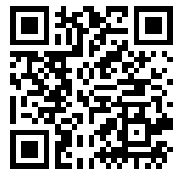

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For the Academy of
Science.

— at Munich.

THE

— from the Author

SILURIAN SYSTEM.

FROM THE EDINBURGH REVIEW.

EDINBURGH: M.DCCC.XLI.

W. A. Fittler

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THE SILURIAN SYSTEM.

FROM THE

EDINBURGH REVIEW,

APRIL, 1841.

N^o. CXLVII.

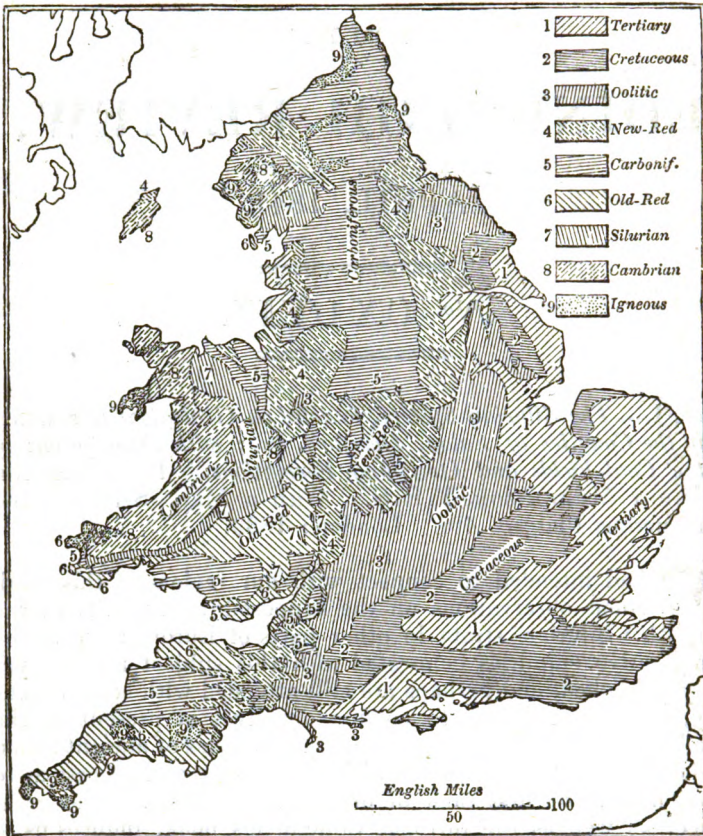
ART. I.—*The Silurian System, founded on Geological Researches in the Counties of Salop, Hereford, &c. ; with Descriptions of the Coal-Fields and Overlying Formations.* By RODERICK IMPEY MURCHISON, F.R.S. With a Map, Sections, and numerous Plates. 4to. London: 1839.

WE had intended to connect with our review of this work some observations on the supposed equivalents of the English 'Silurian' strata in other parts of Europe; but as the comparative enquiries connected with this subject are not yet fully published, and perhaps are still attended with some obscurity, we have resolved to confine ourselves at present to the result of Mr Murchison's examination of a series of ancient rocks, which he has here described with such ability and success as to place him in the first rank of practical geologists. The great price, as well as the intrinsic value of his book, induces us to give an account of its contents without farther delay.

The subjoined geological sketch of England, which is reduced from one of the author's illustrations, will enable our readers, with the assistance of any common map on a larger scale, to form some notion of the situation and extent of what is now to be called in geology 'the Silurian Region,'—a name taken from a tract upon the confines of England and Wales, but principally in the latter territory,* the inhabitants of which are distinguished in history for their persevering opposition to the Romans, under

* A farm near the centre of this district, not far from the town of New Radnor, bears the name of *Siluria* in the Ordnance Map.

Caradoc, whose name and exploits are still associated with many scenes and local traditions in Shropshire and Wales.



It may seem perhaps extraordinary, that while geology has been cultivated with remarkable energy in this country, a district so extensive, and of such great interest as this tract will be found to possess, should have remained almost absolutely unknown till within the last ten years. But a consideration of what we shall lay before our readers, will in some measure explain this anomaly; while it will show the enterprize and sagacity that first led Mr. Murchison to the task which he has so skilfully worked out: and this retrospect is the more necessary, as his introductory chapter is much less satisfactory than might have been expected—giving only a loose and general statement

of the previous history of his subject, instead of the circumstantial series of dates and detail, which, in a work of such magnitude, is customary,—and which ought, we think, to precede the first account of every remarkable discovery.

The region is certainly delightful, both to the geologist and to all who rejoice in simple mountain scenery; and the task of making out its structure, and pursuing its various details, new, as for the greater part they were, not merely in local description, but to geology itself, must have been full of enjoyment. When the stratigraphic clue to the series of strata of which the country is composed had been once obtained, the varied phenomena, which before perplexed the enquirer, fell at once into their places, rewarding the discovery of the principle, by the almost spontaneous solution of difficulties that would otherwise have remained insurmountable.

One of the oldest enquirers, we believe, connected with the geology of this ancient region, is GEORGE OWEN of Henllys, in Pembrokeshire; who has been called the patriarch of English geologists. He lived during the reign of Elizabeth, and wrote, about 1595, a history of his native country; which, however, remained unpublished till 1799, when it was first printed in a volume of the 'Cambrian Register,'* the ancient style and orthography being very properly preserved. In one of his chapters 'on the natural helps which is in the country to better the land,' the author mentions 'two vaynes of limestone, running for the most part right east and west through Pembrokeshire,' which are evidently the carboniferous limestone, bounding the great Welsh coal deposit on the north and south. These beds he traces with great precision, considering the state of the subject when he wrote; and he mentions likewise, a 'third vayne of limestone,' more northerly than the other two, which not improbably belongs to the Silurian System;—distinguishing its qualities from those of the groups above mentioned, and tracing its course with such apparent accuracy, as to deserve the notice of those who examine the country, even at the present time.

A volume of 'Tracts in Natural History,' published in 1799, by Dr ROBERT TOWNSON, author of a book of 'Travels in Hungary,' and of an 'Essay on the Philosophy of Mineralogy,' contains some pages on 'the Mineralogy of Shropshire;' in which the occurrence of limestone with petrifications, within the limits of the ancient territory now called Silurian, is frequently mentioned; and several localities of remarkable appearances are indicated with apparent correctness—but without any thing that

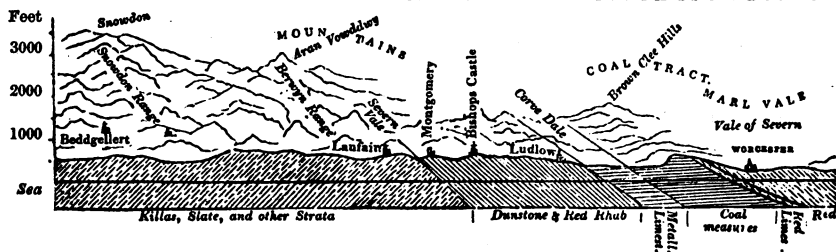
* 8vo. London, 1799, vol. ii.

intimates an acquaintance with the importance of stratigraphic superposition, or of the connexion of the fossils with the order of the beds containing them. Dr Townson seems to have paid particular attention to the environs of *Caer Caradoc*; and he describes very correctly the ridges on the north-east of that hill, which now belong to the lower division of the Silurian rocks, under the name of '*Caradoc Sandstone*.' 'If,' he says, 'from the Lawley and Caradoc we continue our course eastward, we find under both these hills, on their eastern side, a parallel range of white sandstone, which in some places has a very coarse grain. Where it is most regular, as under the Lawley, it presents its escarpment towards these hills, from which it is divided by a small valley, running parallel with the Wenlock Edge;'—and this latter ridge itself is then described as 'extending several miles in a continuous line, and inclining eastward.'

One of the points principally deserving of notice in Dr Townson's 'sketch,' is the account of what he calls 'compound sandstone;' which, instead of 'being formed of grains of quartz alone, consists of very minute fragments of other kinds of stone; sometimes of an argillaceous or jaspideous nature, mixed with a few grains of felspar,' and belonging apparently to that class of rocks distinguished by Mr Murchison under the name of *Volcanic Grits*.

The year 1799 was remarkable in the Geology of England, for the production of WILLIAM SMITH'S '*Table of the Order of the Strata near Bath*,' the basis of his subsequent *Map and Sections*; which, however, were not published till 1815; but the general diffusion of correct stratigraphical principles in this country, may be dated from the commencement of the present century, (1801,) when Smith first printed and distributed his '*Prospectus of a Delineation of the Strata of England and Wales*.' When we reflect that we have reached only the fortieth year from that period, when the very name geology was almost unknown in England, the progress of the science to its present condition does really excite surprise. It can be accounted for only by the peculiar and fortunate exposure of the numerous groups of strata which

ORDER OF THE STRATA FROM LONDON



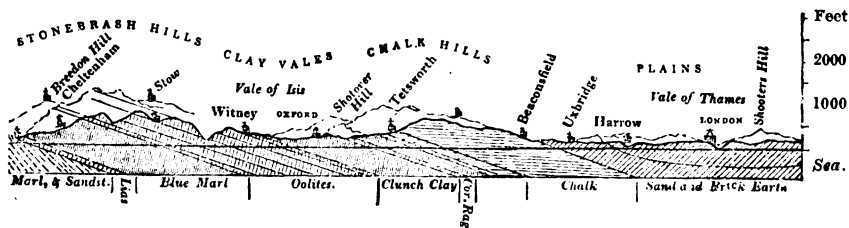
form the British islands—the spirit and intelligence employed upon our mines, and in the various commercial undertakings connected with the mineral structure and productions of our country—the facilities of intercourse every where to be found in England,—and lastly, by the talents and devotion of the small number of persons who long since took up the subject of geology with the most enlightened views, and some of whom still continue to watch over its progress with unabated zeal. From these united causes, the steps in advance have been so numerous, and have succeeded each other so rapidly, that the history of this department of natural science, in England only, during the last thirty years, might, under different circumstances, have been diffused over a century. But our present business is with the more ancient strata alone, which occupy the border counties on the west of England, and a great part of Wales.

About the close of 1809, MR AIKIN, one of the early members of the Geological Society, then recently established, (1807,) published proposals for a survey of Shropshire; and in the course of several succeeding summers had examined that county to a considerable extent, and caused several drawings to be made by Mr Webster; but the project was given up in 1815; and Mr Murchison has justly remarked, ‘that at the early period when ‘this task was undertaken it was almost hopeless; since that ‘county not only contains every sedimentary formation, from the ‘lias to the slates inclusive, but is also rendered most complex ‘by the numberless dislocations of the strata, through the agency ‘of volcanic rocks.’

Mr Aikin subsequently gave papers of great merit to the Geological Transactions, (1st Series, vols. i., iii., iv., and v.,) on detached points of his intended survey; and we shall recur to his unpublished manuscripts, which were put into the hands of the author of the volume now under our examination.

The state of the subject when SMITH’S ‘Geological Map of England’ appeared in 1815, may be judged of from the subjoined (reduced) section, by the author of the map, representing the

TO SNOWDON. W. SMITH, 1815.



succession of the strata from London to Snowdon; in which it will be perceived, that while the ~~strata~~ ⁹⁷⁻¹¹⁶ in the centre and east of England are subdivided in detail, the divisions on the west of the coal-tract are only two, and these of a very indefinite character. The MAP is defective in the same degree:—a large region, included under the terms ‘Red-rhab’ and ‘Dunstone’ being all that separates the coal-tracts from the mountains of Wales; which are themselves disposed of under the terms ‘killas, slate, and other strata.’ In the great map, nevertheless, and in a reduction of it published in 1820, a division is indicated which approaches to that of Mr Murchison; the ‘Red-rhab,’ &c., above mentioned, surrounding the mountainous district in a somewhat crescent-shaped band, which extends from Aberconway on the north, to the extremity of Pembrokeshire—in the same manner as Mr Murchison’s Silurian district (No. 7,) surrounds the Cambrian (No. 8,) in our map above given in the second page. But when Smith’s works are examined in detail, this resemblance will be found to be a very loose approximation, while the differences are many and important.

