Address delivered at the anniversary meeting of the Geological Society of London, on the 19st of February, 1841 : and the announcement of the award of the Wollaston medal and donation fund for the same year / by the Rev. Professor Buckland.

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ADDRESS

DELIVERED AT

THE ANNIVERSARY MEETING

OF THE

GEOLOGICAL SOCIETY OF LONDON,

On the 19*th of* FEBRUARY, 1841;

AND

THE ANNOUNCEMENT OF THE AWARD

OF THE

WOLLASTON MEDAL AND DONATION FUND

FOR THE SAME YEAR.

BY THE REV. PROFESSOR BUCKLAND, D.D., F.R.S.,

CORRESPONDING MEMBER OF THE INSTITUTE OF FRANCE,

PRESIDENT OF THE SOCIETY.

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1841.

AWARD

OF THE

WOLLASTON MEDAL AND DONATION FUND

FOR 1841.

[Extracted from the Proceedings of the Geological Society, Feb. 1841.]

The Wollaston Medal for this year having been awarded to M. Adolphe Brongniart, Dr. Buckland, on placing it in the hands of Mr. De la Beche, the Foreign Secretary of the Society, said:

Mr. De la Beche,

It is my pleasing duty to place in your hands, as Foreign Secretary of the Geological Society of London, the Gold Medal, which the President and Council have awarded to one of our Foreign Members, M. Adolphe Brongniart, Professor of Botany and Vegetable Physiology in the Museum of Natural History at Paris, and Member of the Institute of France, for his discoveries and publications in Fossil Botany.

The name of Brongniart has been honourably associated with the progress of Mineralogy and Geology since the beginning of the present century; and M. Alexandre Brongniart, the colleague of Cuvier in his investigation and description of the environs of Paris, and the author of many other publications of pre-eminent merit and utility in Mineralogy, Geology and Palæontology, has had no small share in directing and advancing the great progress in knowledge of the physical history of the earth, which has been made during the age in which we live. The son of this distinguished father appears before us, on the present occasion, with more than hereditary claims upon our gratitude, for his illustrations of Flora of the ancient

world by his own extensive researches in Botany and Vegetable Physiology.

Geological Botany, if it may not be said to have originated, has made its greatest advances in the present century; it had indeed attracted the attention of L'luyd Scheuchzer and Knorr, in times when the methods of botanical investigation had not assumed that physiological character which now enables us to establish the minute analogies between living and fossil species; but in 1804 we witnessed, in a publication by Baron Schlottheim, the first attempt to systematize, by comparison with existing families of plants, the obscure and curious fossil vegetable remains that characterize the strata of the Coal formation. In 1820 Count Sternberg published his more enlarged illustrations of the same subject, founded on the fossil plants of the coal-field of Bohemia. Not long after this, I, for the first time, heard from the lips of M. Adolphe Brongniart, then a youth visiting Oxford, a summary of those enlarged and enlightened views respecting Geological Botany, which, in 1828, he set forth in his celebrated "Prodromus of the History of Fossil Vegetables," being the Introduction to his great work, which still continues to be the register of his progressive discoveries, illustrating by figures and descriptive comparisons the analogies between living families of the Vegetable Kingdom and the remains of extinct plants, which clothed the surface of a former world. M. Adolphe Brongniart had, even then, arrived at a series of grand and philosophic generalizations as to a four-fold change in the character of fossil plants, concurrent with analogous changes in the fossil remains of extinct animals. He had ascertained that the Flora of the Coal formation was different from that of the New Red Sandstone series, and this again distinct from the Flora of the Oolite formation, whilst the plants in the Tertiary strata differ from the three preceding series, and approximate most nearly to existing vegetables. The dominant types, in the first of these series, he showed to be Ferns, and gigantic Equisetaceæ, and Lycopodiaceæ, indicating a climate intensely hot and humid. In the second, he had found the prevailing types to be Ferns, Calamites, Coniferæ, and Fucoids, indicating a less extreme condition of climate than the first. In the third, he had ascertained that Cycadeæ, Coniferæ, and Zosterites predominate, and evidence a climate not very different from that

of our modern Tropics. In the fourth, that the same families occur with those of our existing Flora, and in nearly the same proportions, and indicate a climate approaching to that which now prevails in the Mediterranean. The lapse of many years of active research has abundantly confirmed these magnificent generalizations of M. Adolphe Brongniart; and the application of the microscope has recently enabled him to make further discoveries of the greatest value in determining the character of many of the most curious extinct families of plants, by comparing the minute details of their internal structure with those of living families to which they most nearly approximate.

None of the many distinguished vegetable physiologists of this country had undertaken any special publication on Fossil Botany, until in the year 1831 an excellent serial work was commenced on this subject, in the Fossil Flora of Great Britain, by Professor Lindley and Mr. Hutton, which is about to be continued by Professor Henslow and Mr. Hutton. The investigators of Fossil Botany have also, of late years, derived most valuable and liberal assistance from Mr. Robert Brown, the companion of Flinders in his voyage to Australia, and the author of the "Prodromus of the Flora of New Holland." Supported by such auxiliaries both in England and on the Continent, Geology is now rapidly advancing its discoveries as to the Fossil Flora of a former world, and daily detecting analogies, which show these extinct systems of organization to have had strict and harmonious, though frequently distant and marvellously varied, relations to the vegetables which adorn the present earth.

I sincerely congratulate my friend and colleague, M. Alexandre Brongniart, on the honours of his son, whom he has lived, and I trust will yet much longer live, to see, maintaining in the department of Botany, a reputation not less brilliant than that which his father has, for almost half a century, enjoyed in Mineralogy, Palæontology and Geology.

Mr. De la Beche, on receiving the Medal, expressed the great gratification he felt on being the official channel, as Foreign Secretary, of transmitting it to the distinguished person to whom it had been so deservedly awarded. He stated that he had been desired to make known to the Society the high sense which M. Adolphe

Brongniart entertained of the honour which the Council had conferred upon him by the award of the Wollaston Medal; and that it would encourage him to new exertions in the field of Fossil Botany. Mr. De la Beche congratulated the Society on these awards to distinguished foreigners, tending to show that the Society are animated by the sole desire of marking the high sense they entertain of the labours of distinguished persons without reference to the artificial demarcations into which the world might be divided, and that men of science constitute but one brotherhood.

ADDRESS

TO THE

GEOLOGICAL SOCIETY,

Delivered at the Anniversary, on the 19th of February, 1841;

BY THE REV. PROFESSOR BUCKLAND, D.D., F.R.S.,

CORRESPONDING MEMBER OF THE INSTITUTE OF FRANCE,

PRESIDENT OF THE SOCIETY.

GENTLEMEN,

DURING the second year in which I have had the honour to occupy this Chair, the state of our Society has been in every respect satisfactory and progressive. On comparing our list of Members at the beginning of 1840 with that of the same period in 1841, we find that, notwithstanding the large amount of losses occasioned by death, the last year has produced an increase of thirteen Members, making our present List of Fellows 781, and our total number 862, including thirty-two Honorary Members, forty-six Foreign Members, and three Personages of Royal blood. Four distinguished promoters of Geological knowledge have been proposed for election into our list of fifty Foreign Members: viz.

Prof. Dumont, of Liege, to whom we gave our Wollaston Medal last year for his Discoveries in Belgium.

M. Pusch, distinguished for his Geological and Palæontological researches in Poland.

M. Deshayes, long celebrated for his publications in Mineral Conchology.

Prof. Agassiz, whose various and extensive works in Natural History, and more especially his grand work on Fossil Fishes, have permanently registered his name among the great discoverers and most philosophic Naturalists of our time.

Our Wollaston Medal has been awarded to one of our Foreign Members, M. Adolphe Brongniart, for his valuable discoveries and publications in Fossil Botany.

Our Funds have been replenished by the sale of our Transactions, and our Household Establishment is in all respects satisfactory.

The Museum has been enriched by many donations, and great progress made in its arrangement by Mr. Lonsdale, assisted by Mr. Woodward. In the British and Irish Series, 112 drawers have been nearly filled with new specimens, including 20 drawers full of a fine series of rock specimens from the subdivisions of the Lias and Oolite formations collected and presented by Mr. Lonsdale, 27 drawers full of specimens of Rocks and Fossils explanatory of the Devonian System, and 18 drawers illustrating the Trap Rocks of Devon and Cornwall. There are also 10 new drawers, illustrating the Carboniferous, or Mountain Limestone, of England and the Isle of Man. Many Fossils also have been arranged in the Series from the English Chalk.

Valuable additions have been made to our Scotch Collection of Plants and Fishes from the Coal measures; and 120 specimens of fishes from the Old Red Sandstone near Forres, have been presented by Lady Gordon Cumming, and named by Agassiz. All our other Ichthyolites from the British Series have also been named by Agassiz.

In the Irish Collection 28 drawers have been arranged from the Mountain Limestone, presented by the Earl of Enniskillen, Sir P. Egerton, Mr. Weaver and Mr. Griffith.

In effecting these arrangements, the determination of the organic remains has been made by Mr. Lonsdale, and the description of the names, localities, and references to books duly registered by Mr. Woodward, your Assistant Curator, who has been advantageously occupied also in preparing enlarged Illustrations of the papers read at our Evening Meetings, and in assisting the students and numerous visitors in your Museum. 81 other drawers have also been labelled and catalogued by Mr. Woodward.

Baron de Meyendorf has presented to us a fine specimen of crystallized native gold from Ekaterinenburg, and a specimen of platinum from Tagil.

About 150 volumes have been added to our Library, including

all the published numbers of D'Orbigny's "Paléontologie Française."

The maps and charts published last year by the Board of Ordnance and the Admiralty, have also been presented to our Collection.

In reviewing public transactions connected with Geology, conducted beyond the limits of our establishment, and of the deepest interest to us, as furthering our primary object, of advancing the knowledge of the structure of the earth, we gratefully acknowledge the cooperation of Her Majesty's Government in the departments of Woods and Forests and of the Board of Ordnance, and also that of the Trustees of the British Museum, the British Association for the Advancement of Science, and of the Institution of Civil Engineers; and in these cooperations we recognize an increasing feeling and general acknowledgement, not only of the scientific importance, but also of the pecuniary value and statistical utility of geological investigations; in directing the researches of industry to those points where they may be profitably applied, and in preventing such wasteful expenditures of capital, as, under ignorance of the internal structure of the earth, and the peculiar productions of each geological formation, we have, in times past, seen thrown away in ruinous searches after coal, where the slightest knowledge of geology would have given certain information that no coal could possibly be found. Never more shall we witness a recurrence of such unpardonable waste of public money as that which is said to have been lavished in sending lime from Plymouth to build the fortress of Gibraltar on a rock, itself exclusively composed of limestone.

MUSEUM OF ŒCONOMIC GEOLOGY.

The collections of this establishment, attached to the office of the Board of Woods and Forests in Craig's Court, Charing Cross, have very materially increased during the past year; and it is understood that arrangements are making for the purpose of opening them gratuitously to public inspection on stated days in every week. The well-known Secretary of the Polytechnic Society of Cornwall, Mr. Jordan, has been appointed the keeper of the Mining Records, which are to be preserved in this Museum, and are already freely communicated.

Here will be also large collections of Models, illustrative of ma-

chinery used in mines, as well Foreign as British; so that not only will the British miner be enabled to compare the machinery employed in different parts of his own country, but he will also find that adopted in foreign countries. It is understood that any one desirous of making drawings of these models for the purpose of erecting machinery from them, will be permitted to do so under proper regulations.

In addition to this collection of Models of Mining Machinery, there will be other Models, illustrating the mode of working mines in different localities. A very beautiful model of the celebrated Dolcoath Mine in Cornwall is now in the collection; and we understand that Mr. Sopwith is preparing for this Museum models of the coal fields of the Forest of Dean, and of Northumberland and Durham*. Models illustrating the mode of working coal, and of ventilating the collieries in the North of England, are also in preparation. From all these the public may receive valuable, condensed, and gratuitous information as to the mode of occurrence of minerals within the earth, the various methods of working mines, and the machinery by which coal and metallic ores are brought to the surface and fitted for the market. There will be also models illustrating the Metallurgic processes, and samples of the various stages of these processes, and their final results.

The agriculturists are availing themselves of the facilities afforded by the laboratory, and analyses of soils have become numerous. It is in contemplation also to have lectures on various branches of Œconomic Geology, including Building Materials, Agricultural Chemistry, Geology, Mineral Analysis and Metallurgy.

The official director of this rising establishment is our indefatigable colleague and Foreign Secretary, Mr. De la Beche†.

ORDNANCE MAP.

The Members of this Society will rejoice to hear, that in consequence of representations from the British Association for the Advancement of Science, and from other scientific and commercial

* These models will be upon a scale of true proportions; that is, the scale of height and of horizontal distance being the same.

† For further account of this establishment, see my Address to the Geological Society, 21st February 1840.

bodies, respecting the inadequacy of the scale of one inch to a mile, which has been hitherto employed in the Ordnance Map of England, the Lords of the Treasury have ordered the survey of the remainder of the Northern part of England ; viz. the six counties of Lancaster, York, Westmoreland, Cumberland, Durham and Northumberland, and the whole of Scotland, to be made on a scale better suited to purposes of public utility as well as of science. The proposed new scale being, as in the survey of Ireland, six inches to a mile, will allow the insertion of minute and valuable geological details, to the reception of which the one-inch scale is wholly inadequate: it will also be of vast advantage for all those profitable commercial purposes that are connected with the supply of mineral fuel to the manufactures, and with the productions of the other great mining districts of the North.

The paramount importance of supplying to the coal owners of this great district that best of all foundations of knowledge as to the structure and extent of the mineral riches of a country, which is afforded by a large and correct map, is too obvious to be insisted on.

In connexion with the Ordnance Geological Survey, we may congratulate ourselves on the information, that Mr. John Phillips, having examined the fossils of the older rocks of Cornwall, Devon, and West Somerset for the Ordnance Report on these counties, is now engaged with the organic remains of East Somerset, Gloucester, Monmouth, and South Wales: this appointment is the more important, because we have lately been taught more forcibly than ever the value of organic remains as affording the best test to identify geological formations. This appointment of Mr. J. Phillips, and the commission not long since given to Mr. De la Beche, to colour geologically the Ordnance Map of the West of England and the district of the Coal formation of South Wales, afford almost the first example of the tardy recognition by the British Government of the vast public importance of the practice which has for nearly twenty years been acted on in France and in the United States, in appointing a commission of eminently qualified scientific men to survey and report on the Mineral and Geological productions of the country, and express the same by colours on the most perfect maps. To supply this deficiency, a large geologically coloured map and deli-

neation of the strata of England and Wales was published in 1815 by Mr. William Smith, under the encouragement of Sir Joseph Banks, and a large number of individual subscribers; and in 1819 a much more perfect physical and geological Map of England was published at the voluntary cost, and by the gratuitous exertions of several Members of this Society (chiefly those of Mr. Greenough), more complete than any Map on a similar scale and extent yet produced by the official labours of any Government in the world.

BRITISH MUSEUM.

You will learn with satisfaction, that in the month of June last, in consequence of an application from the British Association for the Advancement of Science, the Trustees of the British Museum have made an order to transfer to the collection of recent shells in that great National Establishment the duplicates of fossil shells, and other fossil remains of invertebrate animals in the Museum, that they may be arranged with the analogous recent genera and species*.

No systematic zoological arrangement of fossil animal remains has yet been made in any public Museum of this country; on the Continent such arrangements are not unfrequent; a voluminous collection of this kind in the University of Bonn has greatly facilitated and enhanced the value of the arrangements of fossil Zoophytes, radiated, annulate, and molluscous animals, in the splendid publications of Prof. Goldfuss. Such a collateral arrangement of their extinct prototypes by the side of existing species is not only most important to the science of Geology, but is on other grounds indispensable to the perfection of every arrangement of the productions of the Animal Kingdom; inasmuch as every collection in zoology must be essentially and very largely defective which excludes all notice of the congenerous extinct species which so many existing families present only in a fossil state, and omits the still more numerous remains of extinct genera that occur exclusively among the relics of those former conditions of the globe and its inhabitants, whereof our knowledge is due entirely to the researches of Geology.

* The fossils in the collection formed by Mr. William Smith to illustrate the British Strata, being a classical document in the annals of Geology, are exempted from the operation of this order.

In illustration of this subject, a series of fossil Tertiary shells from Bourdeaux has been presented to the Museum by Mr. James Smith of Jordan Hill, near Glasgow.

During the last year the British Museum has also received an accession of a large and splendid Plesiosaurus of a new species, and eleven feet long, found in the lias at Granby, near Belvoir Castle, and presented by His Grace the Duke of Rutland; and of many fine specimens of Fossil Plants from the English, and from the Silesian and Bohemian coal-fields.

RAILWAY SECTIONS.

You will rejoice to hear, that at the late Meeting of the British Association at Glasgow, measures were taken, by the appointment of a Committee, and a grant of money from the funds of the Association, to begin the important work of collecting and preserving information as to the structure and mineral riches of the country, which is now accessible in sections of the strata exposed in cuttings on the numerous railroads in various parts of the United Kingdom. As many of these traverse important mineral districts on the Coal formation, and will speedily be covered up, much valuable information which they are calculated to afford will be lost, unless advantage be taken of the present moment. It was proposed that the Sections thus procured should be deposited in the public Mining Records Office at the Board of Woods and Forests, and a Committee was appointed to represent to Her Majesty's Government the expediency of having accurate descriptions and drawings taken, at the public expense, of the geological features exhibited in the cuttings and excavations of railroads throughout the kingdom; these are now easily accessible, whilst the railways are in process of formation, and an accurate knowledge of them may be of great scientific as well as commercial importance in future times, when the sections now laid open are covered up. I am gratified to inform you that many influential members of the Institution of Civil Engineers have expressed a zealous desire to cooperate with us in carrying into effect this measure, in which they are so pre-eminently qualified to render most efficient assistance.

DISSECTED GEOLOGICAL MODELS.

A valuable communication has been lately made to us by Mr. Sopwith, an active Member of the Institution of Civil Engineers as well as of our own Society, showing, by a series of small models constructed of differently coloured plates of wood, the advantage of expressing in a solid form those fractured conditions of the strata, a right understanding of which is of the greatest importance, both to the working of coal mines and of metallic veins. Many of the complicated phænomena of curvatures and complex intersections of plane surfaces cannot be adequately represented by any kind of geometrical drawings or plans; to the perfect knowledge and œconomical working of a mineral district, it is essential that the subterranean relations of all the strata should be correctly known and expressed in an intelligible form:—1st. The original order of stratification. 2nd. The amount of dislocation by fracture. 3rd. The changes of the surface produced by denudation; and all these can be intelligibly and simultaneously expressed by models.

The deceptive appearances frequently caused by faults or fractures, are represented by dissecting and making the models moveable in the direction of these faults, so that the strata may be restored to their original position, and again shifted or dislocated. The still further difficulties which arise from the denudation of the upper portions of the dislocated strata, can be adequately expressed only by the solid fac-simile of nature which a model affords.

