the Journal. At the commencement I had written that "as I should have to maintain that all the first geologists of the day, * * * * have misunderstood the structure of the country, let me hasten to *deprecate the sentence such audacity would deserve, and avow my belief that nobody whose observations, &c.*"

On receiving the proof, I found the words I have italicised above were omitted, and on writing to the Assistant-Secretary to know why, he informed me that the Council "thought they were unneces-

sary." Of course my vanity was flattered at this, as I concluded the Council thought it was no audacity on my part to set my opinion against that of Sedgwick and Murchison, Weaver, De la Beche, and Phillips, and also that there was nothing else that was unnecessary in my paper.

As regards the paper just mentioned, I must confess that it was with some feeling of curiosity as to what would be done with it, that I sent it to the Geological Society of London, and after it was read I marked its progress through the Council with some of the interest and amusement one feels in watching an uncertain experiment. I heard that it was in the first instance referred to an old friend of my own, who had himself committed a paper on the Devonian rocks. He recommended that my paper should be published in abstract only, and without the illustrations. Some members of the Council, however, demurred to this sentence of virtual suppression, and the paper was then referred to another gentleman, likewise a friend of my own, who was acquainted with part of the district described in the paper. He recommended that my paper should be published in full, with the illustrations, but omitting certain lists of fossils and other less important parts.

The paper was accordingly returned to me for these alterations, which I made of course, and I was afterwards billed to the amount of 16s. 6d. "for printer's corrections," which of course I paid. I conclude the printer's bill is intended to represent the sweetmeat which shall obscure the taste of the powder of correction previously administered.*

This paper was intended as a continuation of that published in the Journal of the Royal Geological Society of Ireland, but addressed to a larger audience through a society possessed of ampler resources to publish the illustrations. The two papers were designed as the commencement of a series which should call the attention of geologists to the subject, which seemed to me to be of sufficient importance to demand the fullest investigation.

At the commencement of the present session, accordingly, I sent in the paper which I now print, accompanied by the sketch map and section. The map was of course merely a condensation of the Geological Survey Map, with the exception of the boundary line that divides into two groups the rocks which had previously been lumped

* Seriously speaking, I must say that this infliction of a fine upon any author who up to the last moment wishes to make his paper as correct as possible, or who, in deference to the wishes of the Council, introduces alterations into the proof, is what in private life would be called *shabby*. Councils, like corporations, are proverbially freed, however, from that fear of personal consequences either in this world or the next, which is believed to act as a restraint upon individuals.

I beg leave to add that I learnt the above facts not from any inquiries that I made, or from any formal communications from any member of the Council, but casually, in the course of friendly conversations with several of them, who were as much amused at them as I was, and who, to borrow an old pun, were obliged, in order that I should participate in the joke, to tell me some of the *res gestæ*.

together as Devonian. This subdivision on the map was the very point which the previous papers were intended to lead up to and support, so that to publish the paper without it, was to act the play but omit the principal character.

When the paper was read, or rather, when I was permitted to give a *viva voce* account of it at the first meeting of the Society for the session 1866-67, its views were opposed in the discussion that followed by two members of the Council. In reply I said that I should refrain from all attempts to argue the matter, as I knew the repugnance the human mind had to being convinced, but I should leave it to the future to decide, only trusting that the Council would allow the paper to appear with the map and section I had prepared for it. To this the principal members of council who were present seemed to me to make gestures of assent. It was therefore with less uncertainty than in the former case that I looked to see it in type, and the map and section engraved, as the natural sequel of the paper already printed, and it was with some surprise that in the following month I received the subjoined letter :—

“ Geological Society, Somerset House,
“ December 7th, 1866.

“ Dear Sir,

“ I am directed by the Council to inform you that
“ they have ordered your supplementary remarks on N. Devon to be
“ printed in abstract in the Society’s Journal, without illustrations.

“ I remain,

“ Yours truly,

“ H. M. Jenkins,

“ Assistant Secretary.”

To this letter I immediately returned the following answer, in which, as it was to be laid before the Council, I treated my friend Mr. Jenkins rather more officially than I should have done had I been writing him a private note.

“ Dublin, December 8th, 1866.

“ Sir,

“ In reply to your letter of December 7th, in which you
“ inform me that the Council of the Geological Society have ‘ ordered
“ ‘ my supplementary paper on N. Devon to be printed in abstract
“ ‘ in the Society’s Journal, without illustrations,’ may I ask you to
“ inform the Council that without the map and section the paper
“ can have no value, and is not worthy a place in the Journal.

“ I would therefore ask the Council to be so good as to return me
“ the paper with the illustrations, and merely print in the Journal
“ the title of the paper.

“ I am, Sir,

“ Your obedient servant,

“ J. BEETE JUKES.”

As the Council have been good enough to comply with this re-

quest, and returned the paper, I now do what I intended to do with the former paper had it met with the same fate, namely, follow Mr. Searles Wood's example, and print and distribute it at my own cost.

The History of the Term Devonian.—The origin of this term "Devonian," and its use to designate, not only the rocks with marine fossils to which it is perfectly applicable, but also the Old Red Sandstone, to which it has been applied by mistake, is I believe the following.

Down to the year 1839 the slates and grits of Devon and Cornwall were called "Greywacke," "Killas," "Transition Slates," and other such names which had no very definite meaning. Even those slates which contained beds of the kind of coal called Culm were not recognised as true Coal measures, but supposed to belong to some older indefinite part of the Carboniferous period, an idea not yet perhaps wholly abandoned.

In Sir H. De la Beche's Report on Cornwall, Devon, and West Somerset, published in 1839, these rocks are spoken of as the "Grauwacke Group," and the Carbonaceous Deposits," and he devotes many pages (*131 et seq.*) to the discussion of the supposed palæontological anomalies which he and the other geologists of the day were evidently puzzled to reconcile.

About that time Mr. Lonsdale, then Assistant-Secretary to the Society, had remarked that the fossils of this "Grauwacke Group" of the West of England had characters intermediate between those of the Silurian rocks lately reduced to order by the labours of Sir Roderick (then Mr.) Murchison, and those of the Carboniferous Limestone. The existence of some Carboniferous species in that so called "Grauwacke Group" was, I believe, recognised by Mr. Lonsdale, together with other species believed to be Silurian, while other peculiar species and genera had characters which seemed to give them an intermediate place between those found in the Silurian rocks and those of the Carboniferous Limestone.

Mr. Lonsdale, therefore, suggested to Sir R. I. Murchison and Professor Sedgwick, who were then working together on these older rocks in the West of England and elsewhere, that the Devon and Cornish rocks were of an age intermediate between the Upper Silurian and the Carboniferous Limestone.

This shrewd suggestion was adopted by Professor Sedgwick and Sir R. I. Murchison, and the age of the Devonian slates was approximately determined by it. It was a great step in advance of the old "Grauwacke" nomenclature, and had it been kept as a mere provisional approximation to the true age of the Devonian rocks of Devonshire, their exact age would probably have been long ago fixed, and I should have been spared the task of endeavouring to establish it.

The provisional character, however, of the approximation was not sufficiently regarded, and two consequences were rashly accepted without being proved :

1st. That the "Devonian" rocks of Devonshire, etc., were altogether older than the Carboniferous Limestone :

2nd. That as their age was intermediate between that of the Carboniferous Limestone and that of the Upper Silurian, the Devonian rocks were contemporaneous with the Old Red Sandstone.

No actual demonstration, either stratigraphical or palæontological, has ever been given of the truth of the first of these assumptions.

But even granting it to be true, it is obvious that the second assumption does not follow as a matter of course. The Devonian rocks containing marine shells and corals, &c. might be altogether older than the Carboniferous Limestone, and younger than the Upper Silurian, and still their true place might be either above or below the Old Red Sandstone.

No stratigraphical evidence has ever been adduced to show that anywhere within the British Islands there was any lateral passage or interstratification of the Devonian slates and grits, and any beds of Old Red Sandstone.

The palæontological evidence, as far as the British Islands are concerned, is wholly against the assumption. Not one single shell, crustacean, echinoderm, or coral, of all the multitudes formed in the "Devonian rocks," has ever been found in any bed of the Old Red Sandstone. Not a single fragment of any of the Old Red Sandstone fish has ever been found in any Devonian bed.

The only fossils common to the two groups are certain plants which are found in the topmost beds of the Old Red Sandstone and the lower portions of the Devonian (or Carboniferous Slate) beds of Ireland and North Devon.

The only region where there is any mingling of the Old Red Sandstone fish and the marine Devonian fossils is the case adduced by Sir R. Murchison from Russia.

I have lately examined with more care than I had previously given to them, the volumes containing the record of the labours of Sir Roderick, and his colleagues, M. E. de Verneuil and Count Keyserling, in Russia. It would savour of impertinence in me if I were to offer any trifling contribution of praise and admiration to the labour, zeal, and ability displayed by the authors of this work. They are known and appreciated by every geologist throughout the world. They gave a vast addition to our knowledge of the Geology of Europe.