In the mean time *the Transition Rocks*,—to which terms a very vague signification was attached, became a sort of limbo for the reception of every thing that was ancient or obscure in the geology of England. But the general principles of stratigraphy were gradually making their way into practical application; and as fossils occasionally presented themselves from the older strata, of a new and singular character, suspicions began to arise that it might be practicable to find an order in the descending series also—although nobody had, at that time, the courage to grapple with the task of seeking for it. The publication of Mr Sowerby’s ‘Mineral Conchology,’—begun in 1812—was in this view of great usefulness; a register being thus opened for the reception of erratic specimens of shells, which were promptly made known, with the faithfulness of portraiture, for which the plates of that work have always been distinguished. One of the earliest numbers contained figures of the extraordinary genus *Pentamerus*, and gave the first representation of the species which characterize two prominent groups of the Silurian System. It is stated in the account of these fossils, that Mr Aikin had mentioned them to the author in 1812;—and that Mr Farey, also,—an original pupil of William Smith, and a sagacious observer—had sent several specimens from Croft Ambrey, near Aymestry, with remarks indicating a method of enquiry, which, if pursued, might probably have led him to correct notions of this part of the country.

The first important encroachment on the unknown tract beneath the old red sandstone, was made in MR GREENOUGH'S 'Geological Map,' published in 1819; a broad band, corresponding very nearly in position and extent with that of the Upper Silurian rocks, being there laid down as extending from Coalbrook Dale, on the north of the Severn, to the latitude of Ludlow; and identified, by its colour and place in the descriptive table, with the limestone groups of Dudley, Sedgely, and Walsall—that of the Abberley and the Malvern Hills—and, less perfectly, with that which reaches from Woolhope to Mayhill, and occurs again, in a protruded outlier, on the west of Usk. The map is less correct in the south-west, from Ludlow to Caermarthen; but on the west of the latter place a continuous line, with the colours of the Dudley group, extends without interruption for some miles. These were very important identifications, and well deserving of an explanatory notice in the 'Memoir' which accompanied the map. But it is to be regretted that this paper was so brief as not to contain any description of the tract now referred to; so that here, as on many other subjects, the mass of valuable information accumulated in the author's notes has been lost to the public. Mr Greenough, however, has frequently expressed a conviction, as the result of his own observations in that country, that adequate enquiry alone was wanting to prove the existence of a succession of strata in the west of England, and in Wales—not less regular than that which had been demonstrated in the centre and east of the Island.

Messrs CONYBEARE and W. PHILLIPS'S 'Outlines,' published in 1822,* while it most essentially advanced geology in England, for some time diverted attention from the older rocks. The first and only volume published, comes down no farther than the coal formation; and in elucidating the upper portion of the secondary strata, it convinced the working geologists—whose number has been at all times small—that quite enough to give them occupation was still to be done, in reforming and completing the description of the more accessible portion of England: while it was obvious that the unknown region of the west required such labour and devotion, in order to effect any important result, as to deter those who had not leisure and other requisites at their full command.

The only modern writers mentioned by Mr Murchison, besides Mr Aikin, as having touched upon the geology of this part of England when he began to explore the country—are Mr Leonard Horner, in a memoir 'on the Mineralogy of the

* 'Outlines of the Geology of England and Wales.' 12mo. 1822.

Malvern hills,' 1811;* Mr Weaver, 'on part of Gloucestershire,' 1819;† and Mr James Yates, 'on the structure of the Border Country,' &c.‡

The AUTHOR of this volume, whose acquaintance with geology began, we believe, about 1825, applied himself with great energy to his new pursuit; and his progress may be traced in the proceedings of the Geological Society, of which he soon became an active member. One of his first papers—on the existence of coal in the oolitic series, at Brora on the coast of Scotland, was produced in 1827;|| and Professor Sedgwick having afterwards joined him in that district, their enquiries were extended to the Isle of Arran,§ and to an examination of the old conglomerates and other strata, between the primary and the oolitic series of the north of Scotland;¶—a task which greatly contributed to their correct acquaintance with the ancient rocks, especially the old red sandstone, and to extended views of the phenomena produced by igneous action, and the intrusion of plutonic masses among the sedimentary deposits. The result of these various researches appears in the 'Geological Transactions.'

The author's knowledge of the igneous rocks was enlarged by an expedition, with Mr Lyell, to the volcanic regions of central France, in the summer of 1828; the results of which also have been printed.** In the course of 1829, he read separate papers on the vicinity of Bassano, and on the schist and fossil fishes of Seefeld; and again joined Professor Sedgwick in an elaborate examination of part of the Tyrol, the Bavarian Alps, and Styria; the fruits of which were, a map and description of the Austrian Alps; with other papers read in 1830 and 1831.†† In the latter year, Mr Murchison was chosen President of the Geological Society for the customary period of two years; and soon after-

* Geol. Trans., 1st series, vol. i. p. 281.

† Ibid. 2d series, vol. i. p. 317.

‡ Ibid. vol. ii. p. 237. To the references above given, we may add a paper 'On the Geology of the Malvern Hills,' by the late Mr W. Phillips:—Thomson's *Annals of Philosophy*, (new series,) 1821, vol. i. p. 16, &c. And another paper with the same title, by the Rev. I. J. Conybeare.—Ibid. vol. iv. p. 237, &c., 1822.

|| Geol. Trans., 2d series, vol. ii. p. 293.

§ Ibid. vol. iii. p. 21.

¶ Ibid. vol. iii. p. 128.

** "On the Excavation of Valleys:" Jameson's Ed. Journal, vol. vii. p. 15.—'Tertiaries of the Cantal:' Geol. Soc. Proc., vol. i. p. 140.—'Tertiaries of Aix-en-Provence:' Jameson's Ed. Journal, vol. ii. p. 287, and Geol. Soc. Proc., vol. i. p. 150.

†† Geol. Trans., 2d series, vol. iii. p. 301.

wards read an account of some enquiries, by himself, on the secondary formations in different parts of Germany.*

The extensive acquaintance which ~~the author~~ had thus acquired with the rocks of various classes in different parts of Europe, and with the Huttonian principles ~~elucidated~~ elucidated in one of our recent numbers,† was an excellent preparative for the task which he next undertook, in the complex region described in the present volume. His examination of the Silurian territory began in 1831, during the summer of which year he explored the borders of England and Wales; and there, he tells us—‘The order of succession visible on the left bank of the Wye, between Hay in Herefordshire and Builth, where the old red sandstone is seen distinctly to be succeeded by grey fossiliferous strata, first led me to expect that I had met with a part of the evidence required for a systematic study of the older formations,’ (p. 5.) These rocks he followed on their line of bearing, to the neighbourhood of Ludlow and Wenlock; and at Aymestry he was so fortunate as to discover a most valuable ally in the Rev. Mr Lewis, who had already developed the structure of the district surrounding his own residence at that place. This gentleman, with Mr Aikin and Mr Greenough, whose map we have already mentioned, were the only persons who had made any advance towards determining the order of the groups, in the region now under consideration: and this seems to be the place for stating the nature of the assistance which the author derived from the two former geologists in this early stage of his enquiries.

MR AIKIN having long abandoned his intended survey of Shropshire, ‘no sooner heard of the progress the author was making in the present work, than he placed at his disposal his original notes and drawings,’ (p. 4.) These papers we have seen: the geological drawings, the greater part by Mr Webster, with some by Mr Edmund Aikin, a brother of the possessor, form a large and very effective portion of the illustrations in the present volume; and the notes belong decidedly to a newer and better school than that of any observer who had preceded the writer in this enquiry. It is right to add, that Mr Aikin has frequently, with his well-known frankness, disclaimed any previous knowledge of the stratigraphic system described by Mr Murchison, and ~~expressed~~ expressed his admiration of the energy and sagacity with which it was brought to light.

One of the general features in the structure of the country

* Geol. Soc. Proc., vol. i. p. 325, &c.

† Ed. Rev., vol. lxix. p. 440, *et seq.*

examined by Mr Aikin—which was more extensive than Mr Murchison seems to have supposed—was, as he believed, a want of conformity between the older (Cambrian) slates, which stretch out westward from beneath the lower secondary groups of England—and the less inclined strata above them. The older slates he regarded as generally dipping towards the north-west at very high angles; while he supposed the newer and more fossiliferous groups, to *rise* slowly from south-east to north-west, reposing upon the slates unconformably. But it is proved in the volume before us, that the lower secondary rocks *also*, are frequently much inclined in the Silurian region; and that their inclination is almost every where connected with plutonic disturbance, so that the dip is various in direction as well as in its angle. With this exception only, Mr Aikin's notes appear to us to coincide with Mr Murchison's descriptions in so many points of detail, that they must have been of great assistance in his enquiries. On looking over them, with the aid of the Ordnance maps, and of this Silurian volume, it now appears that, although the order of superposition was unknown to the writer, the same beds are so correctly identified at several distant points, both by lithological character and by fossils, as to enable a person possessed of the key to connect many of their detached portions. Thus, Mr Aikin recognized the 'Upper Ludlow Rocks' in the vicinity of the Abberley hills. He mentions the concretionary structure which characterizes some of these beds. He distinguished the limestone of Yeo Edge and Mocktree Hill, by its 'quadrivalve shell,' (*Pentamerus Knightii*), from what he calls the 'nodular limestones' of Wenlock and Benthal Edge; and connected several remoter calciferous rocks (the '*Caradoc*' of Murchison) by their peculiar fossils, (*Pentamerus levis* and *oblongus*), to which he had given a temporary distinctive name; indicating, especially, the course of the ridges on the west of Wenlock Edge, from their containing those shells. In these notes we find, also, a line of plutonic elevation, precisely agreeing with that of Mr Murchison, traced for some miles south-west of Caer-Caradoc. And on the subject of 'compound sandstone,' the following question is proposed, which leads exactly to the views illustrated in this volume with great force of evidence:—'Is not the compound sandstone of Lythe Hill, &c., a mixture of grawacke-slate with greenstone, formed during the deposit or outburst of the latter?'

The REV. THOMAS TAYLOR LEWIS was, we believe, the only person who, previously to the author's enquiries, had determined the relations of any continuous portion of the stratigraphic series beneath the old red sandstone, on the double evidence of super-

position and of fossil contents; and, as he communicated the results of his observations fully and freely to Mr Murchison, on his first coming to the vicinity of Aymestry in 1831, and subsequently co-operated with great zeal and effect in carrying on the examination of the country, the researches of this gentleman deserve a permanent place in the history of the subject.

A member of Mr Lewis's family being engaged in the coal and ironworks at Titterstone Clee, in Shropshire, he had early opportunities of making himself familiar with the relations of the old red and carboniferous strata, at that remarkable point—where the coal is singularly capped, and pierced through, by igneous masses, and supported at the height of from 1200 to 1700 feet above the sea by old red sandstone, which thence descends, rapidly, to the immediate vicinity of Ludlow, on the west. Mr Lewis had made collections of the rocks and fossils of these groups as early as 1824; and having previously attended the geological lectures at Cambridge, and paid some attention to the geometry of planes, on afterwards taking up Mr Conybeare's 'Outlines,' he became still better acquainted with the structure and relations of the strata by which he was surrounded. On removing in his clerical capacity to the parish of Aymestry in 1826, he soon began to apply his geological knowledge and his geometry to this new neighbourhood. We have had the pleasure of examining a part of that beautiful and instructive country under his guidance, and are thus enabled to give personal testimony to his exact acquaintance with its structure; and not less cordially to the frankness and absence of pretension with which his knowledge is communicated. And we are satisfied that Mr Lewis was the first person to ascertain that a series of what were called *transition rocks*, succeeds, conformably, to the old red sandstone at Ludlow; to distinguish the groups of strata by many of their principal fossils; and to prove that in the tract immediately adjoining Aymestry, and on the south of Brindgwood Chase, the strata, though thrown up and much disturbed, exhibit every where the same determinate order of succession.