Among the subjects represented in the models prepared by Mr. Sopwith, are the relative position, depth, and upcast and downcast dykes of the component strata of the Newcastle coal-field, and the strata of the great carboniferous limestone series, with their numerous intersections by mineral veins, in the extensive lead-mine districts of Alston Moor and Crossfell. All the varied and complex phænomena of these highly valuable repositories of coal and lead, which are continually perplexing and impeding the progress of the practical miner, are made perfectly intelligible, when their details are expressed in a dissected model. The mercantile value also of these mineral districts is obviously dependent, first, upon a correct knowledge of the amount of coal and mineral veins which they

may contain, and, secondly, upon a knowledge of the most advantageous methods of extracting their contents.

Cases are often exhibited in these models of deceptive indications of coal upon the surface, when, in consequence of complex faults, small portions only of the broken strata remain below; whilst in other cases, many and valuable beds of coal may exist below, where few or no traces of it appear upon the surface.

Mr. Sopwith has founded these models on observations made during extensive practice, as a mineral surveyor, at Newcastle and Alston Moor. The principle of their construction is available to represent all kinds of geological phænomena, and has been applied by him, on a large scale, in a model of the entire coal-field of the Forest of Dean, in which the exact extent and thickness of each bed of coal becomes instantaneously apparent on the removal of the upper laminæ of the model; each component stratum of the coal-field being represented in its proper place by a moveable lamina or stratum of wood, on which a register may be kept of the quantities of coal that are from time to time extracted from the collieries. The model also at once indicates the most advantageous mode of working every portion of the coal-field.

It is of no small importance to the future welfare of the nation, so dependent as we are become for our commercial prosperity upon a continued supply of mineral fuel, that similar models to that of the Forest of Dean, which has been made by Mr. Sopwith for the Office of the Commissioners of Woods and Forests, should be also made of other coal-fields, and preserved in the Mining Record Office, attached to that department, as permanent registers of the amount of coal which is year by year extracted from each of these subterranean main-springs of our commercial activity. By reference to such models, an estimate may, at any time, be formed of the quantity of coal that remains for future consumption; the amount of which will be the measure of the possible duration of our country's exalted position among the kingdoms of the earth.

The idea of expressing, by coloured sections, the alternations and accidents of strata, had occurred many years ago to Mr. Farey, who, in his "History of Derbyshire" (1815), has engraved two large plates (Pl. III. and Pl. IV.), expressing, in coloured diagrams, many similar complex phænomena of faults and fractures, and also the va-

ried effects of denudation, in cases where the edges of strata, in the sides of valleys, vary in superficial extent according to the angle at which these strata may be inclined.

MINERAL CONCHOLOGY.

Your last year's grant of the proceeds of the Wollaston Fund to Mr. Sowerby, has produced the publication of two new numbers of his Mineral Conchology, and a third number is on the point of being published*.

Professor Agassiz has caused to be prepared for sale or exchange at the Museum of Neuchâtel a series of casts of the internal cavities of 101 recent bivalve and 101 recent univalve shells, for the purpose of illustrating fossil genera and species, the shells of which have in many cases entirely perished. He has also caused to be prepared for sale at the same establishment casts of 500 species of fossil Echinoderms—all these casts have recently been added to the collection of shells in the British Museum.

PHOTOGRAPHY.

A valuable application has been made by Captain Ibbetson of a Photogenic process for rapidly producing perfect drawings of fossil shells on metallic plates, from which, when fixt by the engraver's tool, lithographic transfers may be rapidly multiplied to an almost indefinite extent. This process promises to be applicable to organic remains of every kind, and consequently of great utility in Palæontology. From a beautiful fossil starfish I sent by one day's mail to Captain Ibbetson, in London, I received, by the next mail, a parcel of most exact impressions, taken from a photographic drawing, transferred to stone by the process above mentioned.

PHYSICAL GEOLOGY.

It is not long since, in the Transactions of the Cambridge Phi-

* During the last year, Mr. Lyell has called the attention of geologists to the importance of a discovery made in 1837, by M. de Longchamps and M. Tesson, of fossil shells of the genus *Conus*, in the Lias or Inferior Oolite of Normandy, near Caen. Fossils of this family have long been known to abound in the Tertiary strata, and supposed not to occur in any lower formation.

losophical Society (Vol. IV., 1838), we rejoiced to see a mathematician of such high authority as Mr. Hopkins, in a paper entitled "Researches in *Physical Geology*," adopting this term as one of acknowledged and deserved acceptance in our nomenclature, and to find him asserting, "that we are now arrived at that stage of geological science, in which we are able to recognize certain well-defined geological phænomena distinctly approximating to geometrical laws," and following up this assertion by the first example of a geological investigation conducted on principles supplied by mathematical analysis. The apparent irregularities which the disturbances of the globe seem at first sight to present, being thus reduced under the dominion of mathematical calculation, we hail in this paper the commencement of a series of physical deductions, explanatory of the law of parallelism, which is so constantly observed in the case of mineral veins, faults, and anticlinal lines; and referring this law to a mechanical cause, demonstrable by the test of exact geometrical proof.

We have recently witnessed another investigation of this high order, respecting the necessary relations between observed phænomena and the physical cause to which they owe their origin, in a communication to our Society by Mr. Hopkins "On the parallel lines of simultaneous elevation in the Weald of Kent and Sussex*." In this highly philosophical paper, he shows that these lines exactly correspond with the deductions of mathematical theory, resulting from the hypothesis of the elevation having been caused by an expansive force acting from below upon stratified rocks, within the nearly elliptic area of the Wealden formation, in the S.E. of England, and the Bas Boulonnais.

Prepared with the geometrical results of theory as an antecedent basis of his observations, and introducing this new and most efficient auxiliary as a fundamental element in the machinery of Descriptive Geology, he has added to the views of preceding observers a mathematical precision, which forms the commencement of a new method of demonstrative investigation, more exact than has been hitherto applied to problems of such universal extent as those relating to the causes that have produced the movements of stratified rocks in every portion of the globe.

* A district long ago and ably illustrated by the researches of Mr. Mantell.

Assuming theoretically the application of an expansive force acting uniformly upwards within an elliptic area, he finds that the longitudinal fissures thereby produced would nearly coincide with the outlines of the ellipse, forming cracks that are portions of smaller concentric ellipses, parallel to the margin of the larger ellipse; and that these longitudinal fissures would be numerous, and parallel to the strike of the elevated strata; and would also be intersected perpendicularly in the direction of the dip of the strata by many transverse fissures. In all these fundamental deductions from theory, Mr. Hopkins finds an almost mathematically exact coincidence with actual observation of the longitudinal and transverse fractures in the Weald; the former are respectively parallel to the strike of the N. and S. Downs which bound the area of the Wealden district, and are convergent to a point near Petersfield; the latter pervade many minor longitudinal ridges in the same district, and are most obvious in the well-known transverse valleys that intersect at right angles the chalk escarpments of the North and South Downs, forming the only outlets of the nine rivers that take their origin within the ellipsoid area of the Weald.

Many of the minor transverse valleys that intersect the minor longitudinal ridges, give origin to perennial springs, which are thrown out by the dislocation of the strata, where the faults to which these valleys owe their origin intercept the progress of the subterranean waters, by breaking the continuity of the strata they percolate.

From these fundamental observations, he concludes that the Wealden district owes its elevation to one simple elementary cause acting simultaneously, and perhaps at successive intervals, at every point within the area in question; and producing dislocations, not, as some have supposed, along one single central axis of elevation, on the long diameter of the ellipse, but simultaneously on many lines, and causing many minor elevations parallel to the curvatures of the margin of the ellipsoid area in question.

The theory of the simultaneous action of the moving forces within all parts of the elevated area, does away the mechanical difficulty of forming these fissures by a force applied only along one single axis of elevation; whilst the entire series of phænomena accords

with the hypothesis of a broad expansive force acting below, not along one single line, but generally and uniformly under the whole district, with equal intensity at every point.

In this great physical problem, the form of the elevated area is a most important element, and in the case of the Weald, its elliptic form is highly favourable to the comparison which has been instituted by Mr. Hopkins: other important elements are the constitution of the strata, their equable thickness, equable cohesion, and the direction of their natural joints.

In the same simultaneous elevations that have extended from Boulogne through the area of the Wealden formation to the east of Hampshire, near Petersfield, Mr. Hopkins would include also (as Dr. Fitton has done in his observations on the Strata of the South-East of England) the parallel elevations of Portsdown, the Isle of Wight, the Purbeck and Weymouth districts, and the vales of Tisbury, Pewsey and Highclere, on the west and north margins of Wilts and Hants*.

Mr. Hopkins has also arrived at similar conclusions respecting the longitudinal and transverse fractures which he has investigated in the mountain limestone and coal formations of Derbyshire; commencing, as in the present instance, with a theoretical investigation of the mathematical results of expansive forces acting from beneath, and comparing these results with observations on the longitudinal fissures and transverse fractures examined by himself in Derbyshire, and with the answers returned by practical miners in that district to a series of printed questions as to facts which theoretical calculations had indicated as probable, and which have been fully verified by the answers thus obtained.

In these Memoirs of Mr. Hopkins on the Wealden district, and on Derbyshire, we have the first instances of the geological investigation of any portion of the earth for the express purpose of exemplifying a theory founded on the solution of a mechanical problem; the results he has obtained in the coincidence of the phænomena with the mathematical theory by which they have been tested, have been remarkably approximate, and make us feel that the time is

* The term "Valleys of Elevation" was first introduced to English Geology in a paper "On the Valley of Kingsclere and other Valleys," by Dr. Buckland.—*Geol. Trans.*, 2nd Series, vol. ii. part 2. 1827.

arrived when the investigations of geology have begun to exalt themselves beyond the exquisite and delicate investigations of Mineralogy, and the grand and universal laws of co-existence that give dignity and beauty to Palæontology, into those lofty regions of General Physics which connect them with the most sublime demonstrations of Astronomy.

It may be seen, by reference to the Ordnance Geological Survey of Cornwall, that the elevations and depressions of the older slate rocks in the West of England have been attended by numerous parallel fissures and transverse fractures, similar to those in the Weald of Kent and Sussex. In the mining districts of Cornwall, particularly near Redruth, these rents and fissures are known in all their various and curious details, from their having been excavated in search of the metallic ores which they contain. The main direction of these fissures being east and west, they are intersected, like those in the south-east of England, by transverse fractures or cross courses, running nearly north and south. Both these systems in Cornwall obviously result from the same mechanical laws which have not only caused transverse fractures to intersect the longitudinal lines of elevation, in the districts of the Weald and Derbyshire, where Mr. Hopkins has demonstrated their accordance with the theoretical laws of physical induction; but will be found to have affected every mountain chain produced by angular elevation upon the surface of the globe.

In the Annals of Philosophy, 1821, p. 453, I published a Memoir on the Structure of the Alps, in which it was shown that all the rivers which descend on the north side of this greatest European mountain chain, escape from longitudinal valleys parallel to the general axis of elevation and to the escarpments of the elevated strata, by a series of gorges transversely intersecting these escarpments; in the same manner as the four gorges, that intersect the Chalk escarpment of the South Downs, give outlet to four rivers formed in longitudinal valleys on the south side of the central axis of the Wealden elevation, namely, the Arun, Adur, Ouse and Cuckmere rivers; whilst five gorges in the escarpments of the North Downs give exit to five rivers formed in longitudinal valleys on the north side of the same central axis of the Weald, namely, the Wey, the Mole, the Darent, the Medway, and the Stour.

An objection has been sometimes raised to the theory which attributes the existing position of inclined strata to elevation, grounded on an assumption that the same relative positions of the strata in mountains and the valleys adjacent to them may have been caused by the *subsidence* of the lower parts of the strata into the basins, as by the *elevation* of those portions which now occupy the highest place; but these objections are overruled by mechanical and mathematical reasons, arising from observation of the relative positions of the dislocated strata on each side of the "upcast dykes" or faults that run parallel to these assumed lines of elevation; namely, that the dislocated strata, in almost all cases, occupy the place which an upward movement would have given to them respectively on each side of the fault, and which they could not have received from a downward movement under any process of depression*.

Mr. Martin, of Pulborough, has also resumed his consideration of the structure of Western Sussex, and of the anticlinal lines of the London and Hampshire Basins published in 1828 and 1829, with a paper on the relative connection of the eastern and western chalk denudations; in which he traces westward, from the Wealden district of Sussex, a system of six nearly parallel anticlinal lines,

* It is due to the memory of Mr. Farey, the cotemporary and fellow-labourer of Mr. Wm. Smith, that we should here notice the fact of his having many years ago presented to this Society an unpublished section across the Weald of Sussex, along the road from London to Brighton, to which due credit was not then attached. In this section, together with the general direction of the component strata of the district, as given in the sections of Mr. Mantell and Dr. Fitton, he introduces a series of faults, twenty-five in number, between Ryegate Hill upon the North Downs and Clayton Hill on the South Downs, representing minor movements and longitudinal fractures parallel to the great escarpments that bound the area of the Weald; many of these faults have been recognised where he had placed them by Mr. Hopkins. Mr. Farey also, in his "View of the Agriculture and Minerals of Derbyshire," 1815, has given an account of great systems of faults and denudations in Derbyshire and five adjacent counties; together with the coloured figures before alluded to explanatory of the nature of faults and dislocations, or tilts of the strata, and the subsequent effects of denudation upon them; which, though not confirmed in all their details by modern observations, show him to have been a most ingenious original observer, whose merits in this department have not been sufficiently appreciated.

across the high table-land of chalk in Hants, Wilts, and Dorset; three of these lines of elevation proceed westward from the Wealden district, and three penetrate the chalk in an easterly direction from the valleys of Wardour, Warminster, and Pewsey. The continuity of these lines is occasionally interrupted for considerable intervals, and again resumed on the same parallel along the great elevated plain of the chalk.

Mr. Martin traces the most northerly and greatest of these anticlinal lines from the vale of Peasmarsh, between Guildford and Godalming, along the entire base of the North Downs, eastwards to the sea at Folkstone, and westwards to Farnham, Alton, and Popham Beacon, where it terminates in the high flat dome or table-land of chalk. The most southerly anticlinal line extends from Greenhurst, near Steyning, eastward to Lewes, and along the base of the escarpment of the South Downs to East Bourne and Beachey Head; and westwards by Midhurst and Petersfield to the Downs of East Hampshire, through which it emerges in valleys of elevation at East and West Meon, and in the valley between St. Giles's and St. Catherine's Hill at Winchester. The central anticlinal line of the Wealden he traces westward from Hazlemere to Liphook, Selbourne, and Candover near Arlesford, and Beacon Hill near Amesbury.

The anticlinal elevation of the valleys of Wardour, Warminster, and Pewsey, after advancing some miles eastward into the chalk, terminate in the high table-lands of Salisbury Plain and the North Hampshire Downs, which form a great flat dome of elevation between the counties of Sussex, East Somerset, and North Wiltshire.

Mr. Martin considers many of the higher crests and ridges that run in an eastern and western direction above this elevated plain, to be due to saddle-shaped elevations on one or other of the great lines of fracture that attended the upward movement of the chalk. In the details of his paper he confirms and extends the observations of Mr. Mantell and Dr. Fitton, upon the very interesting district which forms the subject of their common investigations*.

* In his Geological Memoir on a part of Western Sussex, Mr. Martin put forth in 1828 some judicious remarks, showing, on the theory of derangement and denudation, that the Weald of Kent and Sussex, as well as the London and Hampshire Basins, had a common origin in a system of elevatory movements posterior to the formation of the tertiary strata. He

POSITIVE GEOLOGY.—EXTENSIVE RECOGNITION OF SILURIAN AND DEVONIAN SYSTEMS ON THE CONTINENT.

We may congratulate ourselves on the advance that has been made during the past year, by the extension of our knowledge as to the existence of the Silurian, Devonian and Carboniferous systems over large districts of the continent of Europe. In my last address I endeavoured to explain the reason why the old red sandstone formation, which occupies so very extensive a place in England, had been scarcely anywhere recognized on the Continent; namely, because we had till lately failed even in our own country to refer to this system those extensive slaty forms of it, which, both here and upon the Continent, had been referred to the grauwacke of the Wernerian series, and had applied the name of old red sand-

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considers that the strata which compose these basins, and were originally horizontal, suffered great disruption in the act of forming basins, either by the elevation of the sides or subsidence of the central portions of each basin; that in this operation deep and extensive fissures were formed in certain parts of the strata thus disturbed, analogous to those we see in the elevation and cracking of the flour which covers the fermenting nucleus of dough in a baker's trough; that the great undulations of the strata are not due to original deposition, but result from subterraneous movements, attended by enormous pressure. Mr. Martin also makes some judicious observations on the too-prevalent habit of using the term *chalk basin* in a manner that seems to imply local depressions peculiar to the site of each so-called basin, forgetting that the chalk itself (although it forms a very convenient and obvious geological horizon) is only an intermediate layer in a succession of basin-shaped strata; and contends that as the formations superincumbent upon and subjacent to it have a conformable disposition, it is just as correct to call them London clay, or green sand, or galt basins, as chalk basins. Again he observes, respecting the deposits of the basin of Paris, that their occurrence elsewhere in horizontal and apparently undisturbed positions, indicates the strata above the chalk to be of a date anterior to their present curvilinear disposition in the form of basins. He further shows, that the act of denudation was not confined to the district of the Weald along the lines of movement in which the greatest elevations took place, but equally laid bare the highest summits of the chalk hills and elevated plains, and swept away much of the contents of the basins; and endeavours to establish the connexion of these elevations and subsidences with diluvial action, by showing that an adequate cause for this action may be found in the elevatory movements produced by forces acting upwards from the interior of the globe.

stone only to a part of this formation, which had hitherto been considered as the type of the whole, namely, to the red marly, sandy, and conglomerate strata of Herefordshire and the adjacent counties, omitting the Killas and other slate-rocks of the Devonian system, which have now been shown to appertain to it.

I further stated, that it would probably be found that this Devonian system includes a large amount of strata upon the continent of Europe, which had been hitherto known by the Wernerian name Grauwacke; and expressed my satisfaction that this name was likely to retain its place in the nomenclature of geology, as a generic term co-extensive with the transition series of the school of Freyberg, and divisible into three great subordinate formations, namely, the Devonian, Silurian, and Cambrian systems.

The labours of Professor Sedgwick and Mr. Murchison in the Rhenish provinces and adjacent parts of Germany, in the summer of 1839, have furnished important additions to our knowledge of the older rocks of the continent, and brought them into comparison with the recently established *palæozoic* types of England; the first efforts of those authors were directed to the right bank of the Rhine, where taking the coal-field of Westphalia as a fixed horizon, they proceeded to deduce therefrom the descending order of the older formations which emerge southwards from beneath that deposit, and established a perfect sequence along a frontier of fifty miles in length, from a true coal-field with carboniferous limestone downwards into Silurian rocks, by passing through an intermediate group loaded with Devonian fossils*.