The letters of Agassiz in the second volume, and the works of Pander both before and after the publication of these volumes, set beyond all doubt the fact that the fish which occur in the Dura Den and Lethen Bar beds of Scotland likewise occur in the Baltic provinces and the Orel district of Russia. These fish belong to the genera *Pterichthys*, *Diploterus*, *Holoptychius*, *Osteolepis*, *Glyptolepis*, *Dendrodus*, &c. The fact that marine shells occur with these fish is strong evidence, and hitherto I believe the only evidence that these fish were marine and not fresh-water fish. Some species of these shells,

moreover, have been recognised as identical with those found in the Devonian beds of Devonshire and Cornwall, others as identical with those found in the Carboniferous Limestone of the United Kingdom and elsewhere.

The stratigraphical and palæontological evidence, therefore, derivable from Russia, are both in favour of the close connection in geological time of the Old Red Sandstone, the Devonian and Carboniferous beds.

But that is in reality the very view which I take of the relation of these deposits.

If we separate from the British Old Red Sandstone those lower beds which contain fishes of the genera *Cephalaspis*, *Auchenaspis*, and *Pteraspis*, &c. [Huxley's family of the *Cephalaspidæ* (*Survey, Decade X., p. 38*), and crustacea of the genera *Pterygotus* and *Eurypterus*, and confine the term Old Red Sandstone to the beds containing the other fish mentioned above, we shall then see that in Scotland, Wales, England, and Ireland this Old Red Sandstone is the conformable base of the great Carboniferous series, everywhere graduating upwards into the recognized Carboniferous beds, frequently containing the same plants—*Knorria*, *Sagenaria*, *Adiantites Hibernicus*, &c. about the junction of the two groups.

This Old Red, therefore, in reality belongs to that Carboniferous series, and if the fish of the Old Red part of it are, in Russia, mingled with the shells that are in Scotland and other places confined to another part, it need not occasion us more surprise than to find many of the shells which are commonly confined to the Carboniferous Limestone occurring in some districts in beds interstratified with the Coal measures, some hundreds or thousands of feet above the beds in which they are most abundant, and to which they are usually confined. Neither need we be surprised if we find more shells in these Russian beds than in the lower Carboniferous beds of Scotland, and among them some species which occur in Devonshire, in the Devonian slates.

How the facts observable in Russia prove that the fossiliferous grey slates on the south side of the Bristol Channel are the same beds as the unfossiliferous red sandstones on the north side of the Bristol Channel, is what I confess I cannot understand.

Of course it is quite possible that, however the beds may vary in lithological or palæontological characters, they were nevertheless deposited contemporaneously; and, when any evidence is adduced to show that they were so, it will be our duty to examine it.

In the meantime I assert in the following paper that beds, which only differ from the Old Red Sandstone of South Wales in the fact that they are partially traversed by slaty cleavage, do exist on the south side of the Bristol Channel, and that they can be separated from the grey fossiliferous slates, and shown to lie underneath them.

Let us settle the exact stratigraphical structure of each of our own districts on its own independent evidence, before we roam over the world and impose a hastily formed nomenclature on the rocks of

other regions ; and then, because that nomenclature is accepted by the local geologists on our authority, argue back from that acceptance in support of it when its applicability to the original area is called in question.

When it is recollected that even the Oolitic and Cretaceous fossils, so distinct in our own islands and Western Europe, become so blended in South America that Mr. Darwin and others can only speak of the rocks as Oolatico-cretaceous, we may well learn caution in arguing about minute points of exact stratigraphical nomenclature in our own islands, from the disposition of rocks and fossils in Russia or North America.

The point which I now propose for the re-consideration of geologists is, "What are the precise stratigraphical relations between the Devonian rocks of Devon, Cornwall, and West Somerset, and the Old Red Sandstone of South Wales and the rest of the United Kingdom ?"

My own opportunities of acquiring a knowledge of the subject.—As many persons may fairly ask me what entitles me to come forward and express an opinion on this matter, I may be pardoned for anticipating the question by a few personal details that would otherwise be impertinent.

Between the years 1830 and 1838 I resided on the borders of Shropshire and Staffordshire, and had frequent opportunities of becoming familiar with the Old Red Sandstone of South Shropshire and North Herefordshire, and examining the sections of Sir R. I. Murchison, as described by Professor Sedgwick in his lectures at Cambridge, or in Sir Roderick's own publications.

In 1839 and 1840 I was acting as Geological Surveyor of the province of Newfoundland ; but in the year 1841 I accompanied Professor Sedgwick in a geological tour through the west of England, when he showed me the neighbourhoods of Newtown Bushel, Ashburton, and Dartmouth ; and also those of Launceston, Tavistock, and Plymouth. In the beginning of 1842 I joined H.M.S. Fly as Naturalist, and spent some weeks on board in Plymouth Harbour, and some days in that of Falmouth, opportunities of increasing my geological knowledge of those neighbourhoods which I did not wholly neglect.

On my return from the voyage of H.M.S. Fly in 1846, I joined the Geological Survey in North Wales, and did not see much of the Old Red Sandstone, except a peep at that near St. Andrew's in Scotland, while on leave of absence for a few days in 1850. At the close of that year, however, I succeeded my friend Dr. Oldham as Local Director of the Irish branch of the Survey. I can well recollect the surprise with which I learnt from him that I should find the Old Red Sandstone of the South of Ireland traversed by slaty cleavage, and its red clays converted into clay-slate.

In the begining of 1851, I had the Old Red Sandstone of Waterford and Cork brought under my notice, and found accordingly

that as we traced it towards the west, the conglomerates died away, the argillaceous beds became thicker and more numerous, and the Old Red Sandstone became a red clay-slate formation. I was, however, still prepared to swear *in verbum magistri*, and by all the geological nomenclature in which I had been trained, and in the beginning of 1852 I obtained leave from Sir H. De la Beche, the Director General of the Survey, to read a paper to the Geological Society of Dublin on the Geology of the County of Waterford (see *J.G.S.D.* vol. 5, page 147) in which the name Devonian for the Old Red Sandstone is maintained. I there proposed to take the actual base of the Carboniferous Limestone as the lower limit of that formation, and consider all below down to the base of the Old Red Sandstone as Devonian.

Sir Henry De la Beche and Professor Edward Forbes both spent some time with me on their annual official visit to Ireland in the years 1851 and '52. On my remarking to Sir Henry that the grey slates which lie below some beds of Carboniferous Limestone, and above the Old Red Sandstone in the country to the west of Cork Harbour were very like the Devonshire "killas," he instantly coincided with me, as if it had never struck him before, but was obvious on its being pointed out.

Forbes, also, on examining the fossils we collected, assured me of their strong similarity to those of the Devonian rocks of Devonshire, and the identity of many species.

It was understood between us that when I had got a sufficient part of the district mapped, and fossils collected from it, and could show at once the best sections, we were to pay a visit, together with Sir Henry, to the West of England, for the purpose of instituting a direct comparison between the rocks and fossils there, and those of the South West of Ireland. Unfortunately, before this purpose could be fulfilled, their illness and death left the task to be afterwards hesitatingly and imperfectly performed by myself alone.

In the meantime the late Mr. Daniel Sharpe had been examining the rocks of Belgium and the Rhine country, in company with M. Dumont, and arrived at the conclusion (which I now hold) that there also the Old Red Sandstone exists, and has been improperly confounded with the Devonian rocks, but is in reality distinct from them. I was present at one of the meetings of the Society in London when one of Mr. Sharpe's papers was read, and took part in the discussion, rather opposing Mr. Sharpe's view, but venturing to point out the South West of Ireland as the district where ultimately the Devonian puzzle would be solved.

In conversation afterwards with Mr. Sharpe, he said he wished very much that some one would fix the proper geological horizon for the *Cucullœa* that occurred at Marwood in Devonshire. This remark*

* On referring to Mr. Sharpe's Paper, published in the 9th vol. of our Journal, I observe the following passage, which so entirely agrees with my present conclusions, that I cannot help quoting it:—

"The difficulty of arranging the rocks of Devon and Cornwall seems mainly

called my special attention to those fossils, when shortly afterwards we found them abundantly to the west of Cork Harbour, where they had previously been discovered by Mr. F. M. Jennings.

About the year 1856 we had nearly finished the survey of that part of the S. W. of Ireland, in which the Old Red Sandstone and the beds above and below it are most completely developed, but unfortunately no complete examination of our great palæontological collections had been made; and there did not then appear to be any prospect of their ever being properly examined. As our office in Dublin was blocked up with the boxes containing it, and as there existed an old order that we should send duplicate collections to the three Queen's Colleges of Belfast, Cork, and Galway, I obtained permission from Sir Roderick Murchison, who was then our Director-General, to send them some of our unopened boxes instead of the selected duplicates. I divided twenty-four of these boxes accordingly between the Colleges, in the hope that their respective Professors of Geology might describe the fossils which, while packed in boxes in our office, were of no use to any one.