Not being a conchologist, it is probable that few of the shells which Mr Lewis thus discovered, were correctly named; but he was accurately acquainted with their forms and localities, and had disposed his specimens in drawers, keeping those of the successive strata apart, and distinguishing them by temporary names of his own; *—his method, thus far, resembling that pursued by

* The following is an extract from a memorandum upon this subject, written by Mr Lewis himself, which is now before us:—'My acquaintance with Aymestry commenced with my entering on the curacy of the

William Smith in making out the succession of the strata near Bath. And at this time, it must be borne in mind, there were no Ordnance maps of Hereford and Shropshire to guide and connect geological enquiries.

Our readers will presently perceive that the four groups of strata thus determined by Mr Lewis, constitute, in fact, the 'Upper Silurian Rocks'—Aymestry being nearly in the focus of those rocks in England; and that their derangements are precisely similar to the disturbances since brought to light at Woolhope, and in other detached points, where portions of the Silurian strata appear within the boundary of the superior groups. He knew, also, that the next (inferior) group of strata, abounding in fossils, (now called 'Caradoc Sandstones,') rises conformably near Acton Scott—from beneath the 'die earth,' (now the 'Wenlock shale:'), and, though not acquainted with the full value of his discoveries, he was quite aware that his groups formed the upper part of the 'transition series.' Mr Lewis had, therefore, at one time thought of publishing an account of the country in his vicinity; and we have felt it to be the more necessary to call attention to what he had done thus early; because, when afterwards more fully informed as to the novelty and importance of his observations, he cheerfully resigned the subject, rejoicing that it had fallen into the hands of a geologist whose practical knowledge was much greater than his own. It gives us great

parish in the autumn of 1826. Its natural beauties soon invited my attention, which was likewise directed to its natural and artificial sections, and its regular, but broken structure; and I began at once very zealously to collect the fossils, which were every where in abundance strewed over the roads and fields, and to dispose of them in drawers, keeping those of each stratum separate, and distinguishing the now named "*upper and lower Ludlow rocks*" by the name of "*upper grauwacke and pendle*," (the latter being the local name;) and the *Aymestry* and *Wenlock limestones* by *Pentamerus*, and *coral or nodular limestone*;—the former from its abounding in the *Pentamerus Knightii*; and the latter from its great richness in corals, and the appearance which its weathered beds assumed in this neighbourhood, even where they were considered worth working for the kilns.'

'I had very soon a collection, from most of the beds extending from the junction of the old red sandstone with the grauwacke, down to the Wenlock shale, (or nodular strata;) and had fairly traced these beds westward and eastward, to the full extent of this parish, in 1829; and along the prolongation of the Croft Ambrey and Gatley escarpements towards Ludlow; and in the outliers of Tinker's Hill and Caynham Camp, on the other side of the river Teme, in the direction of the Clew Hills; and likewise in the neighbourhood of Leintwardine.'

satisfaction to be authorized to add, that Mr Murchison most fully agrees in our opinion upon this subject.

The value of Mr Lewis's knowledge was attested during the spring of 1832, by his discovering in the black limestone of *Sedgeley*, near Dudley, [redacted] his own 'Pentamerus limestone,' with its appropriate fossil; the importance of which identification is dwelt upon in the work before us.* And the order of the beds at Aymestry was soon found by the author of this volume to furnish a clue to the true relations of the detached strata in several other disturbed portions of the Silurian rocks, which are found within the outcrop of the old red sandstone, at some miles' distance, and in combinations so perplexing, that without such a guide their order could not be determined.

The first result of Mr Murchison's own enquiries was made public at the original meeting of the British Association, held at York in September 1831, where he exhibited coloured maps, representing the 'transition rocks,' the old red sandstone, and the carboniferous limestone, on the border of Wales.

The 'geological proceedings' of 1832, contain the abstract of a paper on the secondary formations in the neighbourhood of Ludlow, by Mr Wright of the Ordnance Survey; which is the earliest notice that we have seen in print of the upper transition rocks in that quarter. This paper, we have reason to believe, had great topographic merit; but the abstract does not describe any connected series of strata, and does not distinguish the beds by their fossils.

The author's address to the Geological Society, on relinquishing the Chair in February 1833, adverts to the previous elaborate enquiries of Professor Sedgwick on the ancient rocks, and to his own labours during the two preceding summers; and expresses particular obligation to the officers of the Ordnance Survey for their extraordinary assistance; inasmuch as a considerable space within his field of observation had not then been laid down for publication.† It is unnecessary to enlarge upon the value of the maps produced by this Survey to the geologist in the field, as suggesting enquiry, and enabling him to combine the result of distant observations, which, without such assistance, no labour can connect. But here we must acknowledge, that on first seeing the beautiful sheets which represent the tract between Aymestry,

* P. 480, text; and note, p. 482.

† The Aymestry sheet of this map was published in February 1832; that including Wenlock Edge, not until January 1833; the Caermarthen and Hereford sheets, 1831; Brecon, 1832; Merthyr and Cardiff, 1833.

Ludlow, and Shrewsbury, almost with the relief and distinctness of a model,* and afterwards perceiving, in the country itself, how exactly they express the natural features—the indication of successive outcrops, conformable to those of the midland counties and the east of England, appeared to us so striking, as almost to force the true inferences upon the attention of the geologist; and we felt surprize that a structure, now so apparent, should have so long remained unknown. But a very little reflection was sufficient to correct this error. The *fact*, that the structure and succession were unknown, is undeniable: and notwithstanding the merit of some of those who preceded Mr Murchison, the region might probably have remained undescribed for an uncertain period, but for the fortunate circumstances which led him to perceive and to demonstrate its geological importance.

The first paper of the author on this region, read before the Geological Society in March 1833, contains some inaccuracies, which are important from their relating to the natural order of the groups in question, and to a point of some interest in the history of the subject. It is stated in the abstract given in 'the Proceedings,' that 'the fossils of the Wenlock Edge and 'Dudley limestones are nearly the same;' that 'the exact position, therefore, which the latter occupies in the Geological 'Series of England, is thus for the first time determined;' that throughout its course, in the district included between the Onny and the Lug, this limestone 'is chiefly characterized by the 'abundance of one species of *Pentamerus*; and, that at *Aymestry*, 'it is rich in that and other fossils;—Mr Lewis's name being apparently connected with these statements in a note.† It is obvious that the two characteristic limestones of the district are here confounded. Mr Lewis, who did not participate in this mistake, immediately pointed it out to the author; and it will not escape the notice of our readers, that the Wenlock and Dudley ranges of limestone had been identified in Mr Greenough's map several

* Those who have had an opportunity of examining the exquisite topographical drawings of Mr Carrington, now principal draughtsman to the Survey at the Tower—or of comparing his drawing from the model of the country near Ormes' Head with the original, or with the engraving from it by Bates's method—will feel that this is no exaggerated praise. The later portions of the Ordnance Map, besides their fidelity and expressive power, have the great advantage of speaking the same language throughout; the shading being so graduated as to render each sheet a portion of one consistent whole; in which the inequalities of the surface will be represented according to a connected and proportionate system, in the most distant places.

† Geol. Soc. 'Proceedings,' vol. i. p. 465.

years before either of these gentlemen had begun their examination of this country.

Thus rectified, and augmented by further observations during the summer of 1833, Mr Murchison was enabled to produce (in January 1834) a tabular arrangement of all the transition groups between the old red sandstone and the ancient slates of Wales, which differs but little from that of the present volume, and was the first distinct announcement of the system on which the book is founded: the groups afterwards called Silurian appearing there, for the first time, in their true order, under the general name of the '*upper grauwacke series*.' When his views were nearly matured, he gave to the whole series of strata the name of '*the Silurian System*,' and announced that title, in a communication to the '*Annals of Philosophy*' for July 1835, where also the names and subdivisions of the present work are stated.*

From the appearance of the table last mentioned, until the publication of the work now before us, (1839,) no session of the Geological Society passed over without the production of one or more papers in connexion with this subject; and this presentation of the author's labours, in successive portions, appears to us to illustrate remarkably the usefulness of such institutions. Each summer's work was thus wrought into a producible form; the maps and sections were arranged, and specimens examined; and the whole then submitted to the criticism of the evening meetings of the Society; which—though they must have been of a very general character, since few of the members were qualified at that time to enter into detail—could not fail to suggest many improvements and corrections. The abstracts of the papers thus brought forward in detachments, demonstrate also the author's advance in geological knowledge during the course of his enquiries. New objects continually opened upon him; but, undismayed by difficulty, he did not cease from his exertions till the plan which he had successively extended and

* The term *system*, which may be considered as a substitute for the German term '*formation*,' has, we believe, been objected to, as indicating something more definite than any assemblage of strata can be asserted to be, especially where examined only in one country; and we shall find that the limit (if there be any boundary) between the Silurian and Cambrian systems, is very indistinct. '*Group*' or '*Series*' might perhaps have been preferable words: but it is difficult to find good names for the divisions of strata; and the arrangement of the English series in '*systems*,' in the author's reduced map, from which the sketch above given, (p. 2,) has been taken, is not inconvenient.

improved was executed in all its parts. It is only by having witnessed the progress of these labours, or by tracing them in the Proceedings of the Geological Society, and other Journals, that a just impression can be obtained on this subject. If the young student of geology wishes to find an example of the effect of diligence and perseverance, as ensuring ultimate success, he cannot do better than follow the history of the Silurian System in the pages we have just referred to.

The present volume was published by subscription in 1839, at the request of a great number of resident gentlemen and inhabitants of the country described, and has been brought out with considerable splendour—the illustrations being numerous and excellent. It is divided into two parts: the first, which gives the physical and geological description of the surface and strata, being the work of Mr Murchison himself. The second part, containing an account of the fossils obtained from the several groups, is principally written by the naturalists to whose examination the specimens had been submitted.

The *First part* contains a description not merely of the Silurian region, but of all the groups, from the lower oolite down to the old red sandstone; and there is not any work, to which we can refer our readers with more confidence, on this important portion of the English series of strata. After an introductory chapter, to the defect of which we have already adverted, the author proceeds in a descending order, through the groups beneath the oolitic series;—beginning with the inferior oolite in chapters 1 and 2. Chapters 3 and 4, “on the new red system,” are excellently worked out; and with a joint paper by the author and Mr Strickland, more recently published,* contain a mass of information, indispensable to a correct acquaintance with this formation in England; and to the distinction of certain portions of it, from part of the *old red system*, which had previously baffled some of the best observers.

We cannot pass this group without calling the attention of our readers to some anticipations by William Smith, in 1815; which are very creditable to his sagacity. ‘The mass of strata usually called coal-measures,’ he tells us, ‘is known to be deprived of much of the superficial space which it would occupy, by the overlapping of the “red earth.” *When the unconformability of the red earth shall be more generally known, and its irregular thickness more correctly proved, it is highly probable that much more coal may be discovered; and the coal-measures be found as regu-*

* Geol. Trans., 2d series, vol. v. pp. 331, 348.

'larly connected as other strata. This opinion is confirmed, by the great obscurity of coal-measure outcrops in many of the districts where coals are now working; and it may be further remarked, that those coal districts, which are near to, or surrounded by red, show less of the superficial character common to those strata, than any other parts of their extensive course.' *

Mr Murchison has mentioned several cases in which valuable coal has been discovered, in situations where its existence was at one time quite unsuspected, by sinking to great depths through incumbent masses of the new red sandstone; and has strongly urged the expediency of continuing such researches.

Chapter 5, compares the ancient trappean rocks and the products of existing volcanoes, with a view to the illustration of the intrusive masses traversing the new red and carboniferous series. The phenomena of Graham Island and other recent volcanic ejections in the Mediterranean, are employed to explain the structure of sub-marine volcanic ejections; and after mentioning what has been called '*intrusive trap*,' the author proceeds to 'another and a very ancient class of trap rocks,' which has been little adverted to by writers, though touched upon, as we have shown, by Dr Townson and by Mr Aikin.