* This order was not made clear until some startling difficulties were overcome. All the German authorities had laid down as one continuous band (defining the same as *berg-kalk*), the limestone which at Ratingen is undoubtedly true mountain-limestone, and the calcareous zone which passes from W.S.W. to E.N.E. by the towns of Elberfeldt and Iserlohn. Now although at a first glance the physical features of the country seemed to favour this view (which was indeed adopted in the new map of Von Dechen), the close examination of the authors detected, that whilst the Ratingen limestone contained the fossils of the carboniferous system, that of Elberfeldt and Iserlohn was charged with different types, most of which exist in the lower limestone of Devonshire. Having assured themselves, therefore, that there was an error in the works of previous observers, they returned to Ratingen, and following the carboniferous limestone eastward along its strike they found it to be separated from

In following out these strata to the E.N.E. the authors were astonished at the vast flexures, first laid down by Von Buch and Hoffman, and since more elaborately made out by Von Dechen and Erbreich; and perceived that the shales become more crystalline and slaty, and charged with mineral veins, and the limestones assume the state of marble or highly ferriferous rocks; these strata are also abundantly interrupted by ridges of Trap and frequently *inverted*, the carboniferous and Devonian deposits plunging under the older Grauwacke or Silurian rocks.

Our authors also found that the Devonian strata reappeared in irregular troughs among the Silurian Grauwacke (often with inverted inclination) in various parts of Nassau; many of the limestones, particularly on the river Lahn, being identical, both in structure and in coralline remains, with the beautiful marbles of Babbacombe, Torquay, and Plymouth. In many parts of this region the strata are in a highly mineralized condition, copper and lead ores, as well as the more prevalent iron mines, occurring at intervals; whilst numberless eruptive rocks diversify the surface; and the strata, particularly those of the Devonian age, alternate with a peculiar stratified contemporaneous trap-rock called "Schaalstein," the more schistose varieties of which contain Devonian fossils. The various mineral waters of Nassau are supposed to be due to the last expiring effects of the same causes which produced, in former times, the numerous eruptions of Greenstone, Porphyry, and other igneous rocks.

The quartz rock of the Taunus mountains, the southern limit of the region they examined, is considered to be an altered deposit of the Silurian epoch*.

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that of Elberfeldt, gradually changing in its structure, and passing into thin-bedded black limestone associated with much flinty schist (kiesel schiefer) and chert, and assuming the lithological characters and fossils of the black or culm-limestone of Devonshire.

This black limestone is overlaid by unproductive measures of the coal series, similar to the upper strata of the great trough of North Devon, and is underlaid by psammites, schists, and limestone (Elberfeldt and Iserlohn) containing Devonian fossils, and reposing upon schistose and grauwacke rocks which contain Silurian fossils.

* The most characteristic Devonian Mollusca are Strygocephalus, Gypidium, two or three species of Turritella, Euomphalus, the Terebratula of

The authors next institute a comparison of the formations of Westphalia and Nassau with those of Liège, the Ardennes, and Eifel on the left bank of the Rhine. Starting from the country around Liège, which M. Dumont has rendered classic by his illustrations and his map, Messrs. Sedgwick and Murchison confirm the views of that author, and bear testimony to the great value of the method employed by him in bringing into symmetrical condition that highly tortuous and convulsed tract. They admit that he has most successfully demonstrated the replicatures of the different members of the Carboniferous and infra-carboniferous systems, and established on clear physical evidence, the fact that *whole basins* have been *inverted*. They differ from him, however, in the comparison he has made between the older rocks of his own country and those types of classification which the authors have established in the British Isles. In his table of comparison, M. Dumont supposes that the Old red sandstone of England has no equivalent in Belgium, and that the formations which there occur beneath the Carboniferous limestone (his *terrain anthraxifère*) are the equivalents of the *Silurian system*; our authors show that the psammites, schists, and limestones next below the coal-field and carboniferous limestone of Liège are the exact equivalents of the series which in Westphalia represent the Devonian system. The fossils are the same as those of Elberfeldt, Paffrath, and Devonshire. These beds also contain fishes of the genus *Holoptychius*, which Agassiz has identified with types of the old red sandstone; and on all these grounds, as well as by complete lithological and stratigraphical passage into the overlying carboniferous group, our authors establish that the *terrain anthraxifère* of D'Omalius and Dumont is, like the schistose rocks of Devonshire, the true equivalent of the old red sandstone.

The mountains of the Ardennes consist in their upper members of equivalents of the Silurian system, as indicated both by order of infraposition to the Devonian rocks, and by containing the same types

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Devonshire, with the very peculiar trilobite, *Brontes flabellifer* of Goldfuss. The upper members of the Silurian system are distinguished by Orthoceratites, Homalonoti, and other Trilobites, Pterineæ, Orthis, &c., some of which are identical with species found in the Silurian region; with these are some remarkable forms not yet detected in the British Isles, such as *Delthyris macroptera* and *D. microptera*.

of fossils which characterize the Silurian strata on the right bank of the Rhine; whilst the oldest slaty rocks, in which no fossils have been discovered, are presumed to be in the parallel of the Upper Cambrian group.

The limestones of the Eifel, well known by their fossils, lie in a basin supported by Silurian rocks, and are identical with the lower Devonian limestones of Liège, Westphalia, and Nassau; whilst the shales beneath them graduate into Silurian grauwacke, and contain so many Silurian species that (together with the well-known schists of Wissenbach on the right bank of the Rhine) they are considered to form the uppermost members of the Silurian division.

A similar succession to that from the Eifel to the Ardennes is observable between the Eifel and the Hundsruck, the upper Silurian flagstones being highly fossiliferous, but much contorted and disturbed and altered in their mineral condition; the banks of the Moselle offer the finest proofs of such disturbances. The fossils found in the quartzose rocks of the Hundsruck prove this mountain chain, which is a prolongation of the Taunus, to be, like it, of Silurian formation.

In the Hartz, the authors traced the same succession of mineral masses, each characterized by their peculiar fossils; and, if possible, in still more dislocated positions. In one section, however, they point out a tolerably regular descending order, from the mining tracts of Clausthal, where the beds are the equivalents of the carboniferous strata (floetzlehrer sandstein of the Germans) down to limestones charged with Wernerian types; but in other parts, as near Goslar, the still older Silurian rocks occur upon the flanks of the Brocken, and *overlie* the Devonian schists; whilst it is shown that the granite of the Brocken was in a molten condition after the formation of these old rocks, fragments of which full of shells are found included in this Granite. Other sections show that the chain has subsequently been heaved up "en masse," and all the secondary strata on its northern flanks set on edge, and in some instances inverted, from the Muschelkalk and New red sandstone to the Greensand inclusive. The authors believe that the last great dislocations of the Hartz may be due (as suggested by Von Buch) to the eruption of the Porphyry, which on the southern and south-eastern limits

of the tract is associated with the newest Coal strata and the oldest beds of the New red system (*Rothe todte liegende*).

The Thuringerwald is considered to exhibit the same succession of the older strata as the Rhenish provinces and the Hartz, the central masses being equivalents of the Silurian and possibly of the Upper Cambrian group; but the authors, having passed rapidly over these parts, attach importance only to their observations on the southern limits of that region, near the foot of the Fichtelgebirge, where they indicate a clear descending series, from the true Mountain-limestone with large Producti into lower fossiliferous limestones and slaty rocks, the fossils of which have been elaborately described by Count Munster, and which they place in the parallel of the Devonian system.

The authors express their very great obligations to Mr. Lonsdale, whose intimate knowledge of the Devonian fossils has enabled them to speak with confidence, and whose advice has often dispelled obscurities which must ever attend the elimination of the order of succession of rocks which have been so extremely dislocated, and in many instances so much altered. They also acknowledge the valuable cooperation of their friend M. de Verneuil, who accompanied them during a portion of the time devoted to this laborious survey, and to whose intimate acquaintance with the older fossils they are largely indebted; and who, uniting with his countryman M. d'Archiac, will describe the Mollusca of these regions as a sequel to the geological memoir of the authors.

Mr. Murchison's recent journey over large tracts of Russia was intended to test the accuracy of the new classification of the palæozoic rocks upon a still wider scale than any to which it had been applied. Believing from the works of Strangways, Pander, and Eichwald, that some members of these formations occur near St. Petersburgh, and prompted by the suggestions of M. Von Buch, that the threefold succession of Carboniferous, Old red, and Silurian systems would be found to prevail in Livonia and North-western Russia, Mr. Murchison, accompanied by M. E. de Verneuil, has made during the last summer a most extensive and instructive tour in Russia. The principal results of this journey were offered to the Geological Section of the British Association in September last at Glasgow, showing that the Silurian rocks occupy several islands in

the Baltic and large parts of Livonia and Courland, and range by St. Petersburgh to the W.N.W. On the south they are overlaid by a great red formation which was formerly supposed to be the New red sandstone on account of its saliferous and gypseous beds, but which is now proved to be the Old red sandstone by containing the Ichthyolites which characterize that deposit in the British Isles; these fishes, *Holoptychius*, *Coccosteus*, *Diplopterus*, &c., are associated with Mollusca similar in species to some of the fossils of the Devonian rocks of England, Belgium, and the Rhine. The old red or Devonian rocks of Russia, spreading over a very wide area, are surmounted in the Waldai Hills by Mountain or Carboniferous limestone; the latter formation (in great part resembling in mineral condition a Tertiary deposit of white limestone) may be said to range from Moscow to Archangel, and even into the country of the Samoides, preserving the same lithological and geological characters, and occurring almost universally in horizontal unbroken masses for the distance of nearly one thousand miles. Thus the examination of Russia has not only confirmed the palæozoic classification of the Carboniferous, Devonian, and Silurian systems, but has given new materials for the establishment of correct geological theories as to the formation of the surface of the globe; for we now learn that deposits of this high antiquity have been left in undisturbed positions over very large areas, and that under such circumstances their structure has undergone little or no modification; whilst the large Producti of our Mountain-limestone occur in Russia in a white deposit, resembling the most incoherent parts of the Calcaire grossier of Paris. The general results and details of this important examination of Russia will shortly be brought before our Society.

DEVONIAN SYSTEM.

After reviewing the vast European extent which the equivalents of the Old red sandstone have been shown to occupy on the Continent, we cannot forget how much we owe to the sagacious and exact researches of Mr. Lonsdale, set forth in his most masterly and highly scientific communication to us respecting the age of the limestones of South Devon, wherein, after showing the state of former erroneous and inconsistent opinions upon the subject, he de-

tails the steps that led him to infer from zoological evidence alone, that they were of an intermediate age between the Carboniferous and Silurian rocks.

Mr. John Phillips had already observed the resemblance between many of these Devonian shells and those of the Mountain-limestone, and Mr. De la Beche had long ago noticed the position of the Torbay limestones to be incumbent on strata of Old red sandstone ; and in 1839 suggested that their organic remains would seem to indicate relations to this formation. The cause of the obscurity that overhung this subject arose partly from the absence of any evidence from superposition, in consequence of the insulated place which these rocks occupied in the south of Devon ; and partly from the non-existence, until a recent period, of any extensive catalogues of the organic remains of the Mountain-limestone and Silurian systems with which these fossils of South Devon might be compared.

In 1837 Mr. Lonsdale had ascertained, from an extensive collation of the shells and corals of the south of Devon with those of the Silurian system supplied in the catalogue of Mr. Murchison, and of the Carboniferous system in that of Mr. J. Phillips, that a large proportion of the Devonian fossils presented a character intermediate between those of the formations which lie above and below the Old red sandstone ; and therefore concluded that the strata in which they are found must be subordinate parts of this intermediate formation. The suggestion was adopted by Mr. Murchison and Professor Sedgwick in 1839, and at once shed forth a new and brilliant light that has rapidly dispelled the darkness in which the slate rocks of this extensive formation had, until this discovery of Mr. Lonsdale, been involved. The first application that was made of this new instrument of identification to the continental rocks led to the immediate solution of the difficulties that had attended the attempts of preceding observers to ascertain the equivalents of the English series in the districts adjacent to the coal-fields of Liège and in the Bas Boulonnais; and we have already noticed the vast extent to which, during the past year, a similar identification has been carried in the Rhenish provinces and in Russia.

We should, however, not forget, that, by the recent examination of Russia, the distribution of fossil animals has been found to be materially connected with *mineral conditions* ; for Mr. Murchison

and M. de Verneuil have shown us, that with the resumption of its *red* and *green* characters, the vast Old red system of that empire resumes the very same zoological types as in the North of Scotland.

A short time will probably produce an abundant recognition of the same palæozoic classification in America. We have long been learning an instructive lesson as to the comparatively small value of mineral character in determining the age of strata, where there is no opportunity of appealing to the test of superposition; and organic remains have been found to supply the surest and safest criterion whereby formations can in such cases be made out; thus, the evidence of fossil shells has recently enabled us to identify the Oolite formation in Cutch and the deserts adjacent to the Indus, and on the Tartar side of the Himalaya Mountains. Cases of this kind teach us to appreciate even still more highly than we have been wont to do, the paramount value of Palæontology in determining geological equivalents.

ORIGIN OF COAL.

In the early part of last year some very interesting papers came before us tending to throw light on the obscure and difficult question of the formation of coal.

Mr. J. Hawkshaw, having communicated to us in June 1839 a description of several large fossil trees found in a cut on the Bolton Railway, near the Dixon-fold Station, five miles and a half N.W. of Manchester, standing immediately upon a thin bed of coal perpendicularly to its surface, has added a statement of further facts, confirming his opinion that these trees grew in the place and position where they are now found. His reasons are grounded on observations he made near the shores of the Caribbean sea, on the rapid decomposition of the trunks of solid dicotyledonous trees in hot and moist climates. This decomposition in a few months entirely destroys the timber, leaving only the bark unbroken and hollow, like an empty mould in a foundry; the form of this bark remains perfect after the interior is reduced to dust. He infers from this example, that it does not follow that fossil trees in the coal formation were originally hollow because we find their interior entirely filled with indurated clay or sand, since it appears from effects now proceeding in tropical climates, that the

entire bark may have retained its place and form and have been filled with sand or silt after the interior of the trees had rapidly perished. Similar observations as to the rapid decay of timber have been made by Mr. Schomburgh.

Mr. J. E. Bowman also has endeavoured to prove that coal has been formed from plants which grew on the present areas of the coal seams, and that these beds of vegetable matter were at successive intervals submerged, and covered by sediments, which accumulated until they formed a surface fit for the growth of another series of land plants; and that these processes were repeated in the production of each bed of coal. In this manner he would explain the uniformity in thickness of individual coal beds over very large areas. He further admits, that other trees, branches, and leaves, may have been drifted from the neighbouring lands, and scattered through the beds of shale and sandstone, whilst they were in process of accumulation upon the subsiding or subsided beds of coal. Mr. Bowman agrees with Mr. Hawkshaw in believing the large trees upon the Bolton Railway, near Manchester, to be in their native place and position, and to have been *dicotyledonous*. He further mentions a similar case of at least forty trees, only three or four feet apart, found in 1838, standing erect upon the *upper* surface of a seam of coal fifteen inches thick in the railway tunnel at Clay Cross, five miles south of Chesterfield; these had no traces of large roots, and their exterior consisted of a thin film of coal, furrowed and marked like a *Sigillaria reniformis* ?, the interior being occupied by fine-grained sandstone. Mr. Bowman considers the trunks of fossil trees in the coal formation, which are thickened at their base, and terminate in large expanding forked roots, to have been dicotyledonous, whilst the monocotyledonous trees maintain throughout a nearly uniform thickness, and their roots probably consisted of an assemblage of succulent fibres; and argues, that if beds of coal were, like modern peat bogs, the accumulated remains of many generations of vegetables that grew upon the spot, they may, during such process of gradual accumulation, have afforded a surface adapted for the growth of the trees in question. He attributes the fact of the roots standing above the upper surface of the coal, as we sometimes see the roots of fir-trees above the surface of peat, to the

shrinking of the vegetable matter in which they grew, and considers the actual thickness of each bed of solid coal to be about one-third that of the vegetable mass from which it has been derived*.

Mr. W. E. Logan has also communicated to us a series of minute results of extensive examinations made by himself, and in many cases confirmed by Mr. De la Beche, on the character of the beds of clay immediately *below* the coal seams in South Wales, from which it appears that immediately beneath every bed of coal in that extensive district is a substratum, called the *underclay*, varying in thickness from six inches to more than ten feet; and that this underclay so universally and inseparably accompanies nearly a hundred seams of coal throughout South Wales, that the collier seldom finds coal where this substratum is wanting: it is usually a fire-clay, containing sometimes an admixture of sand, and near Swansea passes into a hard, fine-grained, siliceous sandstone. This never-failing substratum of the coal is everywhere characterized by the exclusive presence of innumerable remains of *Stigmaria ficoides*, the stems of which are often of great length, and usually parallel to the plane of the bed, and more abundant near the top than the bottom of the underclay. From each of these stems there proceeds a series of very long and narrow leaves, forming an entangled mass, which traverses the fire-clay in every direction and to great distances; fragments of the stems of Stigmaria occur in other parts of the coal formation, but in the underclay alone are the long thin leaves attached to them. In 1818 the Rev. H. Steinhauer published in the American Philosophical Transactions, vol. i. p. 273, a similar account of the occurrence in the English coal formation near Brad-

* I wish to correct an error in my Address of last year (p. 230), where it is stated, that the place of the roots of the upright trees discovered in the Bolton Railway was immediately *under* a thin bed of coal; the fact is, that they were all *above* this coal: the difference is material, for if the roots be all *above* the coal seam, these trees, like fir-trees in a peat-bog, may have grown upon the accumulating bed of vegetable matter which is now converted to coal.

The theory that coal, like peat, owes its origin to vegetables that grew on the spot it now occupies, has been entertained by DeLuc, Macculloch, Jameson, Brongniart, Lindley, and other writers, but I have nowhere before seen such convincing proofs of this hypothesis as are furnished by the facts advanced by Mr. Hawkshaw, Mr. Bowman, and Mr. Logan, taken in connexion with one another.

ford in Yorkshire, of continuous stems and leaves of Stigmariæ, differing from those lately observed by Mr. Logan only as to the greater vertical range to which the leaves extended. Mr. Logan has traced them in a vertical direction seven or eight feet from the stem, and more than twenty feet horizontally*, and concludes that it is impossible to account for these phænomena by any theory of drift. He further supposes the Stigmaria to be the plant of which fossil coal is mainly composed.

I think we may derive, from the important facts above quoted, a probable illustration of the processes by which the formation of a coal-field has been conducted. We may assume the areas now covered with coal to have been extensive flats and estuaries, receiving at intervals, during seasons of flood, large deposits of silt and sand, interspersed with leaves and broken branches and trunks of trees, drifted down with the detritus of not far distant lands. We may conceive large portions of the surface of these sedimentary deposits, after the cessation of the floods by which they were respectively transported, to have become the site of broad and shallow ponds or lagoons, which were speedily filled with a matted mass of floating stems and leaves of Stigmaria, to the exclusion of all other plants, in the same manner as the social plant, *Stratiotes aloides*, now crowds the ditches and shallow ponds in Holland, until the water is filled with a dense assemblage of individuals of this single species, leaving no intervals for the growth of any other plants. We may further admit, that by the deposition of mud or silt between the stems and leaves of Stigmaria, the bottom of each lagoon might have been overspread with the earthy sediments that compose the beds of fire-clay immediately below the coal; and that the same lagoon, after

* Mr. John Craig, of Glasgow, in an excellent paper on the coal formation of the West of Scotland read to the British Association at Glasgow, 1840, remarks that "the *Stigmaria ficoides* is frequently found in the shales, with the leaves attached to the stem and spread out laterally, in a manner which never could have occurred had the plant been drifted from a distance. The ripple-marks also (he adds), which are observable on almost all the shales and laminated sandstones throughout the whole carboniferous formation, show that these portions of the coal strata were deposited in very shallow water."