In the meantime Mr. Salter, who had been appointed Palæontologist to the Survey in the place of Professor Edward Forbes in the spring of 1855, had accompanied me that summer in a tour along the South coast of Ireland, in which I took him to the principal fossil localities. The results then arrived at were sketched out in a joint paper, published in the 7th Vol. of the Journal of the Geological Society of Dublin. If the word "Devonian" were omitted in that paper, there is nothing else in it I would wish to change. All the palæontological part of it was, of course, Mr. Salter's own; and I believe that with the exception of the usual progressive development exhibited by all palæontological nomenclature, nothing could be altered in that part either. As the Journal of the Geological Society of Dublin is, perhaps, not so generally accessible as it deserves, I quote one or two passages from the palæontological part of the paper:—

"The fossils in the upper portion of the Carboniferous Slate do not differ except in the absence of certain forms from those of the Carboniferous Limestone." * * * "The Coomhola grits contain a very remarkable assemblage of fossils. Together with some species of Actinocrinus, identical with those from the Carboniferous rocks, *Rhynchonella pleurodon*, *Spirifera cuspidata*, and *disjuncta* (or at least the variety of that Spirifer called *Sp. Verneuxillii*) there have been found numerous bivalve shells. * * *

"These shells belong to *Modiola*, *Cuculloea*, *Avicula*, *Aviculopecten*, *Axinus*, *Nucula*, and a new genus for which the name *Curtonotus*

"due to the existence of faults of the same character as those above described [in Belgium] accompanied with flexures similar to those of the Belgian coal field. In those counties masses of rock, of different ages, are brought into contact along east and west lines of fault; and the prevalence of a southerly dip gives them an appearance of conformable superposition, which has led to most erroneous and contradictory views of the relative ages of the different masses on the part of different observers."—*Q. J. G. S. L. vol. 9, p. 22.*

“(Salter) is proposed. The latter is peculiarly characteristic and abundant; it is also found on the same horizon in Pembroke-shire and North Devon. *Bellerophon*, rounded, sharply keeled and trilobed species are abundant, with spiral shells, and *Orthocera* and a new *Lingula* of large size are not unfrequent. The *Cucullœa* are large, and appear to be distinct species from those of N. Devon; but the *Avicula Damnoniensis* is identical with the English species, and more abundant in the above localities than any other shell. The *Rhynchonella pleurodon*, both of large and small size, is also very abundant.”

In another locality Mr. Salter identifies the “*Cucullœa trapezium* of Devonshire,” and he afterwards gave to the large *Cucullœa* above mentioned the specific name of *Griffithii*.

Subsequently Mr. Salter agreed in the addition of the following:

“*Postscript*, March, 1856.—Since the above was written, the authors are more decidedly inclined to look on the locally developed group above described under the designation of Coom-hola grits, as undoubtedly Carboniferous; and, therefore, on the *Avicula Damnoniensis*, the *Cucullœa*, and the other shells as Carboniferous species. The *Knorria* and some other plants occur in those beds as well as in those below them—namely, the variegated series of the upper part of the Old Red Sandstone, to which, so far as is yet known, the *Cyclopteris Hibernica** and the *Anodon* are confined.”

In this excursion with Mr. Salter we did not visit the hamlet of Ballyheedy, between Ballinhassig and Kinsale, from which in the year 1851 or '52 our fossil collector, James Flanagan, had procured some very remarkable fossil fish. By the advice of Professor E. Forbes, I had immediately on their being found, sent these fish to Sir P. de M. G. Egerton, who was kind enough to inform me that they belonged to the genus *Celacanthus*, a genus he never knew to occur below the Coal measures.† They have since been examined by Professor Huxley, who fully agrees with the above statements of Sir P. Egerton.

In the year 1863 an opportunity occurred to me of revisiting Ballyheedy, and I found that the black slates there are lithologically more like to those of the Irish Coal measures than they are to the ordinary Carboniferous slates on which they rest, and that they were in some places crowded by fossils belonging to the genus *Posidonomya*, apparently *P. Becheri*, with which the surfaces of the beds of the lower part of the Irish Coal measure slates are usually covered.

I was hence led to the conclusion that the Carboniferous Slate had

* Ad. Brongniart afterwards referred this plant to *Adiantites* instead of *Cyclopteris*.

† Similar but better preserved specimens have lately been found by Mr. McHenry, one of our fossil collectors, in the Coal measures, 800 feet above the Carboniferous Limestone, near Ballybunnon, County Kerry.

never been covered by the Carboniferous Limestone, according to our original notion, but directly by the Coal measures, being itself, in its upper part at all events, contemporaneous with the Carboniferous Limestone, and, like it, succeeded by the Coal measures.

In the year 1857, a vacancy occurring on our staff, in consequence of the departure of Mr. Willson for the Indian Survey, we at length obtained the palæontological assistance we had so long required in Ireland, by the transference from England of Mr. W. H. Baily, nominally as one of our senior Geologists, but really to act as Palæontologist.

It was not, however, till the year 1862 or thereabouts that our remaining Carboniferous Slate fossils were fully named and arranged, and it was only in 1864 that I succeeded in bringing out those two numbers of our Explanations (that of Sheet 187, etc., describing the neighbourhood of Cork Harbour, and that of Sheet 192, etc., describing Bantry Bay) which contain the lists of the fossils we had collected from the Carboniferous Slate. These lists were of course drawn up by Mr. Baily, but we had previously sent all the Brachiopoda to Mr. Davidson, who was kind enough to examine them, and revise the names for us (see *Palæontograph. Soc. vol. for 1862; Devonian Brachiopoda*, p. 43, &c.), a circumstance which, joined to the care and caution exercised by Mr. Baily generally in their preparation, makes these lists as trustworthy as any yet published.

In the summer of 1857 we were finishing the survey of the Counties of Cork and Kerry, and as I was still puzzled as to the precise position of the Devonian rocks and their relation to the Old Red Sandstone, I went, on leave of absence, to examine the Old Red Sandstone of South Wales, from Llandeilo fawr and Llandovery by Brecknock round to Pontypool, and thence to Hereford.

In the year 1862, having gained the notion that our Irish Carboniferous Slate was contemporaneous with the Carboniferous Limestone, I took the opportunity of returning from leave of absence on the Continent, to have a look at the neighbourhood of Barnstaple, and revisit that of Launceston and Tavistock.

I was greatly struck by the identity of the section near Barnstaple with that to the westward of Cork Harbour, about Ballinhassig; the same forms of Coal measures, Carboniferous Slate, and Old Red Sandstone, all traversed by slaty cleavage, appearing in both districts, and the most conspicuous and abundant fossils being also the same.

In the year 1864 I spent a month on leave of absence at Coblenz, and though temporary ill health prevented me from doing so much as I should have wished, I saw that there again the Irish Coal measures were represented by the "Posidonomya schists," the Irish Carboniferous Slate and Coomhola grits by the "Cypridinen schiefer," the "Orthoceras schiefer," the "Spirifer sandstein," or "Coblentzen" of the German geologists, with the Old Red Sandstone peeping out from underneath the Spirifer sandstein, exactly where I should have gone to look for it, namely, on the flanks of the hill called the Kuhkopf.

This Old Red Sandstone of the Rhine country has, I suspect, been passed over hitherto, partly because it is unfossiliferous, and partly perhaps because its argillaceous parts are traversed by slaty cleavage, and it was taken for granted that "clay slate" could not be true Old Red Sandstone.

An account of the observations made in these two trips is published in a paper in the 1st vol. of the Journal of the Royal Geological Society of Ireland (a new name for the old Geological Society of Dublin).

In the year 1865 I was able to get the work in Ireland into such a state of forwardness, that I could be spared for a summer month for another visit to North Devon, when I directed my course to Dulverton, Dunster, and Lynton. I was unfortunately called away on private affairs before I could complete the examination of the ground so as to make a sketch map of it, even in the hasty mode I was compelled to adopt, and being uncertain whether I should ever be able to return, I drew up the paper which was published in the 22nd vol. of our Journal. In 1866, however, I again found myself, in the beginning of July, in a position to be spared for a month from the Survey of Ireland, without injury to the service, and went again to North Devon; and, being favoured with a month of fine weather, I was able by hard work and a free use of the not very convenient or expeditious conveyances of the country, to complete the examination of the ground described in the following paper, so far as to draw the provisional boundary which appears on the map between the Old Red Sandstone and the (Carboniferous Slate or) Devonian rocks of the country.

I have gone into the foregoing personal detail, in order to show that my present attempt at putting straight the Devonian puzzle is not a hasty or ill-considered one; but is the fulfilment of a long cherished design, dating from the year 1852 at the latest, and that, in spite of the many necessary distractions imposed by the conduct of the Survey and the labours of my Lectureship in Ireland, I have kept this purpose steadily in view ever since, and left unused no means of acquiring information respecting it that happened to present themselves.

Prophesying is dangerous work, but what I hope to do is to devote my six weeks leave of absence from Ireland during the two or three coming summers, to the examination, first, of South Devon, and secondly of the Rhine district, with the full expectation of being able to trace a distinct Old Red Sandstone base for the Devonian fossiliferous slates and grits in both countries.

I expect thus to be able to show that the true Devonian rocks are everywhere synchronous with the Carboniferous Limestone, their palæontological differences depending on *habitat* and *province*, and not upon *time*. My reason for taking up this task is that I believe it can only be properly performed by some one who is familiar with the rocks of the South West of Ireland, which give the key to the problem.