'These are the rocks named in the following chapters "*volcanic grit*," "*bedded and contemporaneous trap*," and which I undertake to prove were formed at the bottom of the sea, *during* the accumulation of the sedimentary matter with which they are associated, particularly in the lower strata of the Silurian system. At one place these appear as currents, or sheets, of pure volcanic materials; at another they envelope marine remains—pebbles, sand, and fragments of rocks. Some layers consist of finely levigated volcanic scorïæ, passing into sand; and all these varieties alternate, so equally and repeatedly, with beds composed exclusively of shelly and marine sediments, that no doubt can be entertained that the diversified masses so arranged in parallel strata, must have been formed during the same period of igneous action.'—P. 172.

The author soon found that it was absolutely necessary, to the effective elucidation of the Silurian groups, to study and describe anew the several coal-fields included in the area examined, and to explain their relations to the surrounding deposits; but he could scarcely estimate the additional exertions thus required; for, with the exception of the basins of the forests of Dean and of South Wales, none of these coal tracts had been described.' Again, to complete the history of his region, it was necessary to examine all the rocks of igneous or volcanic origin,

* Smith's *Memoir of Geological Map*, p. 49.

which are interlaminated with, or which penetrate the strata, as well as to trace out the lines of elevation and dislocation; and it is justly remarked that the western part of Shropshire, and part of Radnorshire, are probably unrivalled in the number of illustrations bearing on this interesting part of the enquiry. Finally, it was desirable to describe the overlying formations, and to lay down their boundaries upon the map; so that the work thus amplified, would contain, in fact, a description of all the stratified deposits and interjected rocks throughout a tract extending from Nantwich on the north, to Chepstow—and from Birmingham westward to the extremity of Pembrokehire, with the exception only of a part of North Wales.

It is out of our power to follow the detail of chapters 6 to 13, which contain the results of the author's labours on the numerous heads of enquiry just mentioned; our special object being to convey to our readers a distinct notion of the *new* system of rocks, of which this volume contains the first exposition. But in perusing this series of descriptions, (though possibly it might admit of some reduction,) we could not help recalling an observation ascribed to the late Professor Playfair; where, after pointing out the necessity of setting many hands to work, 'in order to obtain a just view of the laws which guide and have guided the phenomena of the mineral kingdom,' he adds, in the true spirit of an inductive philosopher, that 'if the face of the globe were divided into districts and accurately described, there can be no doubt that, from the comparison of these descriptions, the true theory of the earth would spontaneously emerge, without any effort of genius or invention. It would appear as an incontrovertible principle, about which all men, the moment that the facts were stated to them, must of necessity agree.*' The industry of Mr Murchison has had the effect which Professor Playfair in these passages ascribes to a multiplicity of hands. The numerous descriptions of the coal-fields, and of the phenomena attending the igneous rocks, produce the result which is there so well described; and it is, we think, impossible that a reader, the most sceptical as to the truth of the plutonic doctrines, could peruse these varied illustrations,† without acknowledging the validity of the explanation which 'spontaneously emerges' from their
[REDACTED] disposition.

The chapters on the 'old red sandstone,' (14 and 15,) appear

* Ed. Review, vol. xix. p. 209.

† Among these the uniform occurrence of quartz rock in immediate proximity to plutonic masses, is described and dwelt upon by the author with great copiousness of evidence, ably advanced.

to us to be among the best in the volume; the author having judiciously devoted great attention to this group of strata, which immediately precedes the Silurian system. He has thus opened the way to new views respecting the equivalents of the old red group itself in other quarters, which have been the subject of much geological discussion during the last five years; and to which, perhaps, we shall call the attention of our readers on some future occasion.

‘Being convinced that the old red sandstone is of greater magnitude than any of the overlying groups, I venture, for the first time in the annals of British geology, to apply to it the term *‘system,’* in order to convey a just conception of its importance in the natural succession of rocks, and also to show, that as the carboniferous system, in which previous writers have merged it, (but from which it is completely distinguishable, both by lithological characters and zoological contents,) is surmounted by one red group, so is it underlaid by another, this lower red group being infinitely thicker than the upper.’—P. 169.

‘As there is no region of Europe yet examined where the old red sandstone is better exhibited than in the British Isles, so there is no part of the kingdom in which it is so much expanded as in the country here described. Occupying the largest portion of Herefordshire, and the adjacent districts of Worcestershire and Shropshire, it spreads over wide tracts of Monmouthshire, surrounding the coal-field of the forest of Dean; and, forming a girdle round the great south Welsh coal-basin, it constitutes in Brecknockshire the loftiest mountains of South Britain. The enormous thickness of the red stratified deposits included between the coal-measures and the Silurian rocks, will at once be comprehended by any observer who places himself on the eastern slopes of the latter on the Welsh borders of Herefordshire, (near Kington, for example;) whence, casting his eye to the south and south-east, the circle of vision, although extending over all the mountains between the Wye and the Usk, and terminating only in the lofty mountains called the Brecon and Carmarthen fans, 2500 feet above the sea, embraces nothing but old red sandstone. This view does not include a wide superficies, occupied merely by undulating masses of the same strata, but a territory in which successive members of the system rise from beneath each other in distinct mountainous escarpments.’—P. 170.

A triple subdivision of this great mass is adopted from Messrs Buckland and Conybeare.* 1. The first and uppermost portion being composed chiefly of quartzose conglomerate and sandstone, which include—but more rarely than the second—thin courses of impure limestone, mottled red and green. 2. The central masses are formed of alternations of red and green spotted marls, affording, on decomposition, the soil of some of the richest

* Geol. Trans., 2d Series, vol. i. p. 210, &c.—See the *Section* prefixed to the list of fossils, at the end of this article.

tracts of the western midland counties of England, and the adjacent parts of Wales; with irregular courses of limestone also mottled green and red, which, when mixed with sand and marl, constitute what is well known in the country under the name of 'cornstone.' 3. The lowest division of the old red—the 'Tilestone,' is of much smaller thickness than the upper two, but is well defined by its passage, above, into the marls and cornstones; and, downwards, into the Silurian rocks. In Hereford, the beds consist of finely laminated, hard, reddish or green, micaceous quartz sandstones, which split into tiles; and these are associated with reddish shale, which, producing a red soil, clearly separates the sandstone from the upper beds of the Silurian system, the latter decomposing with a grey surface. Junctions are to be seen in the gorge of the Teme, and at several places near Ludlow.

The fossils of this subdivision consist, near Llandovery, of new species of *Arca*, *Avicula*, *Bellerophon*, *Cucullæa*, *Lingula*, *Orthoceras*, *Terebratula*, *Turbo*, *Turritella*, *Trochus*, with the *Tentaculites scalaris* of Schlotheim; an assemblage affording 'proof, that certain genera of mollusks, hitherto supposed to be confined to the younger or tertiary and secondary deposits, have co-existed with genera which peculiarly characterize the older strata.'—(P. 183.)

But the fishes of this great deposit are by much the most important of its organic remains. The forms of some of the genera are very remarkable; while, being recognizable in scales and small fragments, and generally though sparingly diffused, they are very useful auxiliaries in identification. One of the most curious genera, *Cephalaspis*, since found in Scotland, was detected by Dr Lloyd in the central portion of the system, on the north of Ludlow; and *Holoptychus*, another characteristic genus, has lately been discovered in the state of New York, in red sandstone, above the supposed equivalents of Silurian rocks.

The existence of fishes in the old red groups was first ascertained by Professor Sedgwick and the author, in 1827; and the list has since been so much enlarged, that the subjoined table contains ten genera and sixteen species, to which considerable additions have recently been made in Scotland.

'The thickness of the old red sandstone may best be computed by an examination of the various groups which rise from beneath each other, between the edge of the south Welsh coal-basin and the Silurian rocks of Radnorshire. In a space of about eleven miles, all the intervening strata of the old red are conformably inclined and apparently without dislocations, at gentle angles of inclination, decreasing to 5° or 6° as they approach the south-east boundary, and increasing to 15° as they rise towards the north-west or outcrop of the older rocks. In this wide space, there is no possibility of ambiguity or misconception; for the whole of the

beds are successively exposed in lofty escarpements, which are clearly laid bare in the sides of the deep ravines by which the mountains of the Black Forest are fissured. The heights of these mountains vary from 1800 to 2500 feet.—(P. 184.)

It is evident from trigonometry, that if the strata preserved their dimensions in this case, and passed regularly beneath each other for great distances, the thickness must be enormous: but as no such regularity exists, it cannot be determined so directly. The author, however, 'looking to the altitude of the mountains, and the wide area they cover, thinks that, at a moderate calculation, the united thickness of the old red system cannot be less than nine or ten thousand feet,' (p. 184)—a conjecture entitled to respect—especially as it is stated that there is here no room for misconception. Yet, when we call to mind that the whole thickness of the chalk in the east of England is not much more than 1000 feet, we are forcibly struck by this great contrast between the dimensions of the older and of the newer members of the secondary series; and are tempted to suspect, that in the old red sandstone repeated dislocations may have produced a deceptive appearance of greater thickness, by the displacement of masses originally continuous. Too little, however, is yet known of the phenomena and laws of the disposition of strata, to justify speculation upon this subject; and we express this doubt with hesitation; such great thickness being perhaps as likely to turn out the more general rule, with reference to the whole of the globe, and the lesser dimensions of our newer groups the exception, as the contrary.

Chapter 15.—'With the evidence of the frequency of trappean eruptions, during the formation of the Silurian system, and with the proofs we have already given of the outburst of such rocks subsequent to the consolidation of the coal measures, (chapters 5 to 11,) it is surprizing that, during the accumulation of the widely expanded series of old red sandstone, there should apparently have been a total cessation of the evolution of igneous matter. And it is well to remark, that the prevalent horizontality of the great masses of old red sandstone, in the counties of Brecon, Monmouth, and Hereford, is probably due to large tracts of this region not having been the theatre of those violent disturbances which have affected the lower Silurian rocks and the coal-measures.'—(P. 187.)

The change produced on the old red by a dyke near Hereford is very remarkable;—a purple amygdaloid, with kernels and nests of yellowish calcareous spar, being demonstrably nothing more than the spotted marls of the old red sandstone—so altered by the action of heat that they resemble trappean amygdaloids; and the change of character extends to several feet from the dyke.

No coal has yet been found in this region, though on the borders of England and Scotland coal seams have been discovered

within the upper subdivision of old red ;—a new proof, if evidence were wanting, of a gradual transition upwards from this deposit into the carboniferous group.

Besides the continuous mass of the old red sandstone in the border counties of England and Wales, very large outliers exist above the Silurian rocks, in Clun Forest, about twelve to twenty miles from the edge of the great area on the N. W. ; and, as might have been expected, smaller patches nearer to the margin of the great body. These sufficiently prove that the formation must have been originally much more extensive towards the west than it is at present ; while the rapid transition, both of the fossils and mineral character, from the lowest beds into the upper Silurians, are quite as distinct at the extreme point, near Felindre, as in any other part of the formation. On the other hand, the protruded portions of the Silurians, within the margin of the old red, (that of Tortworth, near Wotton-under-Edge, is forty-eight miles within,) demonstrate that the latter system extends, or once extended, in continuity, at least thus far, beneath the higher groups. The details connected with the old-red outliers, are recorded with the author's customary diligence. Wherever they appear, their agricultural surface and hue present a marked contrast with the grey Silurian tracts.

With the aid of the section prefixed to the Table at the end of this article, the reader may form a good general idea of the *Silurian series*, by supposing a thickness of not less than between 8000 and 10,000 feet of strata to run out towards the north-west into Wales, from beneath the old red sandstone, which occupies a great part of Herefordshire. This mass is divided naturally into two principal groups, now called the 'Upper' and 'Lower Silurian Rocks ;' each of them about 4000 feet in thickness. The prevailing component of the upper portion is soft, greenish, or drab-coloured shaly sandstone, which, by exposure, is completely broken down and softened, and thence justly called in the country 'mudstone.' The second division consists, at top, of hard slaty sandstones, frequently containing lime, or even beds of limestone ; but the lowest members form dark-coloured flags, which in many cases pass insensibly into the Cambrian slates below. So that, in fact, the limit of the Silurian system, at the bottom, is very indistinct. The tract thus composed, comprehends the western parts of Herefordshire and Shropshire ; and passes to the south-west, through Radnor, and the wildest tracts of Brecknockshire, and thence, in a narrow strip, even to the extremity of Pembrokeshire.