I learn from Mr. Binney that stems and leaves of Stigmaria abound in the beds of clay or fine sand that lie immediately below many beds of coal in the district of Manchester.

the deposition of these sediments, continued crowded with Stigmariæ, accumulating on one another until they had entirely filled the lagoon with a matted mass of stems and leaves, as modern shallow lakes are gradually filled up and converted into peat-bogs. The surface of the lagoon thus changed to a morass may forthwith have become covered with a luxuriant growth of marsh plants, *e. g.* with Calamites, Lepidodendra, Sigillariæ, &c., the exuviæ of which formed a superstratum of vegetable matter convertible to coal, resting upon a substratum composed exclusively of remains of Stigmariæ. The regions which were the site of this vegetable growth may, by successive subsidences, have been so reduced below the level of the water, as to make them the receptacles of alternating deposits of sand and clay (now converted to strata of sandstone and shale) between the several beds of incipient coal. During these processes, successive series of lagoons may have covered large portions of each last-formed drift; and every lagoon becoming the site of a renewed growth of Stigmariæ, may thus continuously have been laying the foundation and nourishing the materials of future beds of inestimably precious fuel.

In the case of beds of coal that alternate with marine deposits, it has been suggested that extensive subsidence of the estuaries on which lacustrine and terrestrial plants were growing, may have reduced these estuaries below the level of the sea, where the submerged strata of vegetable matter became covered with beds of encrinal limestone and other marine sediments; and that as these received upon their surface further sediments of sand and mud drifted by land-floods into the salt-water, the estuaries were gradually filled up, and again converted into lagoons, upon which a renewed growth of lacustrine and land plants forthwith began to accumulate the materials of other beds of coal.

Both in the marine and the freshwater strata that alternate with the coal-beds, we appeal to the three same intermitting and alternate processes of subsidence, drift, and vegetable growth; the subsidence being in the former case to a depth below the level of the sea, in the latter case to a depth which left the last-formed strata in a position to become the site of vast swampy flats and shallow lagoons. In both cases intermitting accumulations of the earthy materials of the strata over the subsided districts are referred to the transport of

sand and mud by powerful land-floods over areas which by subsidence had acquired a place that made them receptacles of the detritus of distant mountains; as we now see vast sheets of sediment transported from the Rocky Mountains and spread over the great flats and vast estuaries of the Red River, the Missouri, and the Missisippi. The regions on which these ancient alternations of salt-water and fresh-water deposits were going on, must in the mean time have presented extensive surfaces that were periodically oscillating between small distances above and below the level of the sea.

The concentric rings of growth which may be counted in a transverse section of the large coniferous trees whose roots are found resting on the upper surface of a coal-bed, may be quoted as evidence of the time during which it was fixed in this its place of growth; and as such trees may probably be found on the surface of many successive beds in the section of a coal-field, each stage of trees affords a chronometer by which we may calculate the number of years that intervened between the growth of each bed of coal.

In the Newcastle collieries, after the excavation of the coal, short trunks of trees drop down frequently from the roof of the mine, leaving vertical cavities, which the miners call pot-holes; these trees probably grew upon the surface of the vegetable mass by which the coal has been formed; and the occasional assemblage of large numbers of cones and seed-vessels of the same species, *e.g.* of Lepidostrobus and Trigonocarpum, upon one spot, seems to indicate that they dropped into their present place from the trees on which they grew.

Should the above hypotheses be correct, we may expect to find corresponding differences of organic structure on microscopic examination of the vegetable remains in the lower and upper portions of many beds of coal; and the attention of observers may at this time be profitably directed to the examination of thin slices of coal, carefully selected from different regions of the same bed, for the purpose of ascertaining whether differences exist between the component vegetables of the upper and lower regions of individual strata, sufficiently obvious and constant to justify us in referring the lower region of certain strata to a sub-aqueous, and the upper region to a sub-aërial origin. Should an entire bed of coal exhibit

no other vegetable structure than that of Stigmaria, it may be inferred that these plants had not so far filled up the lagoon in which they grew, as to convert it to a sub-aërial swamp, before fresh floods of water from the land overwhelmed these sub-aqueous vegetables with sand and silt. Should we find another coal-bed without any Stigmaria, and interspersed through its whole vertical extent with Calamites and other sub-aërial plants, indicating a swampy soil, we may conclude that the vegetables which formed this bed of coal grew upon humid and swampy flats adjacent to lagoons; and that whilst the latter were accumulating beneath their shallow waters the materials of a future bed of coal, formed exclusively of the aquatic Stigmaria, the adjacent flats were simultaneously accumulating materials destined for a similar function from the sub-aërial swamp-plants of the same era. But in the compound case of coal formed by the conversion of a shallow lagoon into a morass, we should find in the lower portion, next above the fire-clay, no other plants than the aquatic floating Stigmaria, and in the upper region of the same bed no traces of Stigmaria, but many kinds of sub-aërial plants; whilst in its middle region we should discover a contact of aquatic with sub-aërial plants.

We may explain the frequent occurrence of erect trees immediately above the upper surface of a bed of coal, as in the cases we have spoken of near Bolton and Chesterfield, by supposing the roots of these trees to have found support and nutriment in the entangled remains of other plants which had preceded them on the same spot, as the Scotch firs grow in peat without touching any subsoil; but cases of trees thus standing erect are comparatively rare exceptions to their ordinary state of prostration, caused either by decay or tempests, or by the violence of the currents that submerged and buried with sand and silt the morasses in which they grew.

Fragments and large stems of trees that are found truncated at both ends, and inclined in all directions in thick beds of sandstone, like the coniferous trees at Craigleith and Newhaven, near Edinburgh, seem to have been torn from their native bed and drifted with the sand to the place in which they are now imbedded.

Mr. Logan and Mr. L. L. Dillwyn have discovered pebbles or rounded fragments of coal in certain grit beds of the coal formation, from which we learn that some of the older beds of coal had

assumed an indurated state before the deposition of the more recent strata of this great formation, the total thickness of which in South Wales is 12,000 feet. At Penclawdd, on the Bury river near Swansea, Mr. Logan first found, in 1839, a rounded pebble of cannel-coal in a bed of clay; he subsequently discovered that in the Pennant grit of Kilvey Hill, near Swansea, there are many conglomerate beds containing pebbles of coal, intermixed with sand and pebbles of ironstone, and very rarely with boulders of granite and mica-slate. The pebbles are chiefly of common bituminous coal; two *only* have been found composed of cannel-coal, the *only* seams of which known in the lower coal-measures are 2000 feet below the Pennant grit. Mr. Logan believes that coal-pebbles occur throughout the whole mass of the Pennant sandstone, the thickness of which is 3000 feet, but he has seen no such pebbles in the lower coal-measures.

Mr. Buddle has lately found similar pebbles of coal in the Pennant grit of the Forest of Dean.

PARTIAL DENUDATION OF COAL DURING THE CARBONIFEROUS EPOCH.

We have received from Mr. Buddle an interesting paper upon a curious phænomenon in the Forest of Dean, improperly called the Horse *Fault*, being neither a slip nor dislocation, but only an interruption of the continuity of a bed of coal, called the Coleford High Delf, produced by the thinning out of the coal and substitution of sandstone in its place. The extent of this *Horse* has been traced about two miles in length, with a breadth varying from 170 to 340 yards. Besides the total absence of coal in this interrupted portion of the High Delf seam, the upper surface of this seam on each side of the so-called Horse presents an undulating line, causing the thickness of the coal to vary considerably, whilst its lower surface is symmetrical with the subjacent floor of shale, which continues uninterrupted across the space occupied by the Horse. The bed of sandstone next above this High Delf coal-seam is very thick (in one place 94 yards), and occasionally interspersed with pebbles of quartz and fragments of coal, and angular fragments of indurated sandstone containing casts of coal-plants. That portion of it which is called the Horse, fills the space sup-

posed to have once been occupied by the denuded portion of the coal-bed. Mr. Buddle considers this denudation, and also the undulations on the upper surface of the coal, to have been caused by currents of water passing over and removing portions of the stratum of vegetable matter which formed the coal before the deposition of the sandstone, which has filled these inequalities on the surface of the Coleford High Delf seam, and also the broad interruption of its continuity called the Horse Fault.

It is clear that violent currents must occasionally have been in action whilst the carboniferous strata were in progress of accumulation, for without them no kind of pebbles could have found access to the conglomerate beds that occur in this formation; whilst the passage of water over the lower strata of the carboniferous series may have torn off fragments both from the lower sandstones and the lower seams of coal, which the pebbles derived from them show to have been then consolidated.

BLACK BAND OF IRONSTONE IN SCOTLAND.

A most important discovery has recently been made in the coal formation of the West of Scotland, of several beds of ironstone (locally called the Black Band), which are of such great importance in the manufacture of iron, that its application to the smelting furnace has lately raised the value of a single estate at Airdrie more than 10,000*l.* per annum. There are several beds of this ironstone, varying from fourteen to twenty-two inches in thickness; they contain very little clay, and nearly as much carbonaceous matter as serves to calcine the iron; for this reason it is more valuable than the clay ironstones hitherto used, of which in this Scotch coal-field there are sixty-six. As it is probable that similar beds of this most valuable kind of iron ore may have hitherto been overlooked in other coal-fields, the attention of all coal-owners cannot too soon be directed to the discovery of the "Black Band" upon their own property*.

* Mr. Hawkshaw's observation as to the manner in which flashes of bituminous mud, from putrescent lagoons, overflow the country adjacent to them, in the tropical regions of Venezuela, on the arrival of rains after a season of drought, may illustrate the cause of the presence of the large quantity of inflammable matter which occurs in the rich iron ore of the so-called Black Band.

A similar discharge of bituminous mud from lagoons over the surface of

COAL FORMATION IN WIGTONSHIRE.

Mr. Carrick Moor has given us a paper on the West Shore of Loch Ryan in Wigtonshire, showing that sandstones and shale of the coal formation form a narrow band nine miles in length parallel to Loch Ryan; in some parts of which have been found *Stigmaria ficoides* and Calamites, but hitherto no useful beds of coal. On these coal-measures rest nearly horizontal beds of a red sandstone breccia, and beneath them greywacke, probably Silurian, abounding in graphtholites.

COAL IN SICILY, NEW ZEALAND, NEW HOLLAND, BORNEO, SOUTH AMERICA, AND KERGUELEN'S LAND.

At a time when steam navigation is assuming a character of incalculable importance to the world, the discovery of coal in any maritime position in distant regions that lie upon the great commercial highway of nations, demands the attention of all whose duty or interest it is to facilitate the means of rapid intercourse between the most distant extremities of the habitable globe.

Respecting Sicily, we have been informed by Dr. Calvert that he has himself seen a bed of good tertiary coal three feet thick, close to Messina, in a Fiumera to the left of Fort Gonzago, from which thirty years ago the English commander and himself laid in a stock for their winter fires, and which was used by our dragoons for their forge; although this is probably of tertiary formation, it may, like that of Cadebona, afford useful fuel.

From New Zealand I have seen a specimen of coal very like that of Staffordshire, found on the north shore of the southern island, near Cape Farewell, by the crew of a boat accidentally landing at the base of a cliff, in which the first thing noticed was a bed of coal

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certain beds of growing vegetables in the time of the coal formation, may have been the cause of converting the beds thus overflowed and impregnated with bitumen into Kannel or Candle coal; and an argument in favour of this hypothesis is supplied by the fact of the microscopic structure of the plants in Candle coal being more distinctly and universally preserved throughout the entire mass, than in ordinary coal. Similar bituminous irruptions may have caused the sudden death and perfect preservation of the fossil fishes that swarm in certain beds of highly bituminous shale of the coal formation, as also in the copper slate of the Hartz, and other bituminous shales.

three feet in thickness projecting over their heads. This coal in all probability will not only have material influence on the future destiny of the neighbourhood in which such a valuable repository of fuel has been found, but will also facilitate the intercourse by steam between this rising colony and our flourishing establishments in Van Diemen's Land and Australia.

In New Holland, in 1840, the Australian Company sold about 27,000 tons of coal at Newcastle on the river Hunter, with a rapidly increasing demand. And we learn from the Port Phillip Gazette, Oct. 28, 1840, that at Western Port, near Port Phillip, an exploring party has discovered coal of excellent quality, but at some distance from water-carriage.

Mr. Tradescant Lay has also laid before us a notice of the existence of coal, or valuable lignite, in the island of Borneo: should a large supply of it be found in this island, it may become a station of inestimable value for effecting intercourse by steam between China, India and Australia, and the great islands of the Malay Archipelago.

It appears by recent accounts from Valparaiso, that an abundant supply of good coal has lately been obtained at Talcahuano, with which the steamer Peru has made a successful voyage to and from Copiapo*.

We have just learnt from Captain James Ross that good coal has been discovered in Kerguelen's Land in the Southern Ocean.

* As no more coal is in process of formation, and our national prosperity must inevitably terminate with the exhaustion of those precious stores of mineral fuel which form the foundation of our greatest manufacturing and commercial establishments, I feel it my duty to entreat the attention of the legislature to two evil practices which are tending to accelerate the period when the contents of our coal-mines will have been consumed. The first of these is the wanton waste which for more than fifty years has been committed by the coal-owners near Newcastle, by screening and burning annually in never-extinguished *fiery heaps* at the pit's mouth, more than one million of chaldrons of excellent small coal, being nearly one-third of the entire produce of the best coal-mines in England. This criminal destruction of the elements of our national industry, which is accelerating by one-third the not very distant period when these mines will be exhausted, is perpetrated by the colliers, for the purpose of selling the remaining two-thirds at a greater profit than they would derive from the sale of the entire bulk unscreened to the coal-merchant.

The second evil is the exportation of coal to foreign countries, in some

CHALK.

Mr. W. Hamilton has found, near the ruins of Teos, a white cretaceous limestone resembling that described by Mr. Strickland near Smyrna, where it contains Hippurites; he found the same limestone also in the Peninsula of Cape Krio, near Cnidus, at the south-west extremity of the Gulf of Cos; and blue crystalline limestone at Scala Nuova, and at Boodroom on the hills north of the town, under the remains of the Acropolis of Halicarnassus. The island and shores of the Gulf of Syme are also composed of a mass of compact white scaglia or chalk with bands and nodules of siliceous limestone.

The greater part of the Island of Rhodes is composed of chalk containing flints, forming a prolongation from the chalk of Mount Taurus, and partially covered with tertiary strata. In Mount Atairo, the scaglia rises to a narrow ridge nearly 4000 feet high. The Acropolis of Camiro also stands on a table-rock of chalk. In Rhodes the chalk is partially covered with tertiary formations.

Mr. W. C. Williamson has furnished a notice on some fossil shells from Syria, collected chiefly on a part of the Lebanon range immediately above Beyroot: the rocks are here composed of hard cream-coloured limestone containing many veins of flint; the shells, of which twelve species have been sent home, one of them a Hippurite, and a single fish, *Clupea brevissima*, Ag., tab. 61. f. 6, indicate a near alliance to the chalk formation. We have similar evidence of chalk on Mount Lebanon in the well-known fishes from that range, which Agassiz refers to the epoch of the cretaceous deposits.

IGNEOUS ROCKS.

We have, from the Rev. D. Williams, an account of a mass of trap, intersecting the mountain limestone, red marl and lias at the W. end

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of which it is employed to work the machinery of rival manufactories, that in certain cases could scarcely be maintained without a supply of British coals. In 1839, 1,431,861 tons were exported, and in 1840, 1,592,283 tons, of which nearly one-fourth were sent to France. An *increased duty* on coals exported to any country, excepting our own colonies, might afford a remedy. See note on this subject in my Bridgewater Treatise, vol. i. p. 535.

of Bleadon Hill, on the Bristol and Exeter Railway. It resembles in its character that of Hestercombe, on the flank of the Quantoc Hills N.W. of Taunton, and is the first discovery of trap connected with the line of elevation of the Mendip chain. This protrusion of trap is attended by a remarkable fault, which brings the edges of bent strata of lias into contact with those of mountain limestone. Mr. Penistone has also supplied an instructive section of this cutting. The nearest known trap rocks to the Mendips are that of Hestercombe in the Quantoc Hills just mentioned, and that near Tortworth and Berkeley.

In a paper on the Isle of Madeira, Mr. Smith of Jordan Hill has supplied, I believe, the first geological description of this island, the structure of which has long been a desideratum to geologists. Little has hitherto been known beyond the fact that all its shores and its general aspect are volcanic; Mr. Smith has at length discovered sections at the elevation of about 2000 feet, in the central part of the island, which exhibit compact limestone, containing fossil remains of Conus and many other shells of the tertiary period. Nothing is visible beneath this limestone, but above it are lofty precipices which exhibit several beds of sub-aërial lava, lapilli and ashes, alternating with beds of soil converted to brick by the beds of lava incumbent on them. In some of these volcanic beds of loose texture, there occur abundant remains of small roots of trees converted to carbonate of lime, in which few traces of structure have been preserved. I have occasionally seen similar remains of roots, in a state of lac lunæ, in loose calcareous sand, and gravel-beds in England, *e. g.* in the coralline gravel of the lower greensand formation at Coxwell, near Faringdon, and in a diluvial sand and gravel-pit near Claydon in Buckinghamshire.

We have, from Mr. W. Hamilton, a notice of the existence of volcanic formations near the Bay of Fouges (the ancient Phocæa), on the N. extremity of the Gulf of Smyrna, principally trachyte, passing downwards into pumiceous sandy rock, and traversed by trap dykes which have altered the adjacent rocks into imperfect jasper. At Ritri also, on the Bay of Erythræ, opposite Scio, he found trachyte associated with limestone and sandstone older than the trachyte, the limestone being sometimes vertical; near the Acropolis he found vertical strata of indurated shale and jasper, and calcareous beds

much shattered. On low hills near the shore, and on which the ruins of Halicarnassus stand, Mr. Hamilton has also found beds of volcanic sand and trachytic conglomerate; and from Boodroom, six miles S.W., to the hill of Chifoot-kaleh, trachyte, or trachytic conglomerates; he found trachyte also on the promontory of Karabaghla.

SUBSIDENCE OF THE LAND AT PUZZUOLI.