This at all events I can promise, that if the geological structure of South Devon and the Rhine country should be against the conclusions I have now arrived at, I will endeavour to state the evidence on the other side as fully and frankly as I have done that in favour of them.

Doubtless it may appear to some of very little consequence to the science of Geology what rocks we include under this designation of "Devonian." The whole of our present nomenclature is so obviously provisional and temporary, that it may hardly seem worth the trouble to endeavour to give it an exact signification. The terms Cambrian, Silurian, Devonian, Carboniferous, etc. are merely part of the scaffolding useful in building the science of Geology, but no part of the structure itself, and will doubtless be thrown aside by our successors as old lumber, just like the terms "Greywacke," "Transition," etc. have been by ourselves.

It is, however, not the mere nomenclature I wish to correct, but to show that two distinct things have been confounded under one name; and that, by whatever name it be called, the Old Red Sandstone is a group of rocks distinct from those which contain the marine Devonian fossils, and altogether below them.

I would also wish to urge upon the attention of Geologists, that there may have often been two distinct contemporaneous assemblages of animals in every close neighbourhood to each other, the one either sending "colonies," as Barrande calls them, that is, temporary occupants, into the province inhabited by the other; or else one set finally spreading over the other, and thus producing the appearance of absolute *succession* and obscuring the fact of their long *contemporaneity*.

Views of Sir Richard J. Griffith, Bart.

As my present views as to the correct classification of the true Old Red Sandstone of the South West of Ireland are in fact almost the same as those which were previously arrived at by that distinguished veteran in our science, Sir R. J. Griffith, I asked him to be so good as to point out to me the places where I could find his work best described in his own words.

In answer, he has been so good as to draw up for me the following Memorandum, which he has kindly allowed me to print as it stands. Having originally somewhat differed from Sir Richard, it is only due to him that I should show how far the Irish branch of H. M. Geological Survey have been compelled to agree with him by their examination of the same districts with himself; and include the Old Red Sandstone, or at least that upper part of it which contains plants and fish that do not belong to the Cephalaspidae, as the basal part of the Carboniferous series.

"MEMORANDUM.

"My geological views may perhaps be best ascertained from

papers published in, 1st, 'The Reports of the British Association ;' 2nd, 'The Journal of the Royal Geological Society of Ireland ;' 3rd, 'The Report of the Railway Commissioners.'

"It may not, however, be amiss, at the present time, to offer a summary of my mature conclusions, founded upon repeated examinations of the country during a period of upwards of forty-six years.

"From the commencement of my researches I was led to include within the Carboniferous System of Ireland, as subdivided by me, the upper fossiliferous and conformable beds of the series regarded in England and Scotland as 'Devonian,' or 'Old Red Sandstone;' and I termed these rocks 'Yellow Sandstone,' from their weathered surfaces usually presenting a yellowish gray colour, especially in the North of Ireland; as, from a comparison of their fossils with those of the overlying Carboniferous Limestones and Shales, it seemed to me impossible to recognize such a distinction between the two series as would warrant them being placed in separate systems. I was the more confirmed in this view, owing not only to the fossiliferous identity, but to the uniform character and persistent relative position of these strata in every district in Ireland; which I pointed out, in a special manner, in a paper read before the British Association held at Manchester in the year 1842, having, at the same time prepared an Appendix containing very detailed sections of these rocks, and, in addition, an elaborate comparison of the fossils of the Irish Limestones and 'Yellow Sandstones' with those occurring in the so called 'Devonian' system of Devonshire itself. And in pursuance of the examination of this question, I read a paper in the following year, at the meeting of the British Association held in Cork, in which I gave a detailed statement of the succession of rocks comprised in the Carboniferous Limestone system of Ireland, as observed by me in three distinct districts, namely, 1st. the North coast of the County of Mayo, where the succession extends from the western base of the primary Quartzite and Schistic series of Erris, to the 'Calp' and 'Upper Limestone' of Benbulbin and the King's Mountain in the County of Sligo, adjacent to the Connaught Coal District, the Millstone grit rocks of which, succeed conformably the Upper Limestone. In connection with this section I referred to many of the fossils characteristic of the limestone and shales resting on a coarse red conglomerate, which is itself hardly separable from the upper rocks, owing to the occurrence of plants and mollusca nearly to the base. I also exhibited and described a section of a similar succession, commencing with the 'Yellow Sandstone,' and arenaceous limestones and shales which occur on the Northern bank of Lough Erne, in the County of Fermanagh, and terminating on the South East, in the 'Calp' strata of the Slieve Beagh Mountains in the same county.

"The third section described at the meeting beforementioned extended in a Northern direction from the Lower Silurian Rocks of the Cairn Clon Hugh range of mountains in the County of Longford, to the millstone grit series of Slieve-a-Nieran in the County of Lei-

trim, to which I need not further refer, as the Report of the meeting of the British Association for the year 1843 contains a very full abstract of my paper.

“ I have subsequently examined and made sections of these strata as occurring on the coast of Berwickshire and Haddingtonshire in Scotland, and have not found reason to retract the anticipation I expressed in my paper read at the meeting of the British Association held in Dublin in the year 1857, and subsequently published in the *Irish Geological Journal*, to the effect that the ‘Devonian’ fish beds of Scotland were merely the equivalents of the rocks classed by me as ‘Yellow Sandstone’ in the Carboniferous system of Ireland.

“ As it became necessary to provide some line of separation, however arbitrary, as the boundary between the two series of rocks, I was led to adopt the lowest beds in which fossils occurred for that purpose, such fossils consisting for the most part of plants, which are sometimes accompanied by fish remains. Remarkable examples of the occurrence of these plants may be observed in the shales and even limestones of the North coast of the County of Mayo, together with a profusion of nearly the whole suite of the ordinary Carboniferous Mollusca and fish remains. A similar assemblage of fossils occurs in the Sandstones, Shales, and Arenaceous Limestones of the North coast of Donegal Bay, near the towns of Dunkineely and Killybegs, where the gigantic *Stigmariæ*, *Sphenopteris Hibernica*, &c. not only occur in the upper portion of these rocks, but in the coarse red conglomerates themselves, descending almost to the base of the series, which in these districts overlie, in an unconformable position, primary rocks consisting of alternations of quartzite and mica-schist.

“ Again, in the South of Ireland, at various localities, similar examples of the occurrence of these plants may be observed, especially at Tallow-Bridge in the County of Waterford, the Hill of Kiltoran in Kilkenny, and at the Roughty River in the County of Kerry, in which latter place, it may be remarked, they are associated with *Fenestella*.

“ If I do not mistake, plants are also found to occur in the Coomhola beds, and it is probable that if any case could have been sustained for a ‘Devonian Series’ it would have mainly rested on the peculiarities of this geological horizon.

“ In further illustration of my views regarding the true subdivision of the Carboniferous system, as observed in Ireland, I may also refer to the tabular ‘Synoptical View’ which is both appended to my Geological Map, and published in detail in the *Dublin Geological Journal*.

“ It may likewise be observed that, in arranging the Carboniferous system on my Geological Map of Ireland, I had to meet the difficulty of proposing such a boundary between the fossiliferous beds of the “Yellow Sandstone,” and the underlying conformable Red Sandstones and Conglomerates, as would be least liable to objection, and

though the unity of the two series of rocks was anticipated in several papers read by me before the Geological Society of Dublin, I think it will be admitted that, supposing the necessity of some distinction being made, the principle I have adopted was the closest approximation to a scientific method of division that could have been followed.

“ RICHARD GRIFFITH.”

“ Dublin, January 30th, 1867.”

ADDITIONAL NOTES ON THE GROUPING OF THE ROCKS OF
NORTH DEVON AND WEST SOMERSET.

SECTION FROM STAWLEY TO MINEHEAD, W. SOMERSET.



c. Old Red Sandstone. d^1 Carboniferous. d^2 Tertiary Measures.

Length of Section about 18 Miles.

Further Notes on the grouping of the rocks of North Devon and West Somerset, with a map and section. By J. Beete Jukes, M.A., F.R.S.

In a paper published in the August number of the Quarterly Journal for 1866, I gave a sketch of the change which takes place in the Old Red Sandstone and Carboniferous Rocks of the South of Ireland, as they are followed from East to West, and showed that in that change might be found a key to the problem of the Devonian rocks, the exact place of which in the geological series has hitherto remained without actual demonstration.

During the past summer I was fortunately enabled to continue my examination of North Devon and West Somerset, so far as to make the first hasty sketch of a map of the district, coloured as any officer of the Irish branch of H. M. Geological Survey would have coloured it, who had been engaged in the survey of West Cork.

This map I now beg leave to lay before you, together with a few further notes in support of it.*

Wiveliscombe.—Having, by the examination of the country round Barnstable, Ilfracombe, and Lynton, arrived at the conclusion that the Old Red Sandstone forms a ridge running through the centre of North Devon, between two districts of Carboniferous Slate, the northern of which is brought in by a great fault having a down-throw to the north, I was naturally led to Wiveliscombe, in the neighbourhood of which place an east and west fault is indicated by Sir H. De la Beche on the maps of the Geological Survey.