If these great masses were entirely destitute of fossils, they would still be objects of importance from their bulk ; the thinnest

of the subdivisions being nearly double the entire thickness of the chalk on the eastern coast of England. But, on the contrary, they abound in fossils, of new and remarkable character; exhibiting in this respect a striking and sudden contrast with the old red sandstone immediately above; for although the lowest sandstone strata pass into the upper Silurian shale, the gradation is so rapid, that within a few feet from the top, the Silurian beds are in some places crowded with fossils entirely distinct from all those of the old red.

By means of these fossils the groups admit of natural subdivision; and thus, as well as by the external features, the *upper Silurians*, throughout the tract between Aymestry and Coalbrook Dale, are clearly divided into five portions; two very conspicuous groups of limestone, each containing some peculiar fossils, being there separated from each other, and from the old red above them, and the lower Silurians beneath, by thick bands of shale. The upper of these limestones abounds in *Pentamerus Knightii*; the lower, (Wenlock,) which represents that of Dudley, is in some places almost composed of corals.

The *lower Silurian rocks*, so far as they are yet known, consist, at top, of calciferous sandstones, which, along with many other fossils, contain great numbers of two species of *Pentamerus*, (*P. lævis* and *P. oblongus*.) They are succeeded below by the dark (Llandeilo) flags, which are said to be the lowest of the Silurians, abounding in *Asaphus Buchii* and other crustacea. The *Cambrian system*, beneath the whole, has hitherto afforded but a very small number of organized remains.

The foregoing sketch supposes the whole series of strata to be conformable and unbroken;—as the upper beds between Aymestry and Wenlock really are, and as the entire system may possibly be, in other countries. But, in Wales, the Silurian strata have been very much disturbed and broken through by Plutonic operations, apparently of different periods;—one epoch of this violence having been contemporaneous with the original deposition of the strata themselves; since many of the beds in the Caradoc sandstones are composed of a mixture of sedimentary and Plutonic or trappean matter, so as to constitute what in this volume is called ‘volcanic grit.’ The disturbances thus affecting the strata, though in themselves of the greatest interest to the geologist, must nevertheless, so far as the *system* is concerned, be considered as accidents.* They

* The coincidence of date however, in these cases, is of importance; for, as deposition from the sea, and the ejection of eruptive materials, were probably going on in distant parts of the globe at the same time, a

had their origin probably at great depths below the surface, and broke up whatever matter *happened* to be above them. It is indeed already known that Silurian rocks occur in horizontal strata in Sweden; we believe the case is the same in Russia; and in the state of New York, where they exist very extensively, they appear to be much less deranged by igneous disturbance than in England.

The small map (page 2,) will give some notion of the extent and form of the space occupied by the Silurian strata in England and Wales; and if the section at the top of the subjoined *Table* were reduced, and substituted for the western portion of Smith's section (p. 4,) the whole would represent a transverse section of England. The general figure of the Silurian region approaches that of a crescent; stretching without interruption from Llangollen to Old Radnor, with an average breadth of about twenty-five miles; but from Builth, south-westward, to its disappearance in Saint's Bride's Bay, Pembrokeshire, the Silurians occupy no more than a narrow bend, scarcely four miles across where it is widest, and in some places less than one.

The division of the system into two groups—the first extending from the base of the old red sandstone to the bottom of the Wenlock shale; the second, thence to the bottom of the fossiliferous portion of the strata called the 'Llandeilo-flags,'—is apparent in all parts of the region; but we are not yet at all clear as to the distinctions between the lower Silurians and the upper Cambrian rocks.

From near Ironbridge on the Severn, to Aymestry, the natural subdivisions of the upper Silurians are beautifully conspicuous. Their value in deciphering the protruded masses forced up through incumbent strata, as at Woolhope, Dudley, &c., has been already mentioned; and though, in England—to the south of Aymestry—they are not prominent, and in some places not distinguishable at all, it would be premature to assert that they will be wanting in remoter Silurian tracts; since observation alone, and the comparison of several distant equivalents, can supply a general character for the whole system. From this consideration we have thought it best, in the *Table* subjoined to this article, to insert *all* the fossils hitherto found in the Silurian strata in England—it being impossible, at present, to tell what species may be characteristic of the respective groups.

The *TABLE*, therefore, will be found to contain a general section, taken from that given in Mr Murchison's map, and a list of the groups, from the bottom of the oolitic system to the upper part

similar mixture of the two kinds of sediment may be expected to occur in many different places.

of the Cambrian;—with a systematic enumeration of all the known fossils of the strata beneath the carboniferous rocks.

In advancing westward from Aymestry, the whole of the Silurians undergo a great alteration; the shales, or 'mudstones,' becoming hard, and assuming the aspect of sandstones, and thus, as the author remarks, almost changing characters with the Caradoc group; while the latter becomes softer, and more like shale. But although the limestones of Aymestry and Wenlock are not found in continuous strata in this western tract, the *site* of the former can be recognized, at several distant points, by the presence of *Terebratula navicula*, (pp. 338-40,) which abounds in a conspicuous band above it. A limestone like that of Wenlock occurs at Old Radnor, about twelve miles south-west of Aymestry; and is again clearly indicated by a mass of vertical strata, sufficiently calcareous to be burned for lime, and from thirty to forty feet wide, which occurs about thirty-five miles south-west of Radnor, at Pwll-calch, near Myddfai, south of Llandovery, in Carmarthenshire, containing fossils, principally those of the Wenlock formation, (pp. 348-9.) The *last* sign of calcareous beds of this age hitherto observed, is on the banks of the Sowde, about four miles south-west of the place just mentioned; the calcareous matter, in these cases, being flanked by hard sandstone, very different from the Wenlock shales. This recurrence of limestone is quite analogous to what is observable in many other widely distributed groups, of which certain members are known to disappear, and to recur again, at very wide intervals.

It is impracticable within our limits to detail the characters of the subordinate groups above enumerated, which are copiously stated in the author's sixteenth and seventeenth chapters. The following are some of the points most deserving of notice:—

1. The *Upper Ludlow rock* consists of thin-bedded, soft, sub-calcareous sandstone, grey and greenish; sometimes passing into limestone, but at the upper part scarcely distinguishable, except by its fossils, from some of the lowest beds of the old red group; and which easily melts down under the action of the elements. The coming out of this group of grey strata from beneath the old red sandstone, is distinctly seen along a zone or band, extending from the hills near Ludlow on the north-east, to the sea-cliffs at the south-western extremity of Pembrookshire; a distance of about 150 miles. The *Lingula cornea* is common to the upper part of this group, and to the lowest (tilestone) beds of the old red; and, at a short distance below the junction, is a stratum of great interest, from its abounding in the confused remains of fishes, which Dr Lloyd of Ludlow was the first who

brought into notice. The central portion of this Upper Ludlow is somewhat calcareous, and contains fossil remains in unusual perfection. The lowest portion runs frequently into large spheroidal concretions, and likewise easily decomposes into 'mudstone.' The bottom is loaded with *Terebratula navicula* in vast numbers, sometimes occupying a thickness of from thirty to forty feet; and this fossil occurs so steadily, that when the subjacent limestone is wanting, it serves to indicate its place.

2. *Aymestry Limestone*.—The next group is a sub-crystalline and argillaceous limestone, affording a valuable lime for cement under water, which has been named from the village around which it is most distinctly seen; the principal mass of beds being in some places fifty feet thick. It is here distinguished by the great abundance of the *Pentamerus Knightii*, with many other shells, among which *Atrypa affinis* is perhaps one of the most ~~numerous~~. This limestone, which forms a conspicuous but broken range on the east of Wenlock Edge, is no longer prominent on the south of Aymestry; but it appears again on the east, at Sedgeley, near Dudley; and its equivalents form an important feature at Woolhope, on the east of Hereford, and in several other obtruded portions of Silurian strata.

3. The *Lower Ludlow Shale* is more argillaceous than the upper: the colours vary from dark-grey to black.

This division, amongst other fossils, contains the new genera *Cardiola*, *Phragmoceras*, and *Lituities* of Broderip; and the *Ischadites* of König—first discovered by Dr Lloyd.

The thickness of the entire Ludlow formation is estimated at about 1500 feet, the limestone of the middle group being about fifty feet.

4. The continuous ridge of the *Wenlock Limestone*, ranging for about twenty miles from south-west to north-east—with the nearly parallel, though interrupted, escarpement of the Aymestry limestone, at a distance of about a mile on the south-east of it—forms one of the most remarkable external features in the geology of Shropshire; and cannot fail to catch the eye, either in the country itself or in the Ordnance maps. The prominence of this limestone, like that of the Aymestry, is due to its solidity, and to the softness of the shales above and below. The Wenlock is the equivalent of the limestone of Dudley, with which, perhaps, it was at one time continuous; but the name of the former place has been justly preferred by the author for its designation, as the relations of the whole group are much better exhibited near Wenlock than at Dudley. The stratum, when most distinct, consists of large concretionary masses of pure limestone, frequently in the form of calcareous spar, locally called 'ballstones,' which are separated by intervening strata of coarser

stone, called 'measures.' The colour of the latter is a dull grey, but the crystalline varieties are white, ~~or~~ sometimes of a beautiful pink. This 'ballstone,' in the vicinity of the ironworks, is largely used as a flux, and the concretions are frequently thirty feet in diameter: in one case a single mass had been quarried to the depth of eighty feet, the other dimensions remaining unexplored.

The *Trilobites* of Dudley have long been known to collectors. The *Asaphus caudatus* and *Calymene Blumenbachii*, which are the prevailing species at Wenlock, occur likewise in the lower Ludlow; but other species are peculiar to the Wenlock quarries. The number of corals, which are enumerated in the table, forms one of the most striking characteristics of this stratum. These have been described with his usual skill by Mr Lonsdale, in the second part of this work; and the lithographic plates, by Mr Scharf, are of singular beauty.

5. The *Wenlock Shale*, the lowest portion of the upper Silurians, nearly resembles the lower Ludlow rock. It is of a dull greenish-grey or olive colour, argillaceous, occasionally calcareous in concretions, and rarely contains mica. It is best seen beneath the escarpment of Wenlock Edge, where it occupies a deeply denuded valley, by which the limestone is separated from the Caradoc hills on the north-west. The lower part of this shale contains concretions exhibiting internally the structure called cone-in-cone; succeeded by sandy calcareous bands, containing peculiar fossils—the immediate forerunner or commencement of the Caradoc sandstone. In some places this shale assumes the form of flags, called *pendle* by the workmen; and these are sometimes preceded by fuller's or 'walker's' earth;* which is not unfrequent also among the upper Silurian rocks. Concretions of an argillaceous limestone, occur near the bottom; and this lower division, with other fossils, contains the new genera, *Cardiola* and *Phragmoceras*, (Broderip)—which have been found only here, and in the lower Ludlow rock.

The ~~limestone~~ limestone, in the vicinity of Wenlock, cannot be less than 200 feet in thickness; and the shale beneath must exceed 700 feet.

6. and 7. The *Lower Silurian Rocks* may be subdivided into two portions; to the upper of which Mr Murchison has given the name of 'Caradoc sandstone,' from its constituting ranges of eminences, abutting against the remarkable trapean chain called the Caradoc Hills, which run nearly from north-east to south-west, for about seven miles, between the villages of Hope-Bowdler and Church-Stretton in Shropshire—a course

* From the German 'walker-erde.' A 'walk,' or 'walker's-mill,' is still used occasionally, in Herefordshire, instead of fuller's-mill.—P. 204.

nearly parallel to that of Wenlock Edge. Unlike the 'stones' of the upper Silurian rocks, this formation is composed essentially of sandstones of different colours, with occasional subordinate courses of calcareous matter, especially at the upper part. 'Its best and clearest distinctions, however, consist in its infraposition to the upper Silurian rocks, and its organic remains, nearly all of which are dissimilar to the fossils of the formations which immediately overlie it.'—(P. 216-222.)