In a letter on the subsidence of the coast near Puzzuoli, Mr. Hulmandel has shown cause to believe that a gradual subsidence of the soil has been going on for many years, from the fact communicated to him by the oldest friar (aged 93) in the Capuchin Convent at the entrance of Puzzuoli, that the road towards Naples, which when he was young passed between the Convent and the sea, has been obliged to be changed in consequence of the gradual subsiding of the soil. In 1813, the refectory and entrance-gate were from six to twelve inches under water when the wind blew strongly from the west; such submersions were unknown thirty years ago.

ROCKS OF RECENT ELEVATION.

We have from Captain Lloyd an account of an enormous coral reef, almost entirely surrounding the volcanic island of Mauritius; near the Rivière de Galets the sea has worn a barrier of coral from five to fifteen feet high, into most fantastic shapes; and at a considerable distance in the interior of the island, there occur two headlands of coral twenty-five feet above the level of the sea, which present the same marks of abrasion as the reef now exposed to the waves.

The observatory stands on a bed of hard coral ten feet above high-water mark, and at several places in the interior of the island are large blocks of coral surrounded with the debris of marine shells and broken corals. These phænomena seem explicable only on the theory of a recent elevation of those parts of the island on which these coral reefs occur.

LEAD-MINES IN SPAIN.

We have, from Mr. J. Lambert, an account of the lead-mines of the Sierra Almagrera in the S. of Spain, in the province of Almeria. The principal vein occurs in clay-slate resting upon mica-slate, and

its direction is nearly N. and S.; its greatest breadth, in 1840, was nine feet, its chief produce galena with carbonates of lead, iron, and copper: near it are the remains of old workings by the Romans, with large heaps of slags and ancient scoriæ. At the foot of the Sierra Almagrera are strata of tertiary formation. We have also from Mr. Lambert an account of other lead-mines in the Sierra de Gador, between the Sierra Nevada and the Mediterranean. This range is principally composed of transition limestone, alternating with clay-slate and talcose slate: these mines also were worked by the Romans; the lead occurs in small masses or nests, and also in veins and branches of limited extent, which intersect each other and communicate with the nests. At the mine of Arnafe, a bed of lead one foot thick, and accompanied by clay, occurs between two beds of limestone. Similar beds are found in all the mines on the W. declivity of the Sierra.

In the interior of the Sierra the beds exhibit great dislocations, forming crests and hollows, that contain the greatest masses of ore, conforming to all the modifications of the bed. No lead has been found at a greater depth than 200 yards.

At the bottom of many fissures, fragments of ore are found associated with pebbles of the limestone. The best mines will soon be destroyed by improvident methods of working.

PALÆONTOLOGY.

MAMMALIA.—OSSIFEROUS CAVERNS.

Mr. R. A. C. Austen, in a notice on the bone caves of Devonshire, at Torquay and Yealmton, disputes the opinion that the bones in these caves, many of which are evidently gnawed, have been dragged in by the agency of hyænas, founding his objection on the assumption that modern hyænas "do not inhabit caves," and "never drag away their prey, but devour it greedily on the spot." Mr. Austen must have overlooked the evidence of Busbequius, quoted in my 'Reliquiæ Diluvianæ,' p. 22, 1st edit., "Extrahitque cadavera, portatque ad speluncam suam," and cannot have heard of the gnawed bones in the Oxford Museum, extracted by Col. Sykes from the depth of eighteen feet in a cave, at the mouth of which he shot both the male and female hyæna that inhabited it,

and descending its interior ran his head against a putrid portion of an ass which stuck across and obstructed the passage.

Mr. Austen is disposed to substitute the agency of lions for that of hyænas in the work of collecting the bones that are so abundant in the caves of Devonshire, and correctly states that the bones of lions, or a large Felis, larger than a lion, have been found in nearly all the ossiferous caverns. Now in all the caves of which I have any experience, the remains of lions are very rare in comparison with the number of hyænas' bones in the same cavern ; and without denying to these few lions their lion's share in the work of killing their prey and eating the flesh, I must claim the bones as the perquisite of their more ossifragous brethren, and demand justice to the hyænas, as the chief, I do not say the exclusive, agents in dragging them to their dens.

The proportion of teeth in the cave of Kirkdale indicated one lion to nearly 100 hyænas.

REPTILES.

Professor Owen, in a recent paper on the teeth of the Labyrinthodon (Mastodonsaurus of Jaeger), a genus common to the keuper of Germany and to the lower sandstone of Warwick and Leamington, has added another example to the many before produced by him, of the immense importance of microscopic odontology in geological investigations.

Two years have scarcely elapsed, since, by the application of this infallible test, he at once transferred the supposed reptile Basilosaurus of Virginia to a genus allied to the Dugongs in the class of Mammals ; and as if in recompense for this abduction from the family of Reptiles, he has now, by the same microscopic test, removed even the supposed approximation in the form of the teeth of the Mastodonsaurus to that of a Mammal, and shown it to be nearer that of Ichthyosaurus than of any other animal. Professor Jaeger had already shown, by the basilar bones of the head, that his Mastodonsaurus was a huge Batrachian reptile allied to the Salamanders, and its teeth, not yet submitted to microscopic examination of their transverse section, presented no apparent peculiarity of internal structure ; it was reserved for the microscope of Owen to discover within this tooth a condition of cerebriform convolutions or laby-

rinthoid gyrations, hitherto unknown in the entire animal kingdom; and on this just ground he substitutes the characteristic name Labyrinthodon for that of Mastodonsaurus, which implied affinities that have no existence.

The fang of the tooth of the Ichthyosaurus offers the only known approximation to the plan of that of the Labyrinthodon, but on a more simple scale, and had been hitherto considered the most complex condition of dental structure in the family of Reptiles; in both these animals the external layer of cement is inflected inwards to a certain distance from the circumference towards the centre in straight and vertical folds at pretty regular intervals, which are occupied by dentine radiating from the interior of the tooth; but in the tooth of Labyrinthodon, this dentine, or ivory, is composed of calcigerous tubes $\frac{1}{7000}$th of a line in diameter, radiating and converging with primary curvatures and secondary undulations in a manner unexampled in the history of dentition. This gigantic Batrachian prototype of the Bull Frog, Mr. Owen has discovered to be the author of the footsteps ascribed to the so-called Chirotherium. Teeth of two smaller species of Labyrinthodon have been found by Dr. Lloyd in the sandstone of Warwick, and although no English teeth of the Stutgard species have yet been submitted to the microscope, Mr. Owen strongly suspects that the cast of a large jaw containing several teeth, from Guy's Cliff, near Warwick, the original of which has been mislaid in the Oxford Museum, is identical with the Labyrinthodon Salamandroides of Stutgard; thus almost demonstrating the evidence required by Mr. Murchison and Mr. Strickland* to show the identity of the Warwick and Guy's Cliff sandstones with the keuper of Germany. Mr. Owen concludes, that if on the one hand geology has derived essential aid from minute anatomy, in no instance has the comparative anatomist been more indebted to geology than for the fossils which have revealed the most singular and complicated modification of dental structure hitherto known, and of which no conception could have been gained from an investigation of the teeth of living animals.

Professor Owen has communicated to us a Report on two new fossil reptiles, recently acquired by Sir P. Egerton from the chalk

* Geol. Trans., N.S., vol. v. p. 345.

of Kent: one of them a tortoise, allied to the Chelonians which now live in fresh water, or in estuaries; the other a small Saurian, which has teeth generically distinct from any known Lacertians, and resembling the points of stout packing-needles; to this new lizard in the chalk he has given the name *Raphiosaurus*.

Mr. Mackeson has discovered in the bottom of the lower greensand formation near Hythe a very large tibia and several other bones which he refers to the Iguanodon, spread in the quarry over a length of fifteen feet; in the same quarry were a large Ammonite, a Gervillia, and other marine shells characteristic of the lower greensand. We have in these bones another case similar to that of the nearly entire skeleton of Iguanodon found in the greensand near Maidstone, and transferred with Mr. Mantell's collection to the British Museum; showing the duration of the Iguanodon to have extended beyond the period of the Wealden freshwater formation into that of the greensand. In both these cases the carcases must have been drifted into salt water from some not far distant land, the site of which we cannot conjecture to have been nearer than Devonshire, Normandy, or the Ardennes.

ICHTHYOLITES.

Respecting the bone-bed in the Severn near Aust Passage, and at Axmouth Cliff near Lyme Regis, which has hitherto been referred to the bottom of the lias formation, Sir P. Egerton and M. Agassiz have found ichthyological reasons for considering it to be connected with the Triassic or new red sandstone group; because they find in it the teeth of four species of fishes hitherto discovered only in the muschelkalk or *grès bigarré*, and never in the lias, viz. *Gyrolepis Alberti*, *G. tenuistriatus*, *Saurichthys apicalis*, and *Hybodus plicatilis*. It remains to examine the bones of the larger animals in this stratum to ascertain how far they agree with the Saurians of the Triassic system or of the Lias. The teeth of Ceratodus, figured by Agassiz, and many other teeth in the bone-bed not yet described, are unknown in the lias.

During the past year great additions have been made to our stores of knowledge, and specimens in fossil Ichthyology, by the presentation to our Museum of a very large and rich collection of fishes

from the lower beds of the old red sandstone near Forres, which we owe to the zeal and liberality of Lady Gordon Cumming of Altyre.

Her Ladyship and her eldest daughter have further contributed most accurate and exquisitely finished drawings of many fossil fishes from the same locality, in illustration of Dr. Malcolmson's paper on the old red sandstone. These ladies have also supplied many other drawings to the forthcoming volumes of Professor Agassiz. Further information on the fishes of the old red sandstone has been acquired by the diligent researches and extensive collections made in the same department of Palæontology by many scientific gentlemen in the counties of Caithness, Elgin, Nairn, Aberdeen, Forfar and Fife; following up the researches that were begun in this almost new and most curious subject by Dr. Fleming, Professor Sedgwick, Mr. Murchison, Dr. Traill, Dr. Malcolmson and Mr. H. Miller.

The three great subdivisions of the old red sandstone in these counties, with their characteristic genera of fishes, have, by these extensive researches, been fully corroborated, whilst a vast increase has accrued to the known number of species of fishes which appear to be peculiar to the upper, middle, and lower regions of this great formation.

The visit of Professor Agassiz to Scotland in September last, and the grant to him by the British Association of 100*l.* to aid in collecting materials for the publication of a memoir on the fossil fishes of the old red sandstone, have opportunely afforded a concurrence of circumstances most favourable to the diffusion of a new and brilliant light on our future researches in this very ancient department of Palæontology.

Before he left Scotland, Professor Agassiz had recognised, in various collections he visited in that country, undescribed Ichthyolites sufficient to enable him to establish fifteen genera, and more than forty species, the greater part of them not yet named, in the old red sandstone formation*. We have in these details a palæontological confirmation of the fact that the old red sandstone is a system di-

* The names of these new genera are *Acanthodes, Cephalaspis, Cheiracanthus, Cheirolepis, Coccosteus, Ctenacanthus, Ctenoptychius, Diplacanthus, Diplopterus, Glyptolepis, Holoptychius, Onchus, Osteolepis, Platygnathus, Pterichthys.*

stinct from any other formations; all its numerous Ichthyolites being different from those of the carboniferous system above it, and also different from the few fishes yet found in the upper region only of the Silurian system next below it.

Mr. Murchison, during his extensive tour in Russia, in the late summer, has enlarged our knowledge of the range of these curious fishes and of the old red sandstone over vast regions in the north-east departments of Europe. Thus the ichthyological fauna of the old red sandstone has within a few years been found to be one of the richest and most prolific kind; and its extinct species are much more curious and remarkable than those of any other formation, by their deviation from the conditions of existing genera and species. Their most characteristic feature is an immense development of bony matter and enamel on the surface of the skin, thus approaching to the external dermal skeleton of Crustacea and Insects. One of these fishes, the Pterichthys, is so largely and almost entirely encased with bony plates and scales, that it was at first mistaken for a fossil Water-beetle.

The nearest analogies we find among modern fishes to the great development of bony matter and enamel upon the head and scales of many of these ancient species, is that afforded by the large external bones which form the head and large bony dermal scales upon the body of the modern Sturgeons, which further agree with these fossils in having no internal bony skeleton.

Another analogy occurs in the large external bones of the head of the Flying Fish, and of the common Gurnard. These bones are also beautifully studded with ornamental tubercles, arranged in symmetrical groups like gems and pearls on a jewel. This character is most strongly dominant in the tuberculated bones of the fossil genus Coccosteus. The enormous proportion in the size of the head to that of the body in the Gurnard, affords another approximation to a condition of frequent occurrence in the extinct genera of the old red sandstone, and which has given its characteristic feature to the genus Cephalaspis.

Another frequent character in the fossil fishes of the old red sandstone consists in the absence of any internal bony skeleton, as in the modern Sturgeons. The large bony dermal scales, first noticed many years ago in the old red sandstone of Fife by Dr. Fleming, and then

referred by him to a fossil Sturgeon, have been confirmed by Prof. Agassiz as belonging to a genus nearly allied to the modern Sturgeon, and like it possessed a cartilaginous skeleton, of which no traces remain in the fossil state.

Among living fishes, a further analogy to this cartilaginous condition of the internal skeleton has recently been found by Professor Owen in the Siren, a fish of equivocal aspect, provided with lungs as well as branchiæ, and considered as a reptile by preceding writers; it lives in the muddy bottoms of the shallow lakes of Senegal, which are periodically dried up, the fish meantime remaining immured alive in a kind of cocoon of indurated mud. In the cartilaginous skeleton of this existing Siren from Senegal, the anatomy of which has been admirably demonstrated by Professor Owen, we find a beautiful analogy to the cartilaginous condition of the skeleton of many of the most ancient fossil fishes; and this analogy explains the circumstance of the frequent absence of any remains of an internal bony skeleton within the often perfect dermal covering of many species of fishes in strata of the older formations.

From these recent discoveries in Scotland, and the examination of the unexampled collections of fossil fishes in the museums of Lord Enniskillen and Sir P. Egerton, and in other cabinets in this country and on the Continent, Prof. Agassiz has now extended his total number of species of extinct fossil fishes to more than 1700, of which nearly 250 new species have been the fruits of his recent visit to Great Britain and Ireland. I have elsewhere spoken of the inestimable value of the discoveries of Agassiz in the department of fossil ichthyology, not only in relation to geological investigations, but also to zoology and physiology. In his history of the rapid progress he has made within the last six years, it has been duly and gratefully acknowledged by him, that his now voluminous work, the 'Poissons Fossiles,' must at an early stage have ceased for lack of funds, without the liberal support it has received from a large list of subscribers in this country, and from pecuniary grants of the British Association.

In the necessary preparations for this large and costly work, M. Agassiz had accumulated in his portfolio a splendid collection of drawings, chiefly by Dinkel, not less beautiful as works of art, than precious as being the originals of the plates in his great scientific

monument, the 'Poissons Fossiles;' but, engaged as he is in a multitude of other costly and splendid scientific works, the Professor of Neufchatel was anxious to employ the capital thus locked up in his portfolio in a way more profitable to science, by causing it to fructify in the production of other publications. By a recent accident this fact came to the knowledge of Lord Francis Egerton, who forthwith proposed to become the purchaser of this entire collection of original drawings, about 1200 in number, permitting M. Agassiz to retain at Neufchatel the unpublished portion of them as long as may be convenient for the completion of his work. Such opportune and liberal interference to advance the progress of a work of pre-eminent scientific value is becoming of a nobleman long distinguished as a patron of Art, and whose conviction thus substantially shown of the value of researches which are rendering such inestimable service to Science, evinces his Lordship's worthiness of his position as President of the Geological Society at Manchester*.

FOSSIL CRUSTACEANS.—GIGANTIC SPECIES OF EURYPTERUS.

It will be in the recollection of those among us who have watched the progress of the recent rapid discoveries of fossil fishes in the old red sandstone, that at the Edinburgh Meeting of the British Association (1834) a most anomalous fossil from the old red sandstone of Clashbinnie, in the county of Forfar, and considered by the discoverer to be a fish resembling the Angel Fish, was rejected by Agassiz from that class of animals; whilst neither he nor any other naturalist could even conjecture to what class in the animal kingdom it should be referred, and in this enigmatic state it was left by Agassiz in the notice given of it in his 'Poissons Fossiles.' At the late Meeting at Glasgow, this enigma found its solution by our recognising in the College Museum some of the most perplexing characters of the Clashbinnie fossil in two large specimens of Eurypterus in sandstone from the coal-field of that neighbourhood. We had before seen, at the Edinburgh Meeting, a remarkable fossil Crus-

* M. Agassiz has acknowledged in some of the leading scientific journals of the Continent the liberality with which Lord Francis Egerton has thus come forward to facilitate the progress of researches, in which the scientific world is deeply interested.

tacean, nearly of the size and form of a large Molucca crab, found by Dr. Simson in the carboniferous limestone of Kirkton near Bathgate, between Edinburgh and Glasgow; and Dr. Harlan had described and figured a smaller species of Eurypterus from the carboniferous limestone of the United States (see Fourth Report of British Association, 1834, p. 643). We have, therefore, now extended our knowledge of the range of this very remarkable family of Crustaceans from the sandstone and limestone of the coal formation downwards into the old red sandstone.

M. Fischer de Waldheim has lately discovered a new species of Eurypterus, *E. tetragonophthalmus*, in the transition formation of Podolia, nearly allied to the small species in the grauwacke of Westmoreland in New York, on which this genus was founded by Dr. Dekay. (Annals of the Lycæum of Nat. Hist., vol. i. p. 375, pl. 29.)

FOSSIL ARACHNIDANS.

In the family of Arachnidans we have an account by M. Corda, in the Report of the National Museum of Bohemia, 1839, of a second new genus of fossil Scorpioid, *Microlabis Sternbergii*, discovered by the late Count Sternberg in 1838, in the same quarry with the new genus Cyclophthalmus, found by him a few years before in a similar sandstone of the coal formation at Chomle, near Radnitz, in Bohemia*. M. Corda places this new fossil in the class of Pseudo-scorpions, near the Chelifer and Obisium of Leach: it is larger than the living *Obisium carcinoides*. In this, as in the *Cyclophthalmus Sternbergii*, the skin is preserved in several parts of the body in the state of a brown, semi-transparent, horn-like substance, over which pores of the tracheæ and indications of hairs are dispersed at regular intervals. The enduring nature of the peculiar substance (chitine or elytrine), of which, like the elytra of beetles, the skin of scorpions is composed, explains the cause of its perfect preservation in such ancient sandstone. M. Corda justly considers these two fossil scorpioids of Bohemia (the only two of which any account has been yet published) to be among the most remarkable discoveries of modern times.

The Marquis of Northampton has recently acquired four new

* Figures of this unique fossil are given in pl. 46. of my Bridgewater Treatise.

species of fossil spiders, one of them imbedded in the lithographic stone of Solenhofen, the other three from the freshwater formation of Aix. The Solenhofen fossil has ten legs, and is considered by Mr. J. E. Gray to be nearly allied to the genus Nymphon, the living species of which are found parasitic on marine animals; and in the same stone with it is a fossil Ophiura, to which, when living, it may have been attached. Each of the three from Aix has eight legs; they are all probably freshwater spiders of the genus Argyroneta, and two of them are of the same species. In the same freshwater limestone with one of them is an impression resembling a Chelifer or Book Scorpion, having the claws of a scorpion but not its tail.