On rising from the lower Triassic ground east of Wiveliscombe, on to the high land of the Main Down, Heydon Down, and Chipstaple, I found purple sandstones interstratified with purple slates, dipping generally to the south at angles of 50° or 60°. Near the town of Wiveliscombe these beds have in one or two quarries a northerly and north-westerly dip, showing the presence of a local undulation.

* I would take this opportunity of pointing to this case, as an instance of the good effect of having the whole of the United Kingdom of Great Britain and Ireland examined by the same set of men, under one Director-General. The type of the Carboniferous and Old Sandstone formations varies so much, as we follow them from the West of England through Wales and the North into Scotland, that different sets of observers, acting independently of each other, might fail to see their connection, and each set would be apt to contend for the universality of their own type. In Ireland each of these types is to a certain extent represented in different districts which are physically continuous, so that the connection between them can be traced even through some other variations peculiar to that country. In these formations, then, the Irish branch of the Geological Survey may hope to react on that of Great Britain, and repay in the classification thus introduced some of the debt due for the improved classification of the Silurian and Cambrian rocks, which could never have been attained in Ireland alone.

These beds are the same as those which form Haddon Down, and the range of downs running thence westwardly to Morte Bay, every where resembling the cleaved Old Red Sandstone of the south of Ireland.

Near Wiveliscombe the band is from a mile and a half to two miles in width, measured from north to south.

About a mile north-west of Wiveliscombe, near Higher Raddon, there is a quarry in these beds by the road-side, just south of the junction of the two roads, in which coarse reddish-brown earthy micaceous sandstones, thickly bedded, with irregular partings of shiny purple slate, are exhibited. The beds are a good deal disturbed and crushed, in the way that beds often are near a great dislocation. In the field immediately north of that road which runs East and West, a little marshy gully full of springs runs to the East, parallel to the road. On the northern side of this gully small crags of pale greenish-grey, smooth, slippery clay-slate show themselves. The cleavage of the slate dips south at a high angle, and the beds appear to coincide with it. The whole evidence is so strong in favour of this little ravine running along the course of a fault, which gives rise to the numerous springs issuing from it, that Sir Henry De la Beche was induced to insert one in the map, although he did not distinguish between the two kinds of rock by any difference of colour on the map.

This fault is confined to the older rocks, the New Red Sandstone spreading across it on the east, without being affected by it, though from the indications on the Survey map, the Triassic beds seem to be traversed by another east and west fault a little farther north.* Grey slate spreads over all the country to the north of this fault for several miles, and large slate quarries are open near Oakhampton House, a mile or so to the northward of Wiveliscombe. In some of these quarries the slate is a dark-blue, nearly black, earthy slate, with small nodules scattered through it. These nodules are occasionally larger, and are called Bull's Eyes by the quarrymen, precisely as similar nodules are so called by quarrymen in the dark slates of the County of Cork.

In both countries the slates, though used for roofing-slates, are thicker and heavier than the roofing-slates from the Cambrian rocks near Bangor, or those from Ffestiniog and other Lower Silurian slate quarries in North Wales, or in the County of Waterford. In one quarry near Oakhampton House the slates were occasionally stained red by ferruginous and ochreous infiltrations, through a width of twenty or thirty feet, and for a depth, according to the quarrymen, of at least one hundred feet.

The dip of the cleavage is south at 70° , and it appeared that the bedding of the rock coincided with the cleavage, or at least I

* In the earlier editions of the map these two faults are kept separate, the New Red Sandstone stretching unbroken across the more southern fault, as it appeared to me to do. In subsequent editions of the map the two faults have been unfortunately connected into one, apparently by a mistake of the colourer.

could not discern any sign of stratification in any other direction, and would therefore, though with some doubt, suppose it to do so.

Direction and throw of the fault.—There is no indication of the direction or amount of the throw of this fault in Sir H. De la Beche's map, in which all the so called Devonian rocks have the same colour. An examination of the country, however, shows that it must be a down-throw to the north, and that the amount of the throw must be very considerable.

If we start from the Coal-measures on the South that spread from Bampton by Holcombe Rogus, and proceed northwards into the grey slates with marine fossils, we get a regular descending section in them through grey clay slates, with grey grits, without any conspicuous red beds, till we come down to the red grits and slates of the Main Down of Wiveliscombe. To the north of the fault just described, again, nothing but a grey slate formation is to be seen for six miles to the northward, till we come down again to the massive red sandstones and slates which rise out in the heart of Croydon Hill and the neighbourhood of Dunster.

If, therefore, we accept the existence of a sensible east and west fault, near Higher Raddon, north of Wiveliscombe, on the authority of Sir H. De la Beche, it seems difficult to escape from the conclusion that the red sandstone group, supporting a grey slate group on the south side of the fault, is the same as the red sandstone group supporting a grey slate group on the north side of the fault; and that the throw of the fault is to be measured by the original distance that intervened between the higher beds on the north of the fault, and the lower beds on the south side of the fault.

I can hardly suppose this distance to have been less than some 4,000 feet (see Section, fig. 1).

Country S. W. of Wiveliscombe.—The beautiful transverse valley of the Tone affords occasional sections, especially about Coalman's Mill, near Stawley, both in the Carboniferous Slate and the Coal measures.

I met with fossiliferous bands at two places in red-stained grits, interstratified with the Carboniferous slates, that appeared to me to be not unlike the grits on which the Castle Hotel at Lynton stands. One of these places was in a roadside cutting somewhere near Hellings (as well as I could make out from the map), and the other in a quarry by the side of the lane running north from the place called South Hill, near Clayhanger, and not far from the turn of the road south of "Wellhayes," as engraved in the map.

Brendon Hills Iron Mines, and ground N.W. of Wiveliscombe.—From the line of the fault at Higher Raddon, past the church of Huish Champflowers, and thence to the iron mines of the Brendon Hills, I did not see any quarry or cutting of sufficient depth to show the "lie" of the rocks. The debris, however, on the road side, the pieces in the ploughed fields, and the rock fragments shown in

ditches and shallow roadside cuttings, consisted solely of grey clay-slate of the kind called "Killas" in Devon and Cornwall.

Near the iron mines, at the summit of the hills on which is Raleigh's Cross, a quarry showed similar slate bent into an anti-clinal curve, dipping S. by E. at 30° , and N. by W. at 60° ; the cleavage dipping S. at 80° . The weathered slate is of a pale greenish grey colour; but when freshly cut into, shows a blue "slate-colour," as remarked to me by young Mr. Morgans, the son of the manager of the mines, whose kindness in giving me information in his father's absence I must gratefully acknowledge. He informed me that the "lode" runs about W. by N., and E. by S., splitting into two towards the west. Its contents are partly spathose iron and partly hæmatite, the deeper parts being supposed to consist entirely of the carbonate. The lode, or lodes, vary in width from 1 inch to 27 feet, and dip to the S.* at an angle of 50° , increasing to 70° , as the lode is followed westward to Gapworthy, and Goose Moor.

Staining of the Grey Slate.—The hæmatite is sometimes red, and sometimes brown or black, but wherever it occurs the slate is stained red for a distance of many feet on both sides of the lode, while where the carbonate of iron only is found, the grey slate on each side of the lode is unaltered in colour. This observation, which Mr. Morgans made to me before I had even questioned him on the subject, explains the red ferruginous staining which is found to prevail in much of the Carboniferous slate of other parts of the district.

There is also another possible source for the staining of the grey slates in those parts which border on the New Red Sandstone, which I mention with less confidence, but cannot pass altogether in silence. To the S. of Wiveliscombe I found in one or two places the slates of the lower ground of a purple colour, while in the higher ground farther west in the same strike they were greyish blue. It occurred to me to suppose that the slates in the lower ground, which are in close proximity to the New Red Sandstone, had somehow acquired this red tinge from the Triassic beds which formerly rested on them. On the Geological Survey of Ireland we have found the Lower Silurian slates similarly reddened as we approached the Old Red Sandstone boundary, and came to the conclusion that the grey slates had acquired this red tinge during the deposition of the Old Red upon them, or while it rested there.

The mere colour of the Carboniferous slate, therefore, is a much more uncertain test of the formation in Devon and Somerset than it is in Ireland, where red and purple tints are confined to the Old Red Sandstone, and dark bluish grey and black to the Carboniferous slate.

From the frequent presence of the red oxide of iron in the W. of England *both formations* are occasionally tinged of a bright red, or

* Or underlie south at 40° , if we prefer that mode of expression.

“raddled” by ochreous infiltrations, which stain the fingers when the rocks are handled, and the original colours of the rock obscured accordingly.

Between Wiveliscombe and Dulverton.—In proceeding from Wiveliscombe to Dulverton I took the road by Chipstable and Lawtrow Cross.

From Trow Hill, through Chipstable over Heydon Down, the edges of beds of purple slates and sandstones were often seen crossing the lanes, striking nearly E. and W., and apparently dipping S. at high angles. The road is of a bright red colour going down to Leigh, but at Leigh there is a sudden change in the colour of the ground, all to the northward being a pale grey.