A dark purplish-red sandstone occurs in the bed of the Onny, amidst the Caradoc strata, in nearly vertical strata much distorted; which is unlike any of the upper beds, and very much resembles part of the old, or even of the new-red sandstone. Some of the other beds, at the same place, might almost be mistaken for sandy claystone, of trappean origin; and it will be shown hereafter that a rock of this nature in the immediate flanks of Caer-Caradoc, passes into what the author terms 'volcanic grit,' proving that the deposition of this part of the series was contemporaneous with the diffusion, if not the eruption, of igneous materials. Another remarkable rock in this series, is a silicious conglomerate, passing into continuous beds of quartz, which is found in so many instances in immediate apposition with the trappean rocks, where the latter cut through the sandstones, as to leave no doubt that its change of character has been the effect of heat. The author's observations prove that this change is exhibited under such a variety of forms, and in so many different situations, as to point out the true cause, and enable him to explain the production of the quartzose masses at Bromsgrove Lickie, and other places, previously obscure. *Hoar Edge*, a remarkable ridge on the east of Caer-Caradoc, is quartz rock of this description; the beds, altogether about fifty feet in thickness, having been altered by their proximity to the great Plutonic outburst of the Caradoc range itself.

The Caradoc sandstones appear in large mountain masses, in Montgomery and Denbigh shires; where their relations have been investigated by the author with great diligence and success. In Carmarthenshire, a singular tract around *Noeth-grüg* exhibits some very extraordinary contortions of this group;—the place of which, in the system, is clearly determined by the abundance of the characteristic *Pentameri*, and other fossils; while the proofs of Plutonic action appear in the existence of planes of cleavage, distinct from, yet nearly resembling, those of stratification—and, in some cases, even cutting through the *organic remains!* These cleavage planes are always parallel, while the surfaces of the beds are often curved. There is no spot, indeed, Mr Murchison remarks, in which the distinctions between *cleavage* and *joints* are better defined than in this rugged tract.

—It is facts like this which lead us to doubt, whether some of the slaty masses without fossils, now called Cambrian, may not have been originally Silurian rocks, in which the characters have been either wholly or in part defaced by Plutonic action.

7. The *Llandeilo Flags*—the lowest of the Silurians—are not seen in that part of Shropshire which affords the clearest type of the superior formations. The group, therefore, which forms the base of the system, (if it can at present be said to have a base at all,) has been named from the town of *Llandeilo*, in Carmarthenshire, where these flags are very extensively developed; consisting of hard dark-grey or indigo-coloured grit, sometimes slightly micaceous, frequently calcareous—with veins of white crystallized carbonate of lime passing occasionally into an impure limestone. They are specially distinguished by containing the large *Trilobites*, *Asaphus Buchii*, and *A. Tyrannus*.

These flags occupy ridges which pass under the equivalents of the Caradoc, and in several places graduate downwards into the Cambrian strata.

On the west of Ludlow and Wenlock, the outburst of the trappean hills breaks through and cuts off the lower Caradoc strata; but in several points north of Carmarthenshire, dark-coloured flags, with characteristic *Asaphi*, rise from beneath the Caradoc sandstones, and repose on Cambrian rocks. Of the order, therefore, in this lowest division of the Silurian system, there can be no doubt; and although the space occupied by the *Llandeilos*, with reference to that of the Caradoc, is small, the author thinks it better *not* to merge the former, as a mere subdivision, in the Caradoc formation; since they are well marked both by lithological characters and by peculiar fossils, and, in Carmarthenshire and Pembrokeshire, really occupy a larger proportionate space than the latter formation.

On the south-west of Builth, the Silurian tract is suddenly reduced to a narrow strip, which skirts the north-western border of the old red sandstone thence into Pembrokeshire;—the lower Silurians progressively occupying a greater portion of this space in advancing westward; while the upper are comparatively insignificant in extent, and remarkably altered in lithological aspect. Between Llandovery and Llandeilo, the interchange of character in the two divisions is very conspicuous—the shales, which in Salop are more or less incoherent ‘mudstones,’ being here represented by compact sandstone; while the hard Caradoc sandstone of Shropshire, has passed in some places into incoherent schist. It is about midway on the course of this reduced band, that the author has taken the type of his *Llandeilo* group. The tract is on the course of the river Towey, south-west of Llangaddoc; where dark silicious flags, underlying the great mass of Caradoc

sandstone, are well seen at Llandeilo and Dynevor Park. The beds are sufficiently distinguished by their characteristic *Asaphi*; but throughout their range, between Llandeilo and Carmarthen, a space of about fifteen miles in length, and from half a mile to two miles in width, they have been singularly disturbed, often exhibiting divergent strikes and reversed dips. About Llandeilo especially, the dislocations are for the most part such, that the strata are vertical, or very highly inclined.

These lower schists, in their progress westward, contain no calcareous beds; but beyond Saint Clair, on the north of the Taf, a prominent ridge of limestone rises towards the south, containing three remarkable bands, altogether 200 feet thick—the uppermost band alone being seventy feet, and one bed of about ten feet consisting wholly of an aggregate of shells. This limestone, therefore, is thicker than any calcareous mass of this age previously noticed in the Silurian series, and rivals even the Wenlock near Coalbrook Dale. The fossils are, *Crinoidea* in abundance, several species of *Orthis*, *Corals*, and *Asaphus Buchii*. At Mount Pleasant, farther north, the black schist contains casts, much contorted, of several shells; among which are an *Avicula*, (the lowest in situation hitherto known of that genus,) a *Spirifer*, an *Euomphalus*, and an *Orthis*;—and these Mr Murchison regards as occupying the base of the Llandeilo formation here.

Such is the ‘Silurian system,’ which it has been the principal object of the work before us to make known. It will be obvious, that, considered even locally—if there had been no corresponding groups in other places—it forms so large and well characterized a portion of this country, as to deserve the attentive study of every British geologist. But it would be contrary to all analogy to suppose that a series of strata so extensive should be confined to any single region; and we shall find that the system is in fact distributed very widely in distant quarters of the globe.

In the chapters which follow the general description of the system, (from chap. 20. to the end of 42,) the author conducts his reader successively through the several portions of his district; giving in each locality a view of the variations of their mineral characters and fossil contents, and of the stratigraphic and volcanic phenomena which they respectively exhibit. Thus he has described the Breidon hills; the trap rocks of Montgomery, Radnor, Brecknock, and partly of Pembrokeshire. Thence returning eastward, he gives an account of obtruded portions of the Silurians forced up through the incumbent groups of strata; the remarkable anticlinal ridges of Castle-Madoc and Corny-fan on the north of Brecknock—those of Walsall, Dudley, the Abberly and Malvern ranges, the beautiful circular valley

of elevation at Woolhope, (of which we wish we could have given the detail,) and the elevated range thence to Mayhill, with that on the west of Usk; and finally, of the very complex district of Tortworth near Wotton-under Edge: the correct anatomy of any of which districts it would have been impossible to decipher, without a previous acquaintance with the Upper Silurian series as exhibited near Aymestry.

It is only by the perusal of this portion of the volume that a just conception can be formed of its value. No geological book, that we now know of, gives so much information, with such a readable subordination of detail to general principles. Some repetitions there are, and some occasional redundancies may be cut down—among which the author perhaps will not agree with us in placing certain compliments to contributors and friends, of various degree—our objection to which is quite consistent with a wish for the recognition of preceding labours, by a statement of what each enquirer had done. But the defects, altogether, are slight in proportion to the extent of the work; and the execution, throughout, is very creditable to the author.

We do not condemn the expensive form of the book since it has been favourable to the truth and correctness of the sections, which especially required a large scale for distinctness and effect. But when the present edition has been disposed of, we trust that it will be reprinted in a less expensive form; which will be facilitated by the employment of the plates already engraved. In a new edition, the author might also describe the best authenticated equivalents of his groups in other countries, and enlarge his introductory chapter by giving the history of his district in detail.

The *Second Part* of this volume, devoted to the organic remains discovered within the groups described in the first, is principally the work of the several naturalists, who, at the request of the author, undertook the description of the fossils which he from time to time submitted to their inspection. It contains also the maps, and geological sections, and plates of the Silurian fossils; and is certainly one of the most valuable presents which the Palæontologist has ever received. Each of the contributors writes in his own department, in his own language; Mr Murchison having here wisely acted only the part of a general, who chooses the commanders of brigades and detachments, and forms the plan of the campaign; leaving to each chosen officer the conduct and the glory attending upon his own operations. The *Fishes* are described by M. Agassiz; the *Mollusca* and *Conchifera* by Mr Sowerby; the *Corals* by Mr Lonsdale; the *Crustacea* by the author himself, with valuable observations by Mr W. S. M^r Leay:—several departments also have received illustration from Mr

Broderip, Professor John Phillips, Mr C. Stokes, Dr Beck of Copenhagen, Dr Milne Edwards, and Mr König. Our readers will, after this enumeration, need no assurance that this part of the work is very ably executed.

The general map connected with the volume is excellent, but we regret that the mountains have not been represented in the engraving; and could have wished that *two copies* of the map had been given, one without colour, exhibiting the natural features of the country, which colours always disguise and obscure. The geological sections are equal to any thing of the kind we have seen; and the general principles of the work are well illustrated by two abstract sections appended to the map; one—(which we have copied at the top of the table subjoined to this article)—representing, simply, the stratigraphic succession of the groups; the other illustrating the (supposed) volcanic and Plutonic operations of successive periods, which have disturbed or invaded, and in some cases mixed themselves with, the sedimentary deposits during their deposition. The first of these sections is no more than an exposition of facts; the latter is founded upon theory; but so confirmed as to have nearly the force of reality.

The allotment of the description of the fossils, in this second portion of the work, very well exemplifies the advantages of that division of labour which we have mentioned in a former article, as called for by the ██████████ progress of geology.* It can but rarely happen, in the present state of natural science, that the same person can be possessed of great practical skill in geology, and of sufficient acquaintance with natural history, in its various departments, or even with conchology alone, to be enabled to illustrate competently the collections made by himself. A general acquaintance with each department he must have, and the more of this knowledge he can obtain, the better; but his primary and essential business is more allied to that of the physical geographer and topographic engineer, than of the naturalist: Its object is to ascertain *the mineral structure of the earth*; and, interesting and delightful as are the enquiries connected with the study of fossils, the geologist employs his natural history, in the first instance, simply as an instrument of stratigraphical arrangement and identification. We should be sorry to be misunderstood upon this point; or to be supposed either to undervalue, or to depreciate the importance of Palæontology to the science of the earth; but it is only a *department*, which can never supplant or supply the primary and essential necessity for physical, geometrical, and mineralogical research; and it may be useful ██████████ to state

* Vol. lxi. p. 431.

thus distinctly what appears to us to be the correct view of this matter, as the fashion of the day seems rather to run in an opposite direction, and to give an undue proportionate value to the study of fossils alone.

It would be unjust to the authors of the excellent descriptions and disquisitions in the Second Part, to give such a very imperfect abstract of them as our limits would allow. Referring to the Table for a full enumeration of the fossils, we must confine ourselves to some general remarks, which are sufficiently obvious:—1. In descending from the carboniferous strata, after passing over a thickness of no less than from eight or ten thousand feet of old red sandstone, almost barren of organic remains, and at one time considered as altogether destitute of them—we come, at once, upon a series of strata, continued thence to a depth of several hundred feet, which abound throughout in fossils, and include some beds almost entirely composed of them.

2. The great majority of the bodies thus discovered, are of very peculiar character. The *Serpulites*, the delicately striated *Leptaena*, the *Atrypæ*, *Spirifers*, *Orthises*, and numerous *Terebratulæ*, distributed in profusion almost throughout the Silurian system, form an assemblage of a very remarkable general aspect. Many of the *Orthocerata* are also of very unusual appearance; while the genera *Phragmoceras* and *Lituites*, have not yet been found in any superior groups. Of the *Trilobites*—a tribe long since known from the specimens obtained at Dudley, and which here occupies five plates—many species, and even genera, are altogether new; as are likewise many of the corals, in the four plates lithographed by Mr Scharf; while, among the shells, the *Pentameri* of the Aymestry and the Caradoc limestones, and several others, are known only in the Silurian series.