FOSSIL INSECTS.

We noticed last year Mr. Brodie's discovery of the wing of a Libellula and other insects in the Wealden freshwater formation near Dinton, in the vale of Wardour, in Wiltshire. Mr. E. F. Strickland has more recently found a very perfect fossil wing of another Dragonfly in the lias of Warwickshire, near Evesham, on which the opake spot usually found at the anterior margin of the wing in Libellulidæ is distinctly marked. The nervures on this wing closely resemble those on recent species, and approach most nearly to the genus Æshna. The occurrence of Libellulidæ has not hitherto been noticed in any formation older than the lithographic stone of Solenhofen, in the upper region of the oolite series; and the discovery of a species so nearly allied to the existing genus Æshna in the lias formation, where it is associated with reptiles differing so widely from existing forms as the Ichthyosaurus and Plesiosaurus, leads to curious speculations respecting the fauna of this early period.

The discovery of land insects in strata that are, for the most part, crowded with marine remains, is explained by supposing multitudes of insects to have been occasionally drifted by tempests into the sea. In the Proceedings of our Society, vol. ii. p. 688, is a notice by myself of a hitherto unique example of a large neuropterous wing in the Stonesfield slate, a marine formation at the top of the inferior oolite, more nearly allied to the Hemerobius than to any other modern insect. With this Hemerobioid are found at Stonesfield abundant elytra of coleopterous insects, and the bones of insectivorous marsupial quadrupeds and Pterodactyles. In the Mu-

seum of the University of Glasgow I saw, in September last, remains of some small hymenopterous insects attached to fragments of coal from the neighbourhood of that city, but of these no careful examination had then been made.

A large wing of a neuropterous insect, resembling the living Corydalis of Carolina, in a nodule of clay iron ore, probably from the coal-field of Staffordshire, has been figured by Mr. Murchison in his 'Silurian System' (pl. 13 *a.*) from a specimen in the Museum of Mr. Mantell.

FOSSIL RADIATA.

The history of fossil radiated animals has, during the last year, received a valuable accession from the publication, by Professor Agassiz, of the second part of his description of the fossil Echinodermata of Switzerland*.

The family of Cidarides forms the exclusive subject of this memoir, being the most numerous of all the families of Echinites, and at the same time the earliest form under which shells of this kind appear to have existed; they are the only family that occurs so early as the muschelkalk, whilst no other family of Echini is found in formations older than the Jurassic, in which the Cidarides are most numerous; they abound also in the cretaceous and tertiary formations, and in our actual seas†. In the Jura mountains they are most numerous in a stratum, called *Terrain à Chailles*, abounding, with other littoral shells, near the middle region of the oolite formation.

Professor Agassiz has also published the first monograph of another splendid work, 'Monographies d'Échinodermes, vivans et fossiles,' which will be extended to ten or twelve parts, to be completed in three or four years, and will contain about 150 plates, some of them coloured, from careful drawings of this most beautiful class of shells. Collections of casts of all the fossil species of this class known to M. Agassiz may be obtained by purchase, or in exchange for objects of natural history, at the Museum of Neufchatel.

* Mémoires Nouveaux de la Société Helvétique des Sciences Naturelles, vol. iv.

† Cidarides have recently been found in the carboniferous limestone of the Mendip Hills, near Frome, by Miss Bennet, and by myself in the carboniferous limestone near Donegal, in 1811.

In the family of Star-fish two new fossil genera have been recently established by Mr. Gray*, one of these, Comptonia, founded on a specimen from the whetstone pits in the greensand of Blackdown, Devon, recently acquired by the Marquis of Northampton; it is preserved in the state of beautiful chalcedony, and explains the intermediate character of the genus Cœlaster of Agassiz. The other new genus Fromia, comprehends the curious tesselated star-fishes found in the chalk, and also a recent species found in various parts of New Holland.

Professor Agassiz will shortly send an artist to England, to figure for his great work on living and fossil Echinoderms, the individual specimens which Mr. Gray has described in his Monograph on Star-fish. It is a new and important feature in the progress of zoology and palæontology, that this much-neglected department of radiated animals is at length receiving that attention which, from the time of Henry Linck, who dedicated a large volume on this subject to Sir Hans Sloane (1733), to the moment when it has recently been resumed by Nardo, Agassiz, and Gray, it has so long merited in vain.

SPONGES IN CHALK FLINTS.

Mr. Bowerbank, in a paper on siliceous bodies in the chalk, greensand, and Portland oolite, has applied the evidence of microscopic observation to confirm the opinion long entertained by many naturalists, that the tuberous forms of chalk flints and chert are due to organic bodies acting as nuclei, or centres of attraction, to the silex of which these tubercles are composed. Mr. Parkinson, in his interesting work on 'Organic Remains of a Former World' (1808, vol. ii. p. 87 *et seq.*), had noticed acicular spicula, which he found to be common to fossil sponges and fossil Alcyonia; and in pl. 7. fig. 8. of the same vol. he represents the magnified appearance of cruciform spines in a fossil Alcyonite resembling the *Alcyonium cynodium* of Linnæus, and quotes Donati as having described and delineated them before him. It has also long been known that a large proportion of the chalk flints in Wilts, Oxon, and Bucks, contain, within a grey external siliceous crust of variable thickness, a nucleus of semi-transparent flint, often of a purple tint, and exhibit-

* See Monograph on Star-fish, Ann. Nat. Hist., No. 36, Nov. 1840, p. 175.

ing distinctly a congeries of tubes and net-work, nearly allied to modern Alcyonia; these Alcyonia were supposed to have acted as nuclei, or centres of attraction, which became first surrounded by the crust of grey flint, bearing no traces of organization, and subsequently penetrated by a kind of red or purple chalcedony, taking the place of the particles of animal matter as they gradually decayed. This hypothesis has been modified by Mr. Bowerbank, who has superadded the agency of parasitic sponges, which he supposes to have attached themselves to the alcyonic nuclei, and also to Echini and other shells, forming round these organic nuclei a covering or crust of sponge, which assumed, in its mode of growth, those irregularly tuberculated forms that are so common in, and are almost peculiar to, chalk flints.

Having submitted to his microscope thin slices of chalk flints, in search of Foraminifera and Xanthidia, he observed, together with them, patches of brown reticulated tissue and spongiform spicula pervading the entire mass of the flints under examination; this spongiform structure was further pervaded by many tortuous cylindrical and minute canals of uniform diameter, which appeared to be the incurrent canals of the sponge, and by other orifices of greater diameter, resembling excurrent canals. He thinks that the mode in which the spicula, foraminifers, and other extraneous bodies are equably dispersed throughout the silex, shows that these bodies were entangled in the spongiform tissue in which their fossilization has taken place.

With respect to the Echini and other shells, which are more or less filled with, or surrounded by grey flint, he supposes the parasitic sponges to have grown both around and within the cavity of these shells, and in the case of Echini to have sometimes protruded outwards, sending forth branches through their orifices from the parasitic sponge within. He cites the parasitic habit of some modern sponges, which are found investing shells and other substances, in support of this hypothesis.

In chalk flints from Wiltshire he found the spongiform structure and spicula pervading the grey crust that enclosed many zoophytic nuclei; but within these nuclei were neither spicula nor any of the minute extraneous bodies which are frequent in the tubular spongiform crust. The character of these fossil sponges differs from that of any recent sponge.

In chert from the greensand of Fovant, Wilts, and from Lyme Regis, Mr. Bowerbank found a similar but coarser texture; and also in chert casts of Spatangi from the greensand near Shaftesbury. In chert from Portland and Tisbury he found similar cellular tissue, but larger, and in texture more like the modern freshwater sponge.

Mr. Bowerbank supposes the organic matter of the sponges and zoophytes to have afforded to the silex stronger centres of attraction than were offered by the siliceous spicula of the sponges; and there is a geological consideration which seems to favour the hypothesis, of the siliceous matter of chalk flints whilst in a semifluid state having been segregated from the compound mass of lime and silex of the nascent chalk beds, by the attraction of some organic body, in the facts that the upper region of the English soft chalk, which most abounds in flints, is nearly pure carbonate of lime; whilst the lower region of the hard chalk is usually destitute of flints, and has silex diffused throughout its entire substance. I cannot, however, but think there is something too exclusive in Mr. Bowerbank's theory as to the universal presence of parasitic sponges in the external crust of every chalk-flint, and which admits of no case in which an Alcyonium or any kind of extraneous body in chalk may, without the co-operation of a sponge, have become externally invested with a crust of silex of the same kind with that which he allows to have been attracted to corallines and alcyonic bodies by the animal matter they contained.

MICROSCOPIC SHELLS.

Mr. Tennant has informed me that a microscopic examination of the Stonesfield slate by Mr. Darker, and of other oolites, has recently shown them to be crowded with remains of organized bodies, invisible to the naked eye. I learn also from Mr. Tennant that abundant microscopic organic remains have recently been discovered in thin slices of certain beds of carboniferous limestone from Derbyshire; similar results may shortly be expected from a microscopic examination of the chert of the same formation. We must not however be tempted by these discoveries to rush suddenly to the rash and unwarranted conclusion, that all limestone and all silex is of organic origin.

It has not yet been shown that the granules resembling the roe of

fishes, which give character to the oolite formation, and abound occasionally in limestones of the triassic, carboniferous, and silurian series, have any necessary connexion with organic bodies. We may with Ehrenberg admit and admire the extent of microscopic chambered shells and Infusoria, which he has shown so largely to pervade the chalk and other calcareous and siliceous formations, without claiming an exclusively animal origin for the entire substance of all rocks in which lime or silex are the principal ingredients.

When we recollect what great discoveries have been already made in the investigations of fossil botany by means of the microscope, and look to the inestimable value of the information obtained by Professor Owen, as to the structure of the teeth of fossil fishes, reptiles, and mammals, and see the wonderful results of the application of this new power to the examination of chalk and flint by Professor Ehrenberg, Mr. Lonsdale and Mr. Bowerbank, we may justly congratulate ourselves on the commencement of a new epoch in microscopic palæontology.

GEOLOGICAL DYNAMICS.—GLACIAL THEORY.

During the last year M. Agassiz has introduced a new and powerful machinery into the Dynamics of Geology, by asserting the claims of ice to be admitted to the list of locomotive forces that have operated largely not only in forming *morains* (*i. e.* mounds and ridges of gravel and clay intermixed with large fragments of rocks) on the flanks and at the lower extremity of existing glaciers, but also in transporting erratic blocks with the detritus of morains to distant regions, and re-arranging them by the force of floods that originated in the melting of ice and snow.

In the month of June 1840, a notice was read to us by him on the polished and striated surfaces of rocks in the beds of glaciers in the Alps; and another notice in the following November, on the evidence of the existence of glaciers in Scotland, Ireland, and England. In the summer of 1840 he published in Switzerland, in his 'Etudes sur les Glaciers,' a description of facts which lie at the foundation of this question, illustrated by a splendid series of plates, representing the actual condition and residuary effects of existing glaciers in the Alps. These phænomena are so essentially preliminary to the investigation of the evidences of ancient glaciers in

regions where they are now unknown, that no man is fully qualified to enter upon this question who has not prepared himself by the study of modern glaciers with a special view to their *residuary phænomena*, which have been overlooked, or referred to other causes by preceding observers in Alpine regions.

After due acknowledgment of the discoveries of Scheuchzer, Gruner, De Saussure, Hugi, Venetz, and Charpentier, M. Agassiz examines the origin of glaciers in the transformation of snow into solid ice, the different conditions of this ice in its various stages of advancement, the causes of its movement, the history of the detritus that falls upon it and is transported along its surface and lodged in the form of morains upon its sides and at its lower extremity, and the modifications of these morains by the waters of temporary ponds and lakes formed upon and within the glaciers. He also investigates the action of modern glaciers in polishing and producing striæ, ridges and furrows, and rounded bosses resembling wool-sacks (*Roches moutonnés* of De Saussure and *Roches bosselées* of Hugi), on the surface of the hardest rocks over which they pass; and also in grinding to the state of pebbles fragments of rocks that are forced along their bottoms, and in transporting to great distances large blocks of stone interspersed through the substance and poised upon the surface of morains.

Within the records of history the lower terminations of many glaciers have varied considerably, and the morains left by them in the valleys show the extent to which the ice has descended in times comparatively modern. Agassiz has recognized the association of similar residuary phænomena not only in valleys of the Alps below the level of the present glaciers, but along the whole south-east flank of the mountains of the Jura, which run parallel to the Alps at the distance of fifty miles on the north-west side of the great valley of Switzerland. He finds on the Jura limestone, at various heights, from the level of the Lake of Neufchatel to three thousand feet, evidences from which he infers that glaciers descending the great valleys of the Alps have extended across the entire valley of Switzerland over the lakes of Neufchatel and Geneva (then converted into ice), until their course was stopped and deflected in directions parallel to the Jura by the obstructing barrier which this mountain-chain presented. These evidences consist, 1st, in erratic angular

blocks of the granite of Mont Blanc, and other rocks from the high Alps, lodged on the south-east face of the Jura in insulated positions, and frequently upon banks of sand and gravel analogous to the morains now forming in the Alps; 2ndly, in the frequent occurrence of polished surfaces, striæ and furrows on the Jura limestone, similar to those now produced at the bottom of existing glaciers; 3rdly, in the coincidence of these striæ with the direction in which a glacier from the Alps would have been deflected by the barrier presented to it by the Jura, and their non-coincidence with the slope of these mountains; 4thly, in the existence upon the polished surfaces of the Jura limestone of funnel-shaped cavities (*couloirs*), and small indentations similar to the *lapiaz* we see daily forming at the bottom of glaciers by small and temporary cascades descending through cracks and chasms of the ice.

M. Agassiz contends, that this quadruple series of phænomena, which are common to the south-east slopes of the Jura, and to the bottom of existing glaciers in the Alps, is inexplicable on any theory of aqueous action apart from ice; and still further argues, that the concurrent appearance of similar phænomena in other regions of the world justifies the inference that these also have been the site of glaciers. He moreover infers, that very large portions of the now temperate regions of the globe have for a long period been enveloped with a winding-sheet of snow and ice.

In November 1840, the evidence of the existence of glaciers in Scotland and the north of England has been brought before us in three communications: the first detailing the observations of M. Agassiz and Dr. Buckland conjointly during a recent tour in Scotland; the second recording Dr. Buckland's observations in Scotland, Northumberland, Cumberland and Westmoreland; and the third containing evidences of glacial action collected by Mr. Lyell in Forfarshire and the valley of Strathmore.

The phænomena in Scotland, wherein M. Agassiz and Dr. Buckland recognized the evidences of glacial action, consist in the union of rounded, polished, striated and furrowed surfaces with morains and transported blocks, analogous to the similarly associated phænomena upon the Jura and in the Alps. They are described in the six following localities. 1st, the morains on the summit level of the road between Inverary and Loch Awe: 2ndly, the rounded, polished and

striated surfaces of granite near the water's edge at the ferry of Bunawe, and the morains adjacent to it near Mucairn: 3rdly, the polished and striated surfaces of granite, between high and low water, at the ferry of Ballahulish on Loch Leven: 4thly, the rounded, polished and striated surfaces, accompanied by morains, in Glen Roy and the valley of the Spean; from the position of which they infer that the lake, to which many writers have referred the origin of the parallel roads of Glen Roy, was caused by two glaciers descending from Ben Nevis across the valley of the Spean, in the same manner as in 1818 a temporary lake was formed by a barrier of ice in the Val de Bagnes above Martigny; and as at this time, a barrier formed by the glacier of Miage protruding across the Allée Blanche is the sole cause of the Lake Combal, which would immediately be left dry like Glen Roy, should any cause remove the protruding barrier of the glacier of Miage*: a fifth locality, in which there is the same concurrent evidence of morains loaded with transported blocks, and of rounded and polished surfaces on the sides and bottom of a mountain valley, occurs near Sir George Mackenzie's residence at Coul, at the south-west base of Ben Wevis: the 6th and last locality visited conjointly was the site and neighbourhood of the town of New Aberdeen, where the polished surface of the granite had been noticed by Dr. Fleming, and where remodified detritus of morains forms the hillocks of gravel between the town and the sea on the north side of the estuary of the Dee, and cliffs of gravel and till or boulder clay occur on the south of the same estuary.

In another communication Dr. Buckland records his observation of similar phænomena in the valley of Strathmore; in the highland valleys of the Tay and Tumel; on the north-east shoulder of Shiehallion; in the high pass of Glen Cofield, between Taymouth and Strathearn; in Glen Lednoch and Glen Turret, on the north of Comrie; on the sides of Loch Earne; and in the valley of the Teith between Loch Katerine and Doune.

In the lowland districts he notices also the occurrence of rounded, polished and striated surfaces upon the top of the basaltic rocks of Stirling Castle, on the north face of the Castle Rock at Edinburgh, at Blackford hill, on Calton hill, the Costorphin hills, and

* See Captain Basil Hall's Patchwork, vol. i. p. 114.

other hard trap rocks near Edinburgh, many of which have been described and attributed to diluvial action by Sir James Hall.

In Northumberland Dr. Buckland describes an immense accumulation of morains, or detritus of morains, at the east base of the Cheviots, near Wooler. And in the lake districts of Cumberland and Westmoreland he found the sides of many mountain valleys and gorges, by which the waters of these lakes have their exit to the adjacent plains, to bear marks similar to those produced by glaciers, viz. rounded, striated and polished surfaces, accompanied by the accumulation of mounds of gravel and erratic blocks in the low countries subjacent to them.

Mr. Lyell has read a paper on the evidences of the action of ice in Forfarshire, and has re-examined that county in order to satisfy himself whether the boulder formation of that district, which he had previously regarded as the effect of drift-ice on submerged land, might be explained by the agency of ice acting on land already elevated above the sea. This latter conclusion he is now inclined to adopt, believing that it is favoured by the mounds of transported materials bearing the form of morains, and for the most part unstratified, which occur on the sides of almost every valley in the Grampians, and sometimes *across the glens* at right angles, and almost blocking them up. He finds this opinion further confirmed by the local distribution of rocky fragments, and the evidence of their descent from higher to lower levels; and, lastly, he thinks that the rarity of organic remains in the till or boulder clay lends support to the same view. He mentions several deep lakes in the Grampians in Forfarshire, on the lower sides of which enormous accumulations of mud, gravel and angular blocks are strewed, which are derived from precipices on their higher side; these materials would have filled up the lakes, unless we suppose them to have been formerly occupied by ice.

The effects of drift-ice in producing alternations of stratified and unstratified deposits, and in causing curvatures in strata of sand and gravel, while underlying beds remain horizontal and undisturbed, were treated of last year by Mr. Lyell in a paper on the mud-cliffs of Norfolk. But in Forfarshire the till, or unstratified matter containing boulders and angular blocks, is found everywhere underlying the stratified sand and clay; had the whole deposit been accumulated under water, we might have expected alternations; Mr. Lyell there-

fore conjectures that the older till may have been formed in great part when the glaciers were gradually advancing over the country, at the period of the first coming on of a colder climate, and that portions of the morains may have become subsequently stratified in temporary lakes, or during floods in those valleys where stratification is observable.