At Lawtrow Cross the same pale grey hue prevailed, but on walking up the hill to the south of it a sudden change took place, about a quarter of a mile south of the cross-roads, where there was an old quarry in purple slaty sandstone.

So far, then, I believe the Raddon or Wiveliscombe fault runs nearly E. and W. A little farther west, on the south side of the road near Rainsbury, there is a quarry in thick red sandstone with slaty partings of a paler colour, the beds dipping N. N. W. at 55° .

Dulverton and Simonsbath.—I was disappointed in my expectations of finding good sections in the valley of the Barle between Dulverton and Simonsbath, the sides of the valley being clothed with wood and heather in the steeper parts, and with grass on the more gentle slopes.

Detached quarries and other small exposures of rock showed that the beds dipped frequently to the northward, as well as to the southwards, several small anticlinal and synclinal curves being visible about Hawkridge and Tarr Steps. The dip of the beds was often not more than 10° or 15° in both directions, but sometimes as much 40° or 50° . The cleavage near Tarr dipped N. N. W. at 75° , where the beds dipped N. at 40° , and near Hawkridge, in a part where the beds were horizontal the cleavage dipped N. N. W. at 50° .

The rocks are coarse grey and brown grits, interstratified with purple and lilac coloured slates.

Some greenish-yellow, rather soft, earthy sandstones, often splitting into flags, showed themselves near Drayton and Slade on the north side of the Barle, dipping to the N. near Slade Farm, and on the roadside S. of Venford on the south side of the river, where they dipped S. These beds reminded me so much of the Kiltorean Hill stone in Co. Kilkenny that I spent some time in searching for fossils, but did not succeed in finding any.

Near the southern end of Winsford Hill there is a quarry in coarse purple and green grit, dipping S.S.W. at 40° , which I should certainly assign to the Old Red Sandstone, and, measuring from that to Dulverton Common, the width of the Old Red Sandstone band seems to be not less than three miles here.

North of that, by Winsford, to the summit of Dunkerry Beacon in one direction, and by Exford to Simonsbath in the other, I could neither see nor hear of any kind of rock but grey slate, interstratified occasionally with grey and brown grits, and including one or two calcareous bands, which in various places are rather largely quarried for lime.

The iron lodes of the Brendon Hills seem to be continued into Eyeson Hill (which Mr. Morgans senior presumes to have been named originally *Eis-n* Hill by some German miner), from which red hæmatite is being extracted in large quantities.

To the north of Little Ash there is a quarry in some dark blueish-grey slate, weathering pale green, and occasionally pink or red, of which the beds dip S. at 50° , and the cleavage S. at 75° .

At Newlands I visited the limestone quarries, which are of considerable extent. The blue slate becomes along a certain band highly calcareous, and full of veins of calcite, one part of it about six feet thick forming an actual limestone, although still traversed by the cleavage, and without any obvious planes of stratification either above or below. The cleavage dipped S. at 60° , and I presume the bedding coincided with it. I did not find any traces of fossils, but my search was slight and hasty.

An old farm-house called Wishet, a quarter of a mile west of this and the Red Deer public-house, a little farther west on the roadside, are not marked on the Ordnance map. The latter might form a convenient stopping place to any geologist wishing to examine this part of Exmoor.

The Rev. F. Mules of Muddiford, near Barnstaple, gave me some specimens of a red-stained grit containing casts of univalves from Sprecombe, near Orchard, and Black Barrow Down, near Oareford, about two miles north of the Red Deer. These univalves are either *Natica* or *Macrochilus*, according to Mr. Baily.

From the Red Deer, through Simonsbath and along the new road on the south side of the Barle, and up the lateral valley that falls into it from the south, the blue-grey slate frequently showed itself. At one place a blue-grey grit, interstratified with it, dipped S. at 40° . Blue-grey slate was also visible about the head of the brook that runs down past the new house of Emmett's Grange; but on the hill to the south of that (which I suppose to be Two-barrow Down) purple slate of the Old Red Sandstone type was exposed in some levels cut to drain what appeared to be an abandoned iron mine.

Purple slate also showed itself on the southern slope of this hill down towards North Radworthy, succeeded shortly by blue grey slate, which continued thence past Heasley and North Molton, and thence to the Coal-measures of South Molton, the dip of both formations being at high angles to the S., except one slight northern undulation in the Carboniferous slate, near Barkham.

Barnstaple to Challacombe and Bittadon.—Proceeding to Barnstaple I made a traverse through the country by Bratton Fleming, and Loxhore to Challacombe; and another, under the kind

guidance of the Rev. F. Mules, from Barnstaple to Bittadon, and found everywhere a confirmation of the conclusions stated in preceding papers.

Immediately west of the village of Bratton Fleming is a quarry of purple grit and flag, the beds being vertical, and striking E. and W., and purple slates abounded on Bratton Common and about Loxhore, over a space about two miles wide measured from N. to S.

To the south of that band the blue grey clay slate is abundantly shown; greenish sandstones (Marwood beds) being interstratified with it for about a quarter of a mile south of the red beds.

Immediately north of Bratton Down, about Kipscombe, and thence to Challacombe,* pale grey slate is the only rock to be seen, the paleness being the result of weathering from the original dark bluish grey, or black hue. At Kipscombe it dips S. at 65°, the cleavage coinciding with the bedding.

At Shorland there was a deep quarry in a calcareous band, which comes up from Combe Martin, and runs through the country here. It appeared to dip S. at 60°. I did not find any fossils except two or three crinoidal rings.

At Bittadon the Rev. F. Mules was kind enough to conduct me to see a band of rock of rather a peculiar character, which he called "trap shale." It is a sandy slate, full of broken felspar crystals, but hardly worthy of the name of an "ash." He had traced it through the country for some distance. I could not, with the hasty examination which was all I could spare for it, decide whether I should place it deep in the Old Red on the south side of the fault, or high up in the Carboniferous slate on the north side of the fault.†

I was indebted also to Mr. Mules for a number of fossils he had collected from the Sloy and other quarries, especially some specimens of the *Lingula Mola*, named after him by Mr. Salter, but which Mr. Davidson refers to *L. squamiformis*, and some specimens of plants which were exactly the "Linear plants," so abundant in the lower parts of the Carboniferous slate of the County of Cork.

Mr. Baily, having examined these specimens, has given me the following list of them. Plants resembling the *Sphenopteris* figured in Explanation 187 of Irish Survey Maps:—*Sagenaria* (*Knorria*) *Veltheimiana*; *Lingula squamiformis* (*Mola*); *Strophalosia productoides* (= *Leptæna caperata*); *Strophomena rhomboidalis* (var. *analoga*); *Anicula Damnoniensis*; *Cucullæa trapezium* var. *amygdalina*; *Cucullæa angusta*? *Cucullæa Hardingii*? and *Bellerophon subglobatus*.

Combe Martin.—A visit to Combe Martin showed that the rocks were all of the ordinary type of the "Carboniferous slate," dipping on the whole to the S.S.E. at 45° or thereabouts, but with occa-

* The people of the country called the village where the church is, "Bartintown;" a collection of houses down in the valley about one mile N.E. of the church being called Challacombe-town.

† This band of rock is described by Mr. Townshend M. Hall, of Piltown, in his paper published in the *Exeter and Plymouth Gazette*, September 29th, 1865.

sional undulations in other directions. I was particularly struck with some surfaces of grey slate on the east side of the little harbour, which were covered with those small branching stems, of a darker colour and coarser consistence than the rest of the rock, which we have been accustomed to speak of in Ireland as "fucoids," and could have imagined I was in some of the numerous bays of the Co. of Cork.

A man who lives near the church, of the name of George Eastman, who had been accustomed to accompany Mr. Mules in his search for fossils in this neighbourhood, afterwards procured for me some specimens, among which Mr. Baily determined the following species:—*Cyathophyllum coespitosum*; *Favosites cervicornis*; *Chonetes Hardrensis*; *Stringocephalus Burtini*; *Avicula* ? *Cucullæa* ? or *Myalina* ? *Natica* ? *Crinoid*, stems and joints.

My colleague, Mr. Etheridge, informs me that he has collected from the rocks of N. Devon most of the species of shells, or corals, or other fossils which have been found in South Devon. As I hope to see his revised Catalogue shortly published, with his own observations, I will merely observe that if the place of these fossils is rightly fixed stratigraphically in North Devon, they will serve as a guide to lead us through the more complicated structure of South Devon.

The calcareous bands, which are rather largely quarried for lime in this district, are all cleaved nearly as much as the mere clay-slate, and do not make any very conspicuous beds of limestone, not being so distinct even as the Bala limestone is from the slates above and below it. The whole rock is traversed by veins of calcite, often forming nests of large crystals of dog-tooth spar, and other forms of the mineral. The carbonate of lime seems to set in along two or three rather different horizons, and to run along the line of strike from Combe Martin to Wheddon's Cross, and thence to sweep round the southern flank of Croydon Hill to the neighbourhood of Withycombe, as first described by Sedgwick and Murchison, and afterwards shown in the maps of the Geological Survey.