On this head, we refer our readers to the short introductory chapter of the second part, (xliii. p. 581,) where the author, ‘restricting himself to that field of enquiry with which he is ‘conversant,’ maintains ‘that the fossils of the Silurian system, amounting in all to about 350 species, are, with the exception of a very few, essentially distinct from any of the numerous ‘and well-defined fossils of the carboniferous system; and further, ‘that the old red sandstone, which separates these two systems, is ‘also characterized by fossils peculiar to itself. If the naturalist ‘will compare the figures of the only two works yet published ‘upon the older fossiliferous rocks—that of Professor Phillips ‘on the carboniferous system, and this work on the Silurian—he ‘will at once,’ says the author, ‘see the truth of my position.’

3. With the new forms of ancient life above mentioned, and others equally strange—*Tentaculites*, *Graptolites*, *Ischadites*; an

cient *Annelida*, some genera are intermixed—and in the oldest groups—which are frequent in the newer secondary rocks; as *Trochus*, *Turbo*, *Avicula*, *Pleurotomaria*, *Pullastra*, *Nucula*, *Lingula*, *Natica*, *Cardium*, *Mya*, some of the Silurian species of which have a very modern aspect.* While of other genera, common to the Silurians and the older secondary groups, *Bellerophon*, *Euomphalus*, &c.—the Silurian species are of unusual forms. The author, however, conceives that it is proved as a general fact—‘that as we descend into the older strata, we meet with fresh types of animals; since, although two or three species of upper Silurian shells may be detected in the lower Silurian rocks, the mass of organic remains in each group is very distinct;—and the distinction is most strikingly maintained by the crustaceans; no trilobite of one group has, as yet, been detected in any other.’—(P. 640.)

4. Mr Murchison remarks, that although the multitude of individuals in the older fossiliferous strata is often very great, the number of *species* is much smaller than in many of the more recent deposits.†—(P. 583.)

The CAMBRIAN STRATA, beneath the *Llandeilos*, or lowest of the Silurians, do not come within the immediate object of this volume; but an acquaintance with them is necessary to a just view of some of the relations of the latter groups. It is, in fact, extremely doubtful whether the two *systems* ought not to be united in one great suite, since they are not separable by any

* It is not impossible that instances of this anticipation, as it were, in the appearance of genera or species at one time supposed to be confined to the more recent strata, may become more frequent, as the fossil contents of our ancient groups are more closely examined. A paper has just been published by Mr Lyell, on the discovery, by MM. Deslongchamps and Tesson, in the lias or inferior oolite, near Caen, in Normandy, of two species of *Conus*—a genus abundant in the tertiary strata, but previously known to occur only in two examples so low down as even the upper chalk; this new situation being deeper, and more ancient in geological chronology, by nearly the entire thickness of the chalk and oolitic systems, which cannot be less than 3000 feet. This case, like that of the celebrated *Marsupials* of Stonesfield, proves the fallibility of negative propositions in matters of natural history.—(*Ann. and Mag. of Nat. Hist. Dec.* 1840, p. 292, 296.)

† A similar observation has been made with reference to the estuarine and fresh-water deposits, of the comparatively modern *Wealden* of Kent and Sussex, in which the species are few in number, though vast multitudes of individuals are found. The existing land and fresh-water shells, we believe, in all climates, consist but of few genera and species; the individuals being more numerous in proportion.

lithological boundary, and Silurian fossils have been already found within the territory which at one time was considered as Cambrian.

The best examples of transition into the Cambrians, occur in Carmarthenshire, near Llangathen and Grongaer-hill; where the Llandeilo flags pass, on the north-west, into concretions of limestone, first alternating with grit, and containing a few corals and casts of *Encrinites*; whence there is an imperceptible passage into black schist, void of fossils, which both Professor Sedgwick and the author regard as the connecting link between the Cambrian and the Silurian systems. A similar succession is observable in Denbigh and Pembroke shires.

From the hills near Llanwrtyd, about ten miles west of Builth, and sixteen north-west of Brecknock, the Cambrian rocks range to the south-west, through mountainous and sterile tracts; and afterwards, from about Carmarthen, are deflected westwards, in common with the Silurian formations.—‘If these rocks have a tolerably well-defined boundary in that part of their eastern frontier (Noeth-grüg, Llandeilo, and Grongaer,) where they have been described as passing into the younger deposits, *they have no lines of demarcation or division within themselves*, and extend over two-thirds of Carmarthenshire without any changes in their mineral structure.’—‘The separation,’ it is added, ‘of the lower Silurian rocks from the upper Cambrian, *has been generally effected [in this work] by assigning to the former those beds which contain fossils, and to the latter those which do not.* For, although animal remains occur in the Cambrian strata in many other parts of England and Wales, nature has here afforded us no such evidences, *since the incoherent schists near the base of the Silurian system, and those which extend over so large a portion of the region of slaty Cambrian rocks, are lithologically inseparable.* As we ascend in the higher and more arid regions of the north-west, ribs of grit and sandstone begin to alternate with the slaty schists; and finally, the beds of schist, becoming harder, have glossy laminae, are penetrated by thin veins of white quartz, and put on more the characters of slate.’—(P. 359, 360.)

In the remoter tract last mentioned, occur those remarkable examples, pointed out by Professor Sedgwick,* of slaty cleavage pervading whole ranges of mountains, and cutting indiscriminately through strata variously inclined and inflected.

‘I examined,’ Mr Murchison says, ‘these Cambrian rocks towards the interior, by traverses from Llandovery to Llampeter, and from St

* *Geological Transactions*, (2d Series.) Vol. iii. pp. 469—480.

Clears to Newcastle Emlyn'—[well chosen lines of section, as being at right angles to the general strike;]—'but in no portion of the wide space between these places, have I detected any striking variety of mineral structure; the *whole* tract being occupied by schists, grits, and sandstones, more or less impressed with a slaty cleavage, ranging generally from north-east to south-west, and dipping to the north-west.'—(P. 361.)

In Pembrokeshire, perhaps, the Cambrians are separated from the lower Silurian rocks by a somewhat more definite change of character than any we have yet mentioned. The sequence at the junction being as follows, in a descending order:—(a,) the uppermost beds consist—as in the sections already mentioned—of black shivery schist, without fossils, and of great thickness. These are succeeded on the north by (b,) hard and thick flagstones—mineralogically grauwacke: (c,) hard, dark, purple and green close-grained sandstones, perfectly representing the rocks of the Long Mynd in Shropshire, and of the Lammermuir hills in Scotland: (d,) the oldest group in Pembrokeshire is schist, rising from beneath the last-mentioned division; it contains roofing slates, with many courses of sandstone, passing into quartz rock, and traversed by numerous veins of quartz.

It may be satisfactory to our readers to enumerate here, the principal components of the Cambrian system in Wales and Cumberland, on the authority of Professor Sedgwick, from a paper read during the meeting of the British Association in 1835; * in which the groups of slate rocks, in a descending order, are stated to be as follows:—(1.) *Upper Cambrian group*. It occupies the greatest part of the chain of the Berwyns, and is thence expanded through a considerable portion of South Wales, and is connected with the Silurian *Llandeilo* flags, but contains much less calcareous matter and fewer organic remains. A perfect slaty cleavage is often observed in it, transverse to the stratification; but other parts are of a coarse mechanical texture. (2.) *Middle Cambrian*. This composes all the higher mountains of Carnarvonshire and Merionethshire, and abounds in roofing-slate, interstratified with masses of porphyry. It contains (as at the top of Snowdon) a few organic remains, and some highly calcareous slates, but no continuous beds of limestone. The same group, but without organic remains, is greatly developed in Cumberland. (3.) *Lower Cambrian*, occupying the south-west coast of Carnarvonshire, and a great part of Anglesea. It consists chiefly of chlorite-schist, passing into mica-schist and slaty quartz rock, with subordinate masses of serpentine and

* Report, &c., Communications to Sections, vol. iv. p. 59-60.

white granular limestone—no organic remains. Beneath the middle Cambrian there occurs, in Cumberland, a great formation of clayslate, without calcareous matter, and without organic remains. It passes downwards into chialstolite-slate, mica-slate, &c., and gneiss, which rest immediately on granite. Whether it is to be placed on the exact parallel of the *lower Cambrian* of Wales, is still uncertain.

Our information respecting the organic remains of the Cambrian system is very limited. In England, hitherto, they have been rare. The relations of the beds containing moulds of shells on Snowdon, and of the Bala limestone, are still doubtful; and the supposed Cambrian fossils from some other places, we have reason to think, will prove to be Silurian. Almost the only well authenticated remains from the former strata, are the traces of fossil *Annelida*, or sea-worms, from Lampeter, in North Wales, described at the close of the volume before us, by Mr W. M'Leay.

From the series of facts above briefly stated, it appears that, although the chlorite and mica-slates, &c., at the bottom of the Cambrian system, afford a strong contrast to the soft shales and mudstones of the upper Silurian groups, there is a gradual transition of character by which these extremes are insensibly connected: And as the lowest crystalline slates are, by common consent, regarded as metamorphic—while the change, whatever it has been, which has produced the phenomena of *cleavage*, pervades the whole of the Cambrians, and is perceptible even in the lower fossiliferous Silurian beds—it is very difficult to decide how far the original sedimentary character of any portion of the strata has remained unaltered. A geologist who reasons on mere lithological grounds, might claim the whole of the two systems for Cambrian or Silurian, according to the point from whence his observations began: and until fossils, distinctly and widely different from the Silurian, be found among the lower and middle Cambrians, the division of the systems seems to be merely conventional, and matter of temporary convenience.

From the almost universal prevalence of *cleavage*, and other metamorphic changes, as well as of great mechanical disturbance, in the ancient groups of England, it is not probable that the grounds for a determination of the natural divisions of these great stratified masses will be obtained in this country. They should be expected, perhaps, and sought for, in regions—if there be any such—where the groups have retained, along with their original sedimentary condition, the position also in which they were deposited—at least as little altered by elevation or disturbance as is consistent with the fact of their being visible to our

eyes. For this reason, among others, the examination of some distant portions of our eastern hemisphere, and of North America, (where the Silurian groups are already known to exist,) is very much to be desired.

In the mean time, whatever be the destiny of the *System*, the beautiful volume which we have just examined, will remain as a permanent contribution to our knowledge of the structure of a most interesting portion of our country, and of the globe—a record of intelligence and perseverance, of which its author may be justly proud. We have only to add our earnest hope and expectation, that Professor Sedgwick will soon embody and publish the detail of his valuable labours, on the *most* ancient groups of England and Wales; with such illustrations of maps, sections, and representations of fossils—the *pièces justificatives* of geological history—as will give to the student of English geology the satisfaction of knowing, that the *whole* of our series of rocks has been described, in such a manner as to afford a solid and extended foundation for the comparisons and reasonings of those who are to succeed us.

From the great thickness alone of the Silurian groups, it would have been reasonable to anticipate the discovery of similar masses in other parts, at least of Europe, throughout which, rocks of the transition class are very widely diffused. And from the moment when the existence of these strata was established in England and Wales, it became necessary that the '*transition rocks*,' especially at their junction with the secondary series, should every where be rigorously examined anew. Evidence, indeed, has already been obtained, which makes it probable that formations of this age—containing fossils not merely analogous, but identical even in their *species*, with those of the Silurian region—exist extensively in Russia, Norway, North America, the Falkland Islands, and South Africa.* And questions of the highest importance, as well as novelty, are thus brought into view, with respect to the former condition and distribution of organized bodies, and to the laws of geological sedimentary deposition.