Another feature in the distribution of the transported materials of Forfarshire and Perthshire is a continuous stream, from three to three and a half miles wide, of boulders and pebbles, traceable from near Dunkeld by Coupar and the south of Blairgowrie into Strathmore, and thence in a straight line through the lowest depression of the Sidlaw hills from Forfar to Lunan Bay, a distance of thirty-four miles. No great river follows this course, but it is marked everywhere by lakes or ponds, which afford shell-marl, swamps, and peat-mosses, commonly surrounded by ridges of detritus from fifty to seventy feet high, consisting in the lower part of till and boulders, and in the upper part of stratified beds of gravel, sand, loam, and clay, which in some instances are curved or contorted; the form of the included spaces is sometimes oval, sometimes quadrangular. No organic remains have been found in the surrounding ridges, but they resemble greatly in form the mounds of detritus which may once have constituted the lateral, transverse, or medial morains of a great glacier.

Mr. Lyell compares the chain of this part of the Grampians to the Alps, the parallel chain of the Sidlaw hills to the Jura, and Strathmore to the great valley of Switzerland; and the resemblance, he says, is increased by the occurrence in Strathmore and on the Sidlaw hills of blocks derived from the Grampians. He is of opinion that the agency of ice moving upon dry land may account for many appearances which are inexplicable on any other hypothesis, and that this theory must not be rejected because it fails to remove at once every obscurity; especially as various other geological causes, such as oscillations of level in the land, the temporary submergence of portions of it during the supposed glacial period, and the action of drift-ice, may all have co-operated with glaciers to produce the boulder formation. He also hints, that the glaciers of Switzerland, being situated eleven degrees further to the south, can present but an imperfect analogy to the state of things which may once have prevailed in Northern Europe; it is to Sandwich or Kerguelen's Land, or to

South Georgia, and other regions of the southern hemisphere corresponding in latitude to Scotland and England, that we must look for instruction; for these southern and antarctic lands are buried summer and winter beneath perpetual snow, which reaches even to the sea-coast, and yet in the case of South Georgia this perpetual snow is distant only nine hundred miles from Terra del Fuego, a country placed in the same latitude and yet clothed with luxuriant forests. Assuming therefore that the Grampians, Alps, and Jura, and all Scandinavia, were once permanently overspread with snow, he thinks we cannot therefore conclude that the whole globe between the fortieth parallel and the poles was invested simultaneously with a sheet of ice, nor even that the general climate of the whole earth differed materially from that prevailing in our own time.

Mr. Murchison, in an admirable chapter (c. 39.) of his Silurian System, on the Position and Mode of Transport of Boulders which occur in the Northern Drift, has stated good reasons for believing that such a change of climate may have taken place at the epoch of the transport of erratic blocks as permitted the formation of icebergs on the shores and rivers of Cumberland, Scotland, and Ireland; which being drifted southwards, strewed their load of large stones and gravel over the bottoms of then adjacent seas. He also quotes with approbation the ingenious imagination by Mr. C. Darwin, of a proportional distribution of the land and water in central and northern Europe, very different from the present, and under which the southern part of Scotland might present an island "almost wholly covered with everlasting snow," having each bay terminated by ice-cliffs, from which great masses yearly detached would transport fragments of rocks to distant regions; and infers, that as in other parts of the world *there are* conditions in which ice becomes a motive power, such conditions *may* also have existed in our latitudes.

Mr. Murchison has also proposed to explain the dispersion of erratic blocks now resting on beds of clay and sand containing recent species of arctic shells over large districts in the interior of Russia, by supposing "that they had been floated in icebergs, which breaking loose from ancient glaciers in Lapland and the adjacent tracts, were drifted southwards into seas which have been since laid dry." He further suggests, that icebergs loaded with detritus may, by grating upon the bottom of these seas, have produced the parallel striæ and

polished surfaces on the rocks over which they were drifted ; and concludes with admitting so much of the glacial theory as to allow that in former days glaciers probably advanced further to the south, and occupied many insulated tracts, and to a much greater extent than at the present day.

We learn from Professor Hitchcock's excellent work on Elementary Geology (August 1st, 1840), that parallel striæ and furrows, accompanied by rounded and polished surfaces of all the harder rocks, and that vast longitudinal mounds and tumuli of detritus, and erratic blocks sometimes at the distance of many hundred miles from their native place, have been lately observed in so many provinces of the United States, that these phænomena may be placed in the category of geological constants in North America. They have been noticed in Maine, New York, New England, Rhode Island, Massachusetts, Connecticut, Ohio, Michigan, and Illinois, at various elevations, sometimes from 3000 to 4000 feet above the level of the sea ; the prevailing direction of these striæ and furrows is from N.W. to S.E.

We have also long been familiar with the streams of erratic blocks that have been traced south and south-eastwards from the mountains of Scandinavia to the shores of Germany ; and more recently Sefström and Bötlingk have informed us that polished striated and furrowed surfaces are also of constant occurrence in Norway, Sweden, Finland, and Lapland, their mean direction being, like the course of the erratic blocks, from N.W. to S.E. Bötlingk, however, has observed that some of these furrows have centres of dispersion, (as in the case of those produced by modern glaciers that radiate from the Alps), and follow the direction of the major axis of each valley, whilst the general direction of the striæ on the summits in Scandinavia is from N.W. to S.E. He, moreover, states, that in the south of Sweden the striæ incline southwards, but on the east of Lapland northwards to the icy ocean ; the same conformity in the direction of the striæ with that of the major axis of each valley, occurs also in Scotland, Cumberland and North Wales.

Thus we find, that not only the highest and northern mountain groups in the British Islands, but vast regions also of the continents of Northern Europe and of North America have been subjected to the same great physical forces, glacial and diluvial, under much colder conditions of the northern hemisphere than prevail at present ;

and this apparently at a time intermediate between the extinction of European and American elephants by cold, and the creation of the human race. We have not yet, however, sufficient materials for the full admeasurement of the amount of influence which has been exercised by ice in its various forms upon the surface of the globe, and the following are important desiderata. With respect to elongated ridges and tumuli of gravel, it remains to discriminate how far they may have been derived from, or modified by, the action of ice under one or more of the three following conditions: 1. Were they lodged by glaciers alone, without the agency of water, in the form of morains on their flanks and front? 2. Have they been stranded by icebergs loaded with gravel upon the shores of lakes, or estuaries, or seas? 3. Have they been dropped in deep water by floating and melting icebergs, and re-arranged by whirlpools and conflicting currents in the form of oblong reefs and groups of obtuse cones which they actually present? Another large field of inquiry must be forthwith entered upon, in the distinctions we shall have to make between raised sea-beaches and each of the three last-named residuary effects of glacial action.

With respect to *scorings* also and *dressings* on the surfaces of rocks, it is very desirable that we should find some criterion whereby to distinguish between the grinding effects of glaciers marching slowly along dry land, and of icebergs dredging the bottom of the sea, and of large stones and gravel drifted simply by water, in producing striæ, grooves and furrows, together with rounded and polished surfaces on the rocks over which they respectively advance.

I see not yet by what test we may distinguish these residuary phænomena where they occur in regions now remote from either of the causes most competent to their production, viz. in countries that now enjoy a temperate climate and are in some cases elevated nearly four thousand feet above the level of the sea; for where the supposed agent is ice armed and transfixed with stones projecting like the teeth of a file from its base and sides, the effects of similar instruments on similar materials would probably be the same, by whatever cause a slow progressive motion may have been imparted to them; and whether on dry land or beneath the sea.

It remains, moreover, to ascertain to what extent the sudden elevations of land may have produced great movements of water

and diluvial inundations by gigantic waves, analogous to those which are occasioned by modern submarine volcanic action; and to inquire into the effects that may have been produced on the sides and bottoms of valleys of denudation by the drifting of the hard materials that must have been swept through them at and after the time of their excavation.

A further subject of inquiry is, whether there be parallel striæ and furrows on the truncated and abraded surfaces of older rocks that have been overlaid by more recent strata, after an interval in which these surfaces had been exposed to the action of the sea. In cases of this kind that have come under my observation, the surfaces have only been cut off transversely and ground smooth, like the shores of the present seas; but they have no such parallel striæ as those which are of general occurrence beneath diluvium or drift*; nor have large erratic blocks from distant regions been found mixed with the gravel of any of the older conglomerate rocks.

One great cause of the difference of opinion between the diluvialists and the glacialists, is the exclusiveness with which each party would insist upon the agency of the cause which they respectively adopt: the diluvialist apparently errs in refusing to admit the agency of glaciers in mountain valleys that are below the existing limits of ice and snow; whilst Agassiz may have erred in urging too far his theory of expansion as the great locomotive power of glaciers over regions whose surface is too little inclined to admit their progression by the force of gravity; a middle way between these two extreme opinions will probably be found in the hypothesis, that large portions of the northern hemisphere which now enjoy a temperate climate have at no very distant time been so much colder than they are at present, that the mountains of Scotland, Cumberland, and North Wales, with great part of Scandinavia and North America, were within the limits of perpetual snow accompanied by glaciers; and that the melting of this ice and snow was accompanied by great debacles and inundations which drifted the glaciers with their load of detritus into warmer regions, where this load was deposited

* They are sometimes also perforated by lithodomous molluscs, and otherwise beset with parasites, which indicate a period of tranquillity between the action of the forces by which they were shorn away or made smooth, and the deposition of the stratum that was subsequently formed over them.

and re-arranged by currents at vast distances from the rocks in which it had its origin. The contest will probably be settled, as in most cases of extreme opinions and exclusive theories, by a compromise; the glacialist will probably abandon his universal covering of ice and snow, and be content with glaciers on the elevated regions of more southern latitudes than now allow of their formation; the diluvialist, retaining his floating icebergs as the most efficient agents in the transport of drift and erratic blocks to regions distant from their place of origin, may also allow to glaciers their due share in the formation of morains and striated surfaces, in latitudes and at elevations that are no longer within the zones of perpetual congelation.

NOTICE OF DECEASED MEMBERS.

In His Grace JOHN late DUKE OF BEDFORD, our Society has to deplore the loss, in which many other public scientific bodies participate, of a truly English nobleman, who was a liberal patron and an accomplished cultivator of literature, science and the arts.

The department of science to which he was most attached was Botany, which he pursued, not only by collecting in the park and gardens and conservatories of Woburn the most choice and beautiful vegetable productions of every region of the earth, but by printing four splendid botanical works on the four great vegetable families of Grasses, Heaths, Willows and Pines*. In the cultivation of the latter family, like his friend the late Lord Grenville, he took especial delight; but whilst, to cite his own words from a letter to Sir William Hooker, "The study of nature in the productions of the Forest, the Garden and the Conservatory formed one of his most favourite pursuits†," he was not less attentive to literature

* 1. Hortus Gramineus Woburnensis, by Sinclair, 1816.
2. Hortus Ericæus Woburnensis, 4to. 1825.
3. Salictum Woburnense, 1829. 50 Copies.
4. Pinetum Woburnense, 1840. 100 Copies.

None of these works were ever permitted to be offered for sale.

† In another letter to Sir William Hooker he says, "to botany I am more indebted than it is possible for me to express. From that pursuit, under the blessing of God, have mainly been derived to me the health of my body, the culture of my mind, my relaxation at home, my enjoyment

and the study of the fine arts; and his taste and knowledge in the latter department are attested by two sumptuous volumes, the one relating to the Woburn marbles, the other to the history of the house of Russell*. His love of botany led him by necessary connexion to horticulture and agriculture; and with a just appreciation of the value of science in its application to these most useful arts, he maintained in the gardens of Woburn an extensive collection of the various kinds of Grasses; as being that family of plants which beyond all others is of paramount importance, in affording the grand supply of nutriment to man and beast. In still further elucidation of the practical advantages to be derived from a scientific knowledge of these most useful members of the vegetable kingdom, and their adaptation to various soils, culture and climates, he supplied materials for the publication by his gardener, Mr. Sinclair, of an account of experiments on the produce and nutritive qualities of different grasses and other plants used as the food of the more valuable domestic animals; with practical observations on their habits, the soils best adapted to their growth, and the sorts most profitable for various kinds of pasture lands, and for alternate husbandry, accompanied with the discriminating characters of their species.

Whilst thus dedicating his hours of leisure, his garden and estate to the great national work of affording an example of a ready method to increase the amount of the agricultural produce of the country, he felt a further gratification in the consciousness that he was carrying out the plans of his elder brother, to whom he had been devotedly attached, and who had been cut off (A.D. 1802) in the commencement of a highly enlightened course of agricultural improvements. The same affectionate feelings induced him to continue through life the valuable system of practical instruction to the cultivators of the soil of England which his predecessor had begun. He saw and duly appreciated the importance of teaching by example rather than by precept in a matter so palpable as the growth of two ears

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in the fields, many of my most agreeable and honoured acquaintances, and several of my dearest friends."

* 1. Outline Engravings and Descriptions of the Woburn Marbles.

2. Historical Description of Miniatures in Enamel, by Bone, from family portraits at Woburn Abbey.

of corn where only one had grown before; and in a subject not less interesting to the owners and occupiers of the soil than to the nation, viz. the communication of knowledge as to the best methods of improving the breed of stock; and in doing this to large assemblages of farmers at the annual sheep-shearing at Woburn, he anticipated by more than a quarter of a century the universal feeling that has recently given birth to the Royal Agricultural Society of England, and proclaimed to the nation the necessity of applying the discoveries of science to the improvement of agriculture.

His Grace was also an extensive planter, and well aware of the advantages of scientific management of woods and forests; a matter too much neglected in this country, but which forms the subject of special education in almost all the other states of Europe.

In relation to Geology, His Grace had studied with more profit than usually attends the speculative consideration of such subjects, the effects of actual causes in filling up estuaries and marshes, and gradually converting them into valuable land; and by the artificial process of warping and silting to preserve and fix the tidal sediments, he co-operated with nature in this effective process of transmuting swamps and shallow lakes into the most fertile cornfields and verdant meadows. The excavations that came under his review in the operations of deep draining in the fens, called his attention also to the phænomena of bog timber and peat, which seem frequently to have grown in situations below the high-water level of the sea; and he had formed just and lucid theoretical views as to the difficult problem of the causes and conditions which could admit of the growth of peat mosses and forest timber in such situations.

The most important of the great works of drainage undertaken by the late Duke of Bedford was that called the Nene outfall drainage; it consisted of a new tidal channel for the river Nene, about seven miles long, commencing six miles below the town of Wisbeach, and terminating in the sea. The engineers employed in this great operation were the late Mr. Rennie, Mr. Telford and Sir John Rennie. The difficulty of the operation consisted in its being cut through light incoherent sand, liable to be moved by the flux and reflux of the tide. The new channel was dug to nearly half the depth required (about eleven feet), when the old course of the

Nene was dammed up, and its waters being turned into the new channel, in a few weeks deepened it eleven feet more, with an inclination of about four inches per mile, precisely as the engineers desired and had anticipated. The bottom of this channel is from 80 to 100 feet wide, and its surface at high water from 200 to 300 feet. The object of this measure was to turn the course of the Nene from the shallow and shifting sands of its natural estuary in Cross Keys Wash; and to improve at the same time the navigation of the Nene, the drainage of the district, and the communication between the counties of Norfolk and Lincoln. By its successful execution the surface of the river at low water has been reduced nearly eleven feet, thus producing an outfall sufficient for the perfect drainage of a most valuable tract of fens; ships of 400 tons have taken the place of shallow barges in the Nene; the trade of Wisbeach has been increased from 50,000 to nearly 120,000 tons a year; a bridge and embankment have been substituted for a long and dangerous shallow ford between Norfolk and Lincolnshire; and 1500 acres of the old estuary have already been recovered from the sea, whilst more is in progress of recovery. A further collateral advantage has attended this work, from connecting with it a portion of the great Bedford level, imperfectly drained by His Grace's ancestors; so that a district called *the North Level*, containing 50,000 acres, and adjacent districts, amounting altogether to 60,000 acres, has now a perfect drainage in the wettest seasons through the new channel of the Nene, and has become one of the most fertile and prosperous agricultural districts in England, in which agues and marsh fevers exist no more.

The general level of these fens being about midway between high- and low-water mark, the drainage is accomplished by self-acting sluices, which open to let out the water during the ebb, and are shut by the pressure of the rising tide. Under the preceding imperfect drainage the fens depended chiefly on the tedious and uncertain action of windmills for lifting the water above the impediments that obstructed its passage to the sea. Of this great work of national improvement the late Duke of Bedford was the mainspring and chief conductor; the large extent of his Grace's property in the district naturally gave him the greatest interest in its success, and threw the chief direction of the measure upon his

hands; and the generosity and perseverance with which he devoted himself to the superintendence of it inspired a general confidence throughout all the parties engaged with him in this costly and arduous undertaking.

I learn from Sir John Rennie's report and estimates on the improvement of the navigation of the river Nene, and for the more efficient drainage of Moreton's Leam Wash and Whittlesea Mere; and from a pamphlet lately published (1840) by Mr. Tycho Wing on the navigation of the Nene, that a further grand work of drainage is in contemplation under the auspices of the present Duke of Bedford and Earl Fitzwilliam, for draining, by means of the Nene outfall, Whittlesea Mere and a large district of contiguous fens, at a cost of £360,000, with a proposed benefit of recovering 5000 acres from their present condition of shallow lakes and morasses, and of giving a perfect drainage to 50,000 acres besides those now occupied by these lakes*.

Many and honourable are the wreaths that intertwine to form the civic crown of John late Duke of Bedford, the just reward of his various and unceasing labours to advance the useful and ornamental arts of peace, and ameliorate the condition of his country; but from none of these labours will he derive more lasting fame, and a higher title to the gratitude of posterity, than from the great improvements in the agriculture of England which have followed from the example he has set; and from the completion he effected, of that great and difficult operation, the perfect drainage of the fens connected with the Bedford Levels. In this drainage he has finished a work fraught not only with private emolument to himself and the other proprietors of the vast tracts of valuable land recovered from a state of unwholesome and unprofitable swamps; but pregnant also with national advantage, by augmenting the productive powers of the soil of England; and glorious, as forming the consummation

* We may form some estimate of the public as well as private benefits resulting from operations of this kind, from the case of a tract of fen in the Isle of Ely, called Padsols, of which, in the year 1800, 800 acres were sold for 800*s.*; in 1816 part of this fen was let for 2*s.* 6*d.* an acre; in 1832, when the drainage was nearly completed, it was let for 10*s.*, and is now let for 40*s.* an acre. The rent of this whole district has increased sevenfold since 1830.

of a work of ages, which beginning with the Roman conquerors of Britain, and continued at various intervals by the successive possessors of the country, has received its full accomplishment under the auspices of the noble family of Russell.

In Mr. Richard Bright, of Ham Green, near Bristol, the Society has lost one of its first members. He was both a patron and cultivator of geology and mineralogy in a generation earlier than our own. Born in 1754, he died in 1840, at the age of 86.