This limestone is said to make good mortar for building purposes, and also to be better than the South Welsh Carboniferous limestone for spreading on the land, or "putting on spane," as the men phrased it; "spane" meaning apparently the surface of the cultivated ground, and being probably the origin of the name "Span Head."

On the road from Combe Martin to Trentishoe, near Trentsihove Barrows, was a quarry in a red-speckled grey sandstone and flag, the beds dipping S.S.W. at 50°. This might have passed for a bed in the Old Red Sandstone, but is probably a Coomhola grit, as it must apparently be above the beds of Heddon's Mouth, Woodabay, and Lynton. It is also similar to the red grits which contain the casts of *Natica*, or other univalves, near Sprecombe.

Countesbury, Glenthorn, Porlock, and Dunkerry Beacon.—About

Countisbury Church are several quarries of greenish sandstone, with an easterly dip at angles of some 35° . They are occasionally stained reddish, and are probably not far above the Old Red Sandstone, if indeed they do not belong to it. One block had in it a marking like the impression of a plant stem.

In the valley of the East Lyne, south of this, about Ashton and Wood, bluish grey grits in blue slates dipped N.N.W. at 70° in one place, and S.S.E. at 20° in another. These are clearly in the Carboniferous Slate which stretches thence down the valley all the way to Lynmouth.

On the other hand, as I descended from the summit of the hill about Wingate, towards the coast, I found in the neighbourhood of Glenthorne that the rocks assumed more and more of the Old Red Sandstone type, consisting of massive brown and red grits interstratified with purplish slates.

Where the footpath of Glenthorne comes out on to the pebble-beach, thick massive grits, some greenish grey, but others of various shades of red, interstratified with yellowish green shaly partings, and occasionally with purple slates, undulated along the shore in both directions, being thrown into bold anticlinal and synclinal curves. The contortions are so large and numerous, that no general dip could be assigned to the rocks from local observation, but I have no doubt of their ultimately plunging southwards under the grey slates.

The same description will apply to the rocks near Culbone, and those forming the hills over Porlock Quay and Porlock, and those about Hurlstone Point and Bossington Beacon. Thick strong fine-grained gritstone* or sandstone, interstratified with thinner beds of shale or slate, are thrown into numerous and rapid undulations, generally with a prevailing northerly or southerly dip, but sometimes easterly or westerly. Slaty cleavage shows itself occasionally throughout the rocks, but seems to be altogether absent from some parts. Red and purple hues predominate, but they by no means exclude many other colours, the whole being similar to many parts of the Old Red Sandstone of the south-western portion of Ireland.

In going up from the village of Porlock by Lucoft to Dunkerry Beacon, the first rocks met with were massive grey grits with purple streaks, very hard and splintery. These had partings of brown slaty rock. The dip at one place was N. at 40° or 50° . A little higher were green grits and purple slates, dipping N. E. at 40° . These are known as the "Coltscombe Rocks," and it is indicative of the rare exposure of rock in the country that such insignificant crags should have a distinctive appellation.

* The use of the term "gritstone" as distinguished from "sandstone" cannot be definitely determined. In my mind it is associated with a fine grained, hard, siliceous stone such as is often interstratified with slate rocks. The "millstone grit" of Derbyshire and Yorkshire is an exception to what I understand by a "gristone" and would rather form the type of a "sandstone." In many parts of the United Kingdom, however, any stone of which the grains are visible and composed of siliceous matter is spoken of as a "grit" or "greet," and in such terms I think popular use ought to be a guide to the Geologist.

In the lane leading from Lucoft to the Stock Mill, pale greenish grey sandy flags dipped E. S. E. at 20° , while rising the opposite hill to Liddelcombe (not Middlecombe, as in the map) a band of purple slate was visible in similar greenish sandstones, dipping E. at 50° .

Near Wilmotsham (called Wimbersham) soft greenish grey sandstone, very like the Drayton beds near Dulverton, dipped S. at 30° , and down in the bed of the brook, on the road to Stoke Pero, a hard grey grit mottled with red dipped S. 35° E. at 35° .

South of Stoke Pero church a greenish flag, mottled with purple, dips S. E. at 25° . On and about Dunkerry Beacon there is no exposure of rock that I could find, till I came to the head of the brook that runs down on the south side of the hill towards Bincombe, where greenish grey slates showed themselves abundantly, dipping S. at 25° .

In making this traverse, I had no doubt that for the first mile or two from Porlock I was in the Old Red Sandstone, and that Dunkerry Beacon rises within the Carboniferous Slate area; but it would obviously require some weeks or months of hard work to determine the precise boundary between those two formations, and, having determined it, to trace it through the steep-sided wooded combs and swelling downs of this beautiful district.

Minehead, Dunster, and Croydon Hill.—The eastern portion of the North Hill, near Minehead Quay, is formed of rocks similar to those at the western end, near Hurlstone Point.

A little east of Greenaley Point a large quarry on the hill side showed green and purplish grit in thick beds, interstratified with slaty partings, all dipping N. at 40° . Near Minehead Quay the rocks seemed to be contorted, and there were many blocks lying about, containing pebbles as large as almonds.

Grabbist (Grabhurst ?) Hill just N. of Dunster appeared to be composed of brown grits with reddish slaty shales lying in a horizontal position. Red and brown sandstone, and purple and brown slates, of the ordinary Old Red type, show themselves about Dunster, through Dunster Park, about Langcombe, and thence up the dingles in the centre of Croydon Hill, and are largely quarried near the village of Timberscombe. About Dunster they dip to the east and south east at various low angles rarely exceeding 15° . About Timberscombe they dip S. W. at 15° or 20° . In the centre of Croydon Hill they appear to be contorted in various directions, but always at low angles.

On the south slope of Croydon Hill grey and red-speckled grits showed themselves, like those which were lying loose on the ground in many places on Dunkerry Beacon. These, I have presumed, occur in the lower part of the Carboniferous slate, corresponding to our Irish Coomhola grits.

Going up from Timberscombe to Wheddon's Cross, in a traverse in which I was assisted by my friend Dr. Whitehead of Manchester,

we found, scarcely half a mile S. W. of the house called Bickham, an old lime-kiln in the wood on the west of the road, and some old quarries from which the calcareous slate had been extracted on the east of it. The debris of the rocks in this neighbourhood was a grey clay-slate, often much "raddled" by ferruginous staining.

A little S. of this, near the foot of the lane going up to Oaktrow, was a quarry by the road side showing slate and grit which dipped E. S. E. at 20° . The colour of the rocks was grey, with purple and red streaks and stains which soiled the fingers. Some calcareous concretionary masses in these beds were full of fossils, large *Spiriferæ* and others, but all in the state of casts, and so tender and friable that it was with difficulty we could carry away specimens. In those blocks which I succeeded in taking to Dublin, Mr. Baily detected *Fenestella antiqua* and *Spirifera Verneuilii*, but the other fossils were too much broken to be determinable. A palæontologist who would visit the quarry, and determine the species on the spot, would I think be better rewarded.

These beds are not very far above the top of the Old Red Sandstone in Croydon Hill. Higher up the road were larger quarries in somewhat similar beds, dipping S. at 20° , and above these were beds of grey slate untinged with any ferruginous stains, which showed themselves at intervals all the way to Wheddon's Cross.

Near Wheddon's Cross I again searched the old lime quarries for fossils, but was again unsuccessful in finding anything but *Favosites polymorpha*, which Mr. Etheridge informs me is now known as *F. cervicornis*, together with the *Fenestella antiqua* and erinoid joints, (*Actinocrinus variabilis*.)

From Wheddon's Cross the calcareous band sweeps round the southern flank of Croydon Hill, as described by Sedgwick and Murchison, past Luxborough, where it is largely quarried, and Treborough, and then bends to the northward, and north-westward up to Withycombe, beyond which its farther course is concealed under the New Red Sandstone.

An old lime quarry is to be seen about 200 yards S. of Withycombe, in which the beds dip E. at 10° , and in the lane leading up to the Hill Farm the unconformable junction of the New Red Sandstone with the Carboniferous slate can be seen.

I did not succeed in collecting any fossils near Withycombe, but Mr. Percival has been kind enough to allow us to examine the casts of bivalve shells which he found in this neighbourhood. These are too rough for accurate determination, but might, according to Mr. Baily, belong either to *Sanguinolites*, *Pterinea*, or *Cucullea*, one of them being like the cast of *Cucullea Griffithii*.

The Brachiopoda and other fossils mentioned by Mr. Percival in the Geological Magazine, April, 1866, would probably be similar to those near Oaktrow, on the other side of the Croydon Hill anticlinal.

The Quantock Hills, Buncombe Hill, Cannington Park, and West Monkton.—Crossing the New Red Sandstone of the Williton Valley

to the Quantock Hills, we found the rocks in a quarry on the hillside south of St. Audries to be hard brown thick-bedded gritstone, with reddish slaty partings, quite of the Old Red Sandstone type. The beds dip W. S. W. at 50° .