Had we proposed at present to enter upon this most interesting enquiry, we should have called the attention of our readers to an able statement of many of the views connected with it, in a paper read before the Geological Society of France during the

* Murchison, *Sil. Syst.* p. 583.

last year, by M. de Verneuil,* who accompanied Mr Murchison in a recent examination of the ancient rocks of Northern Russia; and we shall so far anticipate the statement, which may soon be expected from these two gentlemen on the result of their expedition, as to say, that equivalents of the carboniferous limestone, the old red sandstone, and the Silurian system, have been ascertained to exist in that region very extensively. †

The recent geological surveys of the United States concur with private information from that country, to prove that Silurian fossils are found there to such an extent, that an exact comparison of the American with the English system is of great importance to the progress of the subject. M. de Verneuil, in the paper above referred to, had shown that ~~the~~ fossils of our carboniferous and Silurian systems occur in the state of Ohio; and, since this article has been in progress, a recent collection of geological 'Reports' on the state of New York, has come into our hands, which contains new proofs of the existence of the system in that province also. In two former series of these documents, published before the appearance of Mr Murchison's book, Mr T. A. Conrad—'Palæontologist to the New York survey'—had mentioned that representatives of the Cambrian and Silurian systems ‡ appear there; and 'that it was doubtful whether a 'more perfect series of transition strata than that of New York, 'can be found in any other part of the world.' The latest collection of reports on New York, dated in January 1840, enters more fully into this subject. The vicinity of Schoharie, from which a numerous collection of fossils had been formed by Mr J. Gebhard, affords, according to Mr Conrad, 'one of 'the finest geological sections in the whole range of the (American) Silurian system, each of the formations being marked by 'a wide terrace, suggesting the idea of a staircase on a large 'scale.' § In this collection of documents also, Mr James Hall, one of the 'State Geologists,' speaks with equal decision of the 'Silurian groups;' and mentions the important fact that the *old red sandstone*, containing *Holoptychus nobilissimus*, with remains of a *Megalichthys*, and of a *Saurian* genus, supposed to be new, § forms the limit between the carboniferous and Silurian systems, §

* Bulletin de la Soc. Geol. de France, tom. xi. p. 166—179.

† "Report of Geol. Sect." during meeting of Brit. Assoc. at Glasgow, Sept. 1840.—and Bullet. de la Soc. Geol. de France, tom. xii. p. 54—56.

‡ Second Annual Report, 1839: p. 57, 66.

§ "Reports," &c., 1840: p. 203—4.

§ *Sauritolepis Taylori*, named in honour of Mr R. C. Taylor, late of London, 'who first described the sandstone of Blossburg, and suggested 'its analogy to the old red sandstone of England.'—P. 453. Note.

and is distinctly above the latter; which alone is *prima facie* evidence that these groups have been correctly identified. A full list of fossils is given by the reporters; and with every allowance for possible errors—though we cannot enter fully into the comparison without the aid of maps and sections, the resemblance of the region which has afforded these remains to the Silurian tract of England, appears to be sufficiently established.* We shall extract, therefore, a passage from the report of Mr Hall; and we have no doubt that the author of the volume we have just examined, will be gratified by the testimony to the usefulness of his work, thus naturally expressed by a fellow-labourer in a distant country:—‘ Since the publication of Mr Murchison’s work, we have been enabled to establish, with great certainty, the analogy of our rocks with those of the Silurian system, as developed in England and Wales. In this country, however, the greater undisturbed range, and apparently better development of particular members, with more numerous species of organic remains, enables us to limit our subdivisions within narrower bounds, and thus offers greater facility for the study of particular groups.’ —‘ The work,’ it is added, ‘ forms an era, and an important one, in the development of the older fossiliferous rocks, which have been so long enveloped in obscurity. It offers inducements to the study of the same, which have never before been presented: since, particularly in this part of our country, the rocks of the Silurian system are better developed than any other, while the means of studying them with guides have been entirely wanting. Thus the student, after weary months of labour, abandons the subject in despair, being unable to identify the rocks or fossils with any system heretofore published; and, having made too little progress to systematize the whole, distrusts what he does know, because it seems inapplicable to what he supposes to be the same rocks, or their equivalents, in another country.’ †

* Among the genera mentioned in the reports, which occur also in Mr Murchison’s list in the subjoined table, are the following:—*Homalonotus*, *Asaphus*, *Calymene*, *Trinucleus*, *Agnostus*, *Bellerophon*, *Orthoceras*, *Euomphalus*, *Lituites*, *Lingula*, *Terebratula*, *Pentamerus*, *Orthis*, *Atrypa*, *Leptaena*, *Delthyris*, *Avicula*—numerous corals, (*Favosites*, *Catenipora*, *Cyathophyllum*, &c.) *Tentaculites*. An American specimen of a very remarkable shell, *Bellerophon dilatatus*, (pl. 12, fig. 23, 24, of Murchison,) brought to England by Mr Featherstonehaugh, which we have seen at the museum of the Geological Society, could not be distinguished, on direct comparison, from specimens found in the Wenlock limestone at Burrington, near Aymestry.

† “ Annual Reports relative to the Geological Survey of the State of New York,” &c., No. 50, January 24, 1840, p. 394-5.

We shall conclude this article by mentioning two points, on which we hope that our wishes may be successful.

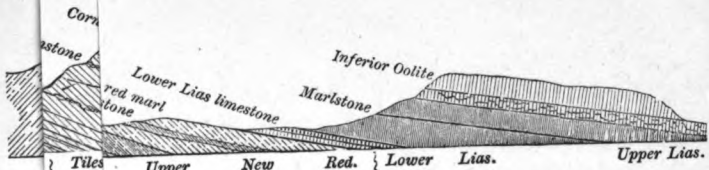
1. We earnestly suggest to the author of the volume we have just examined, and would gladly extend our recommendation to M. de Verneui, whose acquaintance with the fossils of the more ancient strata particularly qualifies him for such an enquiry, not to let another summer pass without examining in person some of the supposed Silurian tracts in North America. 2. We would press upon the attention of British geologists the necessity of making themselves familiar, by personal examination, with the Silurian rocks of England and Wales. They will probably find enough to reward enquiry in the discovery of some new phenomena, and of many details which, with all his diligence and activity, must have eluded the author of the present volume in a region so extensive:—and we do not hesitate to propose an invasion also of the *Cambrian* territory, where Professor Sedgwick's empire has been so long established, that, whenever he publishes a full account of his observations, he can have no rival to fear. But the great benefit resulting from what we recommend, will be, that our practical geologists will thus be enabled to appreciate the comparative works of foreigners, and themselves be qualified to compare with effect the ancient rocks of other countries with our own. Assuredly no person can henceforth consider himself as acquainted with the geology of England, by whom the Silurian strata have not been studied in the field.

THE END.

D

N. I.M.E.

S. EAST.



RED SYSTEM. 3. OOLITIC SYSTEM.

Gr.	Polyparia.			Incertae Sedis.	OLD RED.	
	oidea.					
OLD DEV. SYS.	<ul style="list-style-type: none"> <i>Bellerophon</i> — carinat — striatus — globatus — trilobatus <i>Orthoceras</i> — semipapillatum 					
SILURIAN SYSTEM.	<ul style="list-style-type: none"> <i>Bellerophon</i> — carinat — globatus — expansus <i>Cyrtoceras</i> — laeve <i>Orthoceras</i> — bullatum <i>Bellerophon</i> — Aymesi <i>Lituites</i> — bina — gigantea <i>Orthoceras</i> — Mocktrilobatus — pyriformis — virgatum 	<ul style="list-style-type: none"> <i>Alveolites</i> ? — fibrosa 	<ul style="list-style-type: none"> <i>Favosites</i> — polymorpha. 	<ul style="list-style-type: none"> <i>Tentaculites</i> — scalaris <i>Cophinus</i> — dubius <i>Spongarium</i> — Edwardsii 	UPPER LUDLOW.	
	<ul style="list-style-type: none"> <i>L. ? Biddites</i> <i>Phragmodolaris</i> — arcuatilobata — bina — ? nautipora — ventricaroides — compressus <i>Cyrtoceras</i> — biformis — laeve 	<ul style="list-style-type: none"> <i>Graptolithus</i> — Ludensis <i>Turbinolopsis</i> — bina <i>Cyclolites</i> — lenticulata — praecata 	<ul style="list-style-type: none"> <i>Ptilodictya</i> — lanceolata <i>Glaucomena</i> — disticha <i>Hornera</i> — crassa <i>Fenestella</i> — antiqua — Milleri — prisca — reticulata <i>Discopora</i> — antiqua — squamata — ? lavosa <i>Bivenicosa</i> — irregularis <i>Retepora</i> — infundibulum <i>Echarka</i> ? — scalpellum <i>Blumenbachium</i> — globosum <i>Gorgonia</i> — assimilis <i>Ceripora</i> — granulosa <i>Millepora</i> — repens <i>Stromatopora</i> — concentrica 	<ul style="list-style-type: none"> <i>S. nummultisimilis</i> <i>Favosites</i> — alveolaris — Gothlandica — multipora — fibrosa — spongites <i>Syngonopora</i> — reticulata — bifurcata — filiformis ? — capsitosa <i>Catenipora</i> — escharoides <i>Porites</i> — pyriformis — tubulata — exspatiata — discoidea <i>Monticularia</i> — conferta <i>Astrora</i> — amana <i>Acerularia</i> — Baltica <i>Cyathophyllum</i> — turbinatum — capsitosum — dianthum <i>Cyathophyllum</i> — siluricum — cylindricum <i>Strombodes</i> — plicatum <i>Cladocora</i> — sulcata <i>Limaria</i> — clathrata — fructicosa <i>Turbinolopsis</i> — bina <i>Verticillipora</i> ? — abnormis <i>Cnemidium</i> — tenue 	<ul style="list-style-type: none"> <i>Tentaculites</i> — tenuis <i>Isachadites</i> — Königii 	LOWER LUDLOW.
	<ul style="list-style-type: none"> <i>Bellerophon</i> — dilatatus — Wenlockdactylus <i>Lituites</i> — laris — giganteiformis — ? Biddites <i>Orthoceras</i> — annulatus — theocrinites — bina <i>Lituites</i> ? — Cornu — Cornu <i>Orthoceras</i> — virgatopanus — annulatus — dactylus — dactylus 	<ul style="list-style-type: none"> <i>Aulopora</i> — conglomerata — consimilis — serpens — tubiformis <i>Echarkina</i> ? — angularis 	<ul style="list-style-type: none"> <i>F. fibrosa</i> <i>Catenipora</i> — escharoides <i>Porites</i> — pyriformis — petaliformis <i>Caryophyllia</i> — flexuosa <i>Cyathophyllum</i> — turbinatum — angustum — capsitosum — dianthum <i>Graptolithus</i> — Ludensis <i>Limaria</i> — fructicosa <i>Turbinolopsis</i> — bina 	<ul style="list-style-type: none"> <i>Tentaculites</i> — ornatus <i>Cornulites</i> — serpiarius 	WENLOCK.	
	<ul style="list-style-type: none"> <i>Bellerophon</i> — trilobatus — bilobatus — acutus <i>Nautilus</i> — undosus <i>Orthoceras</i> — annulatus — Nummifera 	<ul style="list-style-type: none"> <i>Aulopora</i> — serpens <i>Gorgonia</i> ? — (not named) <i>Stromatopora</i> — concentrica <i>Favosites</i> — alveolaris — Gothlandica — multipora 	<ul style="list-style-type: none"> <i>Catenipora</i> — escharoides — escharoides <i>Cyathophyllum</i> — turbinatum — angustum — ? capsitosum — dianthum <i>Graptolithus</i> — Murchisonii <i>Turbinolopsis</i> — bina — ? 	<ul style="list-style-type: none"> <i>Tentaculites</i> — scalaris — annulatus 	W. SHALE.	
	<ul style="list-style-type: none"> <i>Bellerophon</i> — bilobatus 				CARADOC.	
	<ul style="list-style-type: none"> <i>Bellerophon</i> — bilobatus 	<ul style="list-style-type: none"> <i>Catenipora</i> — escharoides 	<ul style="list-style-type: none"> <i>Porites</i> — inordinata 	<ul style="list-style-type: none"> <i>Graptolithus</i> — foliaceus — Murchisonii 	<ul style="list-style-type: none"> <i>Polymeria</i> — Demetarium 	LANDELO.
	CAMBRIAN SYSTEM					CAMBRIAN.
	Upper					BRIAN.