Angular pieces of purplish grit lay scattered over all the hills above this, but we did not see any rock exposed sufficiently, to show its "lie," till we came nearly to Holford, where the dip was S. E. at 25° . The lowest rocks shown here were red grits and greenish shales or slates; but these passed under beds of "raddled" slate that looked like the lowest beds of the Carboniferous Slate.

At the turn of the road a quarter of a mile S. of Holford, red grits and green shales were shown in a quarry, dipping E. N. E. at 40° , while at the corner of Sherwage Wood, a little farther to the S. E., red slates dip East at 5° , and seem to be the same beds as those shown in the village of Holford.

A little before coming to the seventeenth milestone, near the road S. of Doddington is an old limestone quarry in grey calcareous slate, very much reddened by ferruginous stains, in which the beds dipped S. E. at 30° or 40° . *Favosites cervicornis* and some other fossils were rather abundant here.

A little farther to the east was a quarry in reddish-brown gritstone and greyish-green slaty shale, which with some contortions, dipped N. E. at 40° . They must apparently be above the limestone, and yet are not unlike the rocks met with to the south of St. Audries.

This was not far from Nether Stowey, whence we proceeded to the limestone of Cannington Park, where I unexpectedly met my colleague Mr. Etheridge. In the later editions of the Geological Survey Maps this limestone has been coloured as Carboniferous limestone, and marked *d 2*. Mr. Etheridge, however, declared to me on the spot, his conviction that it was not ordinary Carboniferous limestone, but Devonian, like that of Torquay and Plymouth. On afterwards referring to a sheet of one of the early editions of the Survey Maps, I found this patch of limestone coloured of the same tint as those Devonian limestones, and not as Carboniferous limestone. Had it been the ordinary Carboniferous limestone, I should have expected to find the band of "Devonian" immediately to the south of it and just north of the village of Cannington to be composed of black shale or slate, instead of which it consists of pale purple, fine-grained, rather micaceous sandstone, traversed by a rude cleavage.

The New Red Sandstone spreads over all the country here, merely permitting detached bosses of the Palæozoic rocks to be seen.

A subsequent day's work with Mr. Etheridge over Buncombe Hill to Asholt, and round by West Monkton, convinced me that all that district belonged to the Carboniferous slate group, with fossiliferous calcareous bands at intervals, and occasional groups of beds of strong gritstones, often stained red from ferruginous infiltrations.

Near the mill North of Kingston a quarry in grey slate, a good deal raddled with red ochre, shewed the beds dipping S. at 10° the cleavage S. E. at 40° , while higher up Buncombe Hill purplish grits

and slates dipped S. at 30° . Grey slate was abundantly exhibited about Lower Asholt.

On Asholt Common there was a quarry opened on a calcareous band dipping S.W. at 30° , in which corals were plentiful, belonging, according to Mr. Etheridge, to *Favosites cervicornis*, *Stromatopora concentrica*, *Cyathophyllum capito-um*, and others.

A little further North grey slates and grits, "raddled" on the outside, dip N.E. at 10° .

A rather imperfect cleavage was traceable everywhere, dipping S. at 20° or 30° .

On the hills West of Asholt reddish brown grits with an easterly dip began to make their appearance, while on the hill South of Asholt church was a large quarry in a good crystalline limestone dipping N. at 10° .

Near West Monkton grey slates and grits, with occasional ferruginous stains, dip S. at 20° or 30° , the cleavage having a dip to about S. S. E. at 50° or 60° .

General Conclusion. I have thought it right to give in detail some of the observations for dip, &c. that I made in each locality, in order to give an opportunity to other observers to test my correctness or correct my errors. I felt I was bound to do this as I come forward to controvert opinions that have been widely spread, and to shew that there was an unsuspected flaw in the foundations on which they were based.

For those who have no time or opportunity to enter into details, I will briefly sum up the conclusions respecting the Palæozoic rocks of North Devon and West Somerset to which my previous experience in Ireland has led me:—

1st. There are three areas of Old Red Sandstone:—

a. The Quantock Hills.

b. The Porlock, Minehead, and Dunster area.

c. The Morte Bay and Wiveliscombe ridge.

These have each an irregular anticlinal form, as shewn in the accompanying sketch-map. The Quantock Hills anticlinal is partly concealed on the western flank by the New Red of the Williton Valley. The Porlock, Minehead, and Dunster anticlinal has its south-eastern termination tolerably well shown in Croydon Hill, but is obscured on the North and North-east by the sea and the New Red of the Williton valley. The Morte Bay and Wiveliscombe anticlinal has its northern arm broken down by a great longitudinal fault running along its crest.

2nd. Each of these three areas of Old Red Sandstone dips under a great mass of Carboniferous slate, as shown in the map. The Carboniferous slate of the two northern areas, that spreading S.E. from the Quantock Hills, and that stretching through Exmoor Forest to Morte Point, is thrown into numerous undulations, and thus spreads over wider spaces than it would otherwise occupy. The beds of the southern area, running from the country south of Wiveliscombe to Baggy Point, have a much more steady strike, and

dip at a higher angle to the south (though not altogether devoid of undulation), and therefore soon become covered by the Coal measures.

3rd. These three groups—the Coal-measures, the Carboniferous Slate, and the Old Red Sandstone, to the South of the Bristol Channel, are contemporaneous with the three groups—the Coal-measures, the Carboniferous Limestone, and the Old Red Sandstone to the North of the Bristol Channel; but have a different lithological character, the original difference impressed at the time of formation being rendered more marked by all three being traversed by slaty cleavage to the south of the Channel, while they are all devoid of it in South Wales.*

If we take the true Old Red Sandstone as the conformable base of the British Carboniferous series, we can speak of the rocks south of the Bristol Channel as the Devonian type of that series.

4th. I believe the still lower beds, hitherto spoken of as Old Red Sandstone in Wales and Scotland, which contain *Cephalaspis*, *Auchenaspis* and other similar fish, and which also contain *Eurypterus* and *Pterygotus*, etc. will ultimately be separated from the true Old Red Sandstone, and assigned to the Upper Silurian or some intermediate period; but that belief does not at all affect the present question.

5th. Even should it ultimately turn out that the red rocks of the central band, stretching from Morte Bay to Wiveliscombe, are not brought up by a great fault, as I believe, but are truly intercalated between the two groups of fossiliferous grey slates, still the general conclusions I now advocate will not be altogether vitiated. The red rocks of Porlock and Dunster may then be taken as the top of the true Old Red Sandstone lying underneath a great mass of Carboniferous Slate, which would in that case differ from that of Ireland not only in the greater abundance of limestone, but in containing a central mass, some 3,000 feet thick, of red grits and slates of the same lithological type as the Old Red Sandstone below. I do not think this a likely occurrence, and I believe all the available evidence to be against it; but should it be true, still the “Devonian rocks” remain a conformable series between the top of the Old Red Sandstone and the base of the Coalmeasures.†

Note on the Map.—The small map accompanying this paper is merely offered as a sketch roughly defining the areas occupied by

* It was doubtless the presence of slaty cleavage which gave such a prestige of antiquity to the rocks South of the Bristol Channel, as hindered their purely Carboniferous relations from being recognised. The old idea of a formation of Gneiss, then one of Mica schist, and then of Clay-slate, even yet lingers in some men's minds.

† It will be a remarkable fact if these conclusions are well founded, and can, as I believe, be extended to the whole of Devon and Cornwall, that almost the whole mineral wealth of Great Britain, not only in Coal and Iron, but in the Lead veins of the North, and the Tin and Copper veins of the West, is derivable from the Carboniferous formation.

the Carboniferous Slate and Old Red Sandstone. I used the Geological Survey map in the field, re-colouring the part hitherto called Devonian, so as to make it agree with the maps published by the Irish branch of the Survey. It will of course be understood that I did this merely in the old, hasty, amateur style in which detached quarries or sections are connected by lines that are guessed at. When the country is re-surveyed in the accurate manner now gradually arrived at on the Geological Survey, in which not only the quarries and cuttings but the bed of every brook and the ditches round every field are examined, so that no square yard of land is left unlooked at, the details of the boundaries will doubtless be very different from mine.

To do the country properly will take as many years as I have given weeks to it.

I may be pardoned perhaps for noticing an instance of the difference between the old and new style of work, which I can do without invidiousness, as I shall merely be criticising myself. In 1841, I made a Geological map of Charnwood Forest in Leicestershire for Potter's History of the District, spending some weeks and working hard at it. I had previously, in 1837, been taken over Charnwood Forest, in company with my friend Ansted, by our old master, Professor Sedgwick, and been taught by him to distinguish between bedding and cleavage, and shown the outlines of the structure of the district.

I believe the map I made in 1841 was a substantial advance on any previous attempt, as I ventured to introduce the New Red into the heart of the Forest; but on comparing it with the more accurate and detailed map made by my colleagues, Messrs. Howell and Hull, under Professor Ramsay's direction, my map looks like the rude drawing of a child by the finished picture of an artist.

I can easily believe, therefore, that this will be true of the map accompanying this paper; but I also believe that the hypothesis on which it is based will stand, in this case, as it did in the other, however different the details of the boundaries may be.