Throughout the more busy years of his life he was an intelligent merchant, much engaged in promoting the commercial improvements of his native city. Honest, warm, and disinterested, he won early and maintained steadily, during a period of more than sixty years, the universal love and respect of his neighbours; and the best proof of this lay in that most enviable power he had acquired of conciliating and guiding men of all sects and opinions in the pursuit of objects of public utility, and the perfect confidence with which his friends resorted to his judgement and advice in the more delicate affairs of private life.

Upwards of sixty years ago Bristol possessed many zealous and intelligent individuals who understood the value of science and had cultivated it; and several had already made good progress in forming valuable geological collections; Catcott had bequeathed a large and interesting collection of minerals and organic remains to the Bristol Library. Bristol was then the cradle of English geology; Townsend, Richardson, and Smith resided in its immediate neighbourhood, and there Smith commenced his most important generalizations.

A love of chemistry acquired in youth under Priestley and Aikin, a personal intimacy with Whitehurst, and a commercial connexion with mines of Cornwall, made Mr. Bright an early collector, and William Smith and Richard Phillips lent him their willing assistance.

Though the metropolis was never his place of residence, he availed himself of frequent visits thither in earlier years to acquire an extensive and accurate knowledge of the pursuits of men of science. Before he had reached the age of manhood in 1774, we find him interested in the best construction of chemical furnaces, and studying Dr. Black's 'Tables of Double and Single Attractions.' In

1780 he was a member of a private Philosophical Society in London, composed of names* which are to this day almost all held in respect or reverence. It met once a fortnight, on Friday evenings, at the Chapter Coffee House, from seven till nine.

When Davy quitted Penzance for Clifton and assisted Dr. Beddoes in delivering chemical lectures, Mr. Bright's attachment to the science revived with double force. He attended these lectures with eagerness and delight; established a well-appointed laboratory in his own garden; and the tarnished dollars, which in 1800, on the announcement of Volta's discoveries, assisted in forming a galvanic pile, are still preserved.

About this time he was much interested in the discovery of large masses of sulphate of strontian in the fields adjoining his house at Ham Green. Specimens of these, beautifully crystallized, were found in nearly an horizontal stratum immediately under the soil: at the same spot, the magnesian conglomerate has since yielded specimens of meiomite.

Mr. Bright's influence and taste and knowledge of architecture were often employed in behalf of his native city. The library, the infirmary, the asylum for the blind, the college, the observatory, are among those establishments for which in succession he has laboured; and on none did he bestow more of his time and thought than on *The Bristol Institution*, both at the period of its formation in 1822, and for the eighteen years which intervened between that and his decease. Provincial establishments of this kind were at this time new experiments, and when political feelings were strong, he co-operated most efficiently with his friends Dr. Beake, then Dean of Bristol, Mr. Harford, Mr. Sanders, and The Rev. W. D. Conybeare, to induce men of all parties to meet together on that neutral ground,—the formation of a scientific society for a common object —to promote the study of the works of nature, and the advancement of literature, science, and art.

Amid all his various scientific interests, mineralogy, geology, and fossil osteology claimed the first place. Cuvier's researches were

* Dr. Hunter, Dr. Crawford, Dr. Price, Dr. Priestley, Dr. Kier, Dr. Cleghorne, Dr. Quin, Dr. Wells, Messrs. Nairne, Aubert, Whitehurst, Horsefall, Jones (afterwards Sir William), Howard, Bolton, Kirwan, Blackhall, Bright, Benjamin Vaughan.

noted and abstracted in 1835 as earnestly as Adair Crawford's work on Heat was in 1779. He was as eager to possess and examine specimens of the fossil Infusoria of Ehrenberg at the age of 84, as he had been when scarcely twenty to hail a new discovery of his friend Dr. Priestley; and he felt as glad and excited in forming a personal acquaintance with the eminent geologists who came to the meeting of the British Association in 1836, as he had formerly been in his introduction to Franklin at Paris in 1777. At the age of 82, when bodily infirmity prevented him from taking any very active part in the proceedings of the British Association assembled at Bristol, he made his house and collections at Ham Green accessible to all its members. He was at that moment ardently following up the very latest discoveries in geology, and adding to his cabinet, with all the fervour and delight of youth, fresh accessions from the stores of organic remains, then newly discovered at the base of the Himalaya mountains.

He has published nothing. His name however may remain associated with the progress of science, by his liberal co-operation with Professor Whewell and the members of the British Association in the erection of a machine for registering the tides of the Avon upon a cliff overhanging that river, within the grounds of his residence at Ham Green, upon the very spot (though at the time it was unknown to be so) from whence Captain Sturmy made his observations which were transmitted to Sir Isaac Newton. During three years Mr. Bright undertook the special care and superintendence of this machine. The results of this register were peculiarly valuable in establishing the diurnal variation of the tides. When a machine of much superior construction was, after the lapse of three years, erected at the Hotwells, the original gauge at Ham Green became useless, and was removed. The new gauge is under Mr. Bunt's immediate care in *operation* as it was in *construction*, and his unremitting observations have already been rewarded by experimental proof of a very important general law, so recently announced, that it is possible I may be the first to give the intelligence to many of those who hear me, viz. that the variations of atmospheric pressure, as indicated by the barometer, exert a regular and very considerable influence on the height of high water in the Avon; an increase of atmospheric pressure, by which the mercury was raised one inch,

producing a depression of fourteen inches in the height of the water.

In his death our Society has to lament the loss of, I believe, the only father, who, during many years, has, together with two sons, been among the number of its most zealous and efficient members. To one of these sons, Dr. Richard Bright, we owe an early paper in our Transactions, on the Geology of his father's neighbourhood. He has travelled in the less-frequented parts of Europe, and published records of his journeys both in Iceland* and Hungary; the medical profession also acknowledge their obligation to him for several important works.

In the Rev. Dr. Cooke, of Tortworth Rectory, in Gloucestershire, we have lost a zealous member, whose early life was passed, before Geology was heard of, in academic pursuits as a Fellow and Tutor of Oriel College, Oxford, and whose taste for literature and the fine arts, and acute perception of the beauty of natural objects had prepared his mind to appreciate the value of those additions to natural knowledge, which the discoveries of geology caused to burst upon him, after he had passed the meridian of life. He was, in his early days, a frequent visitor of North and South Wales, with a view to the enjoyment of natural scenery; and from the time when he first became initiated in the mysteries of geology he found this enjoyment infinitely enhanced, by adding to the pleasures he derived from the contemplation of fine scenery, the further delight arising from the fascinating study of the subterranean structure of the earth, and of the organic remains of a former world. From the year 1818, when he became a member of our Society, until the infirmities of age arrested his activity, few summers passed in which he did not make some excursion to the most instructive geological localities of England, to enrich his cabinets with stores of well-selected organic remains, and follow up the progress of the most recent discoveries.

Dr. Cooke was a near relative of our valuable and frequent correspondent, Mr. Weaver, and a fellow-labourer with him in his searches on the neighbourhood of Tortworth, published in the first volume of the second series of our Transactions. He was a

* He accompanied Sir George M'Kenzie, and contributed to his work on Iceland.

man of taste, talent and energy, in whom, after early cultivation in another school, the ardour of geological pursuits became the ruling passion, which, together with all his mental faculties, continued unabated to the last.

Dr. Du Gard, one of the Honorary Members of the Society, maintained during a long life of professional practice in the town of Shrewsbury, the reputation of a well-informed and benevolent man. Highly esteeming the active cultivators of science, he welcomed them to his home, and threw open to them without reserve the stores of his local knowledge. He bestowed continual attention to all the geological discoveries in that neighbourhood, and made collections both of minerals and organic remains, which he presented to the Natural History Society recently established in Shrewsbury, among which are some remarkable minerals from the ridges of Caer Caradoc, and from the mining tract on the western flank of the Stiper Stones.

I am assured by Mr. Murchison that the geological and topographical knowledge of Dr. Du Gard were of considerable use to him in his investigation of the Silurian System near Shrewsbury, and that its value was much raised by the very friendly manner in which it was invariably communicated. On this point, indeed, I can myself speak with grateful recollections, for in the first geological tour which I ever made (1810), I was indebted to him for valuable information, and for minerals from Caer Caradoc, which he presented through me to the Oxford Museum. Dr. Du Gard made analyses of several springs of mineral water, near the junction of intrusive rocks with the older sedimentary deposits. Of two of these, Prolimoor near Wentnor and Admaston near the Wrekin, he published printed notices.

Robert Fergusson, Esq., of Raith, F.R.S. L. & E. & H.S., M.P. for the Kirkaldy district of Burghs, and Lord Lieutenant for the county of Fife, was elected into our Society in February 1809, soon after its formation on the 13th of November, 1807. In 1810 he was made one of the Trustees of the Society, and placed on the list of our Vice-Presidents, in which office he remained during the four years following. He was on all occasions a most liberal contributor to the wants of the Society. He assisted also in providing for the publication of Count Bournon's work on Crystallography, and

was a firm friend and supporter of that distinguished mineralogist, of whose aid he availed himself in forming one of the finest mineral collections of that time.

When, in the infancy of our establishment, an attempt was made to withdraw from the Geological Society all those members who were Fellows of the Royal Society, Mr. Fergusson steadily adhered to that line of conduct which our then President, Mr. Greenough, recommended, and which proved successful. He was an active member of our Council, and took great interest in all our proceedings, and was a frequent contributor also to our collection of minerals and Library; besides many other books, we are indebted to him for a complete series of the *Journal de Physique*, the numbers of which were transmitted at his cost as soon as published.

Mr. Fergusson was generous and amiable in disposition, courteous in manners, an ardent lover of truth, tolerant and charitable towards those from whom he differed in opinion; his hospitable mansion at Raith was ever open to the cultivators of science; the disciples of the school of Playfair found there an especial welcome, Leslie had a room in his house, and a workshop for himself whenever he chose to come. With Leslie he visited Cambridge in 1806, in the time of Dr. Edward Daniel Clarke; mineralogy and the Huttonian theory being at that time the principal scientific objects of his attention. During the peace of 1802 he travelled on the Continent, and visited Constantinople, Greece and Paris, where, and likewise at Constantinople, he met Dr. E. D. Clarke.

He never published any scientific memoirs, but was eminent as an enthusiastic patron of science and an encourager of knowledge of every description; mineralogy, geology and the fine arts were his favourite pursuits; he had a sound judgment in matters of geological theory; and was to the last one of our most steady friends and coadjutors, and among the most frequent attendants at our Meetings. In his death the Geological Society has to deplore the loss of one of its earliest associates, and most zealous and liberal supporters.

Mr. John Gibson was a native of Yorkshire, engaged in large chemical works at Stratford-le-Bow in Essex, to whom we are indebted for our first knowledge of the existence of fossil remains of extinct animals in the cave at Kirkdale. Being on a visit to his friends near

Helmsley in 1821, his attention was attracted by some bones he found thrown upon the road, together with stones from an oolite quarry adjacent to the church at Kirkdale. He at once perceived that they were not, as the quarry-men supposed, the bones of cattle that had perished by some murrain and been cast into a chasm of the rock, but that they were derived from animals no longer existing in the country. These bones were in quantity sufficient, not only to supply the cabinets of gentlemen in the neighbourhood, but also to enable Mr. Gibson to bring a collection of them to London, therewith furnishing an extensive cabinet of his own, and distributing liberally his duplicates to several public museums in London, including the British Museum, the Museums of the College of Surgeons and that of the Geological Society, of which Society he immediately became a member.

Mr. Gibson's attention being thus awakened to the consideration of organic remains, he soon discovered that, at Stratford-le-Bow, he was living in a land once inhabited by pachydermata that were contemporaneous with the ancient inhabitants of the cave of Kirkdale; and soon added to his rich osteological collection from Yorkshire the remains of elephants, rhinoceros, hippopotami, oxen and deer, which abound near Stratford in the brick-earth pits, that are extensively excavated at Ilford. In his death we have to deplore the loss of an acute and zealous discoverer and promoter of Palæontology; and it has become the bounden duty of all the cultivators of this science, and more particularly of myself, to record our sense of the judicious sagacity and liberality of Mr. Gibson, but for whom the catacombs of Kirkdale might never have been heard of, and their records of our Yorkshire Hyænopolis might have perished without finding an interpreter.

Dr. Laird. Our ingratitude would be unpardonable, if in reviewing the list of our losses during the past year, we omitted to pay our tribute of acknowledgement to one, who though personally known to but few of our present Members, has laid a deep obligation upon every individual among us by the services he rendered at the first formation of the Geological Society in 1807, as the colleague of Mr. Horner in the laborious functions of our secretariat. We are well aware of the labour and difficulties of the unobtrusive, but most important duties which devolve on this department in all pub-

lic establishments; and that an efficient secretary is always among the greatest benefactors, and usually the mainspring of the movements of infant societies. During the three first years of the existence of the Geological Society of London, we find the name of Dr. Laird associated with that of Mr. Horner in the unwearied and zealous discharge of the laborious functions which the establishment of a new Society, under circumstances of formidable opposition from high quarters, inevitably entailed upon the public-spirited individuals who were thus efficient in laying the foundation of that prosperous and useful career in which for more than thirty years we have proceeded.

Dr. Laird was the intimate friend of Dr. Babington, with whom he passed much of his time, assisting him in his correspondence, and occasionally aiding him in his profession. In Dr. Babington's house were held the first meetings of the individuals who, having come together chiefly for the purpose of mutual improvement in his favourite science, Mineralogy, soon transferred their attention to the more comprehensive master-science of Geology. Geology at this time had made comparatively little progress in England, and as the services of a pupil of Werner, Dr. Berger of Geneva, were then available, Dr. Laird was very instrumental, together with Dr. Babington, in making the necessary arrangements and pecuniary subscriptions to engage Dr. Berger to travel, first in Devonshire and Cornwall, and subsequently in the Isle of Man and north of Ireland, and to prepare the geological accounts of these districts, which appear in the three first volumes of our Transactions, forming curious and instructive documents as to the state of geological knowledge in England thirty years ago. Dr. Laird never published any paper, either scientific or medical, nor contributed to our Proceedings; but we owe to him the judicious selection of our motto from the *Novum Organum*, which still stands on the first page of every volume of our Transactions. Having served three years he retired from the office of Secretary to devote himself to the practice of his profession, and not long after, being in the prime of life, was seized with a paralytic stroke, which obliged him to pass the remainder of his days in close retirement.

Dr. Laird was an excellent mineralogist, possessed considerable talents, extensive information in his profession, and a most cheerful

disposition, and was greatly esteemed and beloved by his brethren; and although for many years cut off from any active intercourse with our proceedings, has left his name enrolled high on the list of our first and essential benefactors.

Mr. Robert F. Seale, M.R.A.S., and lately in the East India Company's Civil Service at St. Helena, was a member of a family long established in that island; he is known in geology as the author of a work, published in 1834 by Ackermann, on the Geognosy of the Island of St. Helena, illustrated in a series of views, plans and sections, accompanied with explanatory remarks and observations. He was also the constructor of a beautiful and elaborate large plaster model of the island of St. Helena, now in the East India Company's Military College at Addiscombe, founded on surveys and observations made by himself during a period of fourteen years. In an instructive series of coarse but very effective lithographic plates, which form the chief material of his volume on St. Helena, he has so graphically represented the peculiar conditions of the different varieties of igneous rocks which chiefly compose this island, that an eye experienced in the various appearances of beds and dykes of lava and basalt, at once feels conscious of the fidelity of the portraits he has given of the different modifications of the vertically columnar structure of the horizontal strata, and of the horizontally columnar structure of the dykes represented in his views of many portions of this island. Some of these plates express the fantastic shapes and castellated forms of residuary insulated fragments, both of dykes and columnar strata, which are familiar to us in the volcanic rocks of Puy en Vellée, and in the Vivarais and Valence. St. Helena is bounded on all sides by inaccessible precipices, of which many extensive views are given in the engravings.

Besides the many varieties of scoriæ, lava, and basalt, of which the island is mainly composed, he states it to abound, especially in the southern quarter, with hills of stratified limestone devoid of shells: whilst in three or four parts of the island there occur marine shells of a single species now unknown upon the present coast, accumulated in large quantities at various heights above the level of the sea, e. g. on Flagstaff Hill at 1900 feet, not imbedded in stratified limestone, but lodged upon projecting flats on the sides of the hills, and in one instance on an extensive plain.

In a large amphitheatre near Prosperous Bay Hill, at the base of perpendicular precipices nearly 1000 feet high, and now frequented by birds, they find, buried at various depths in the detritus of torrents, innumerable skeletons of other birds, now unknown in the island, e. g. the *Phaëton ethereus* and *Diomedea exulans*. This bone-bed extends a mile in length, and from 1 to 350 yards in breadth, and is from 10 to 90 feet deep. Similar remains are found also at the base of another hill called Sugar-loaf Hill.

In the southern quarter of the island the limestone hills give origin to inexhaustible springs of the purest water. In the whole island, he notices the occurrence of 245 springs; whilst in the barren island of Ascension, which is composed entirely of volcanic rocks, he says there is but one diminutive stream of fresh water, and attributes the superior fertility of St. Helena to the abundant presence of limestone and calcareous substances.

In 1830, Mr. Seale arranged and prepared a printed catalogue of a large collection of the minerals, rocks, shells, and miscellaneous articles in the Deadwood Cabinet at St. Helena, which shows him to have possessed considerable knowledge in mineralogy and conchology.

Sir JEFFERY WYATVILLE, R.A., F.R.S., F.S.A., F.G.S., born August 1766, was the son of Mr. Joseph Wyatt, an architect of considerable ability at Burton-on-Trent, and received his professional education under his uncles, Mr. Samuel Wyatt, a man of great skill and knowledge, and the more celebrated Mr. James Wyatt, who was for some time Surveyor-General of His Majesty's Works, and President of the Royal Academy*.

In the year 1799 Mr. Jeffery Wyatt had obtained such knowledge and skill in his profession, and attracted such public notice by the drawings he exhibited at Somerset House, that he received commissions from many persons of distinction, and began the world "on his own account." From this time his reputation increased rapidly, and in comparatively a few years he was engaged in more works

* From the age of 12 to 17 his ruling passion was to enter the navy, and twice he ran away from home and school, under the influence of a strong desire of going to sea, which had been excited by reading Sir Walter Raleigh's History of the World. He had a narrow escape from joining the Royal George, shortly before she went down at Spithead.

for the principal nobility than generally falls to the lot of the most highly favoured architects; his talent as an artist at the same time gained him the honour of being chosen an Associate of the Royal Academy.

He was employed by the late Marquess of Bath in considerable works at the ancient Elizabethan palace of Longleat, the improvements of which he executed with such judgment, that it laid the foundation of his architectural success, as well as secured the respect and friendship of its noble possessor. He was also employed professionally at Chatsworth, Woburn, Ashridge, Wollaton, Bretby, Gopsal, Belton, Lilleshall, Golden Grove, and more than 100 of the principal mansions in 35 out of the 40 English counties, and 4 of the 12 Welsh counties. But the work which henceforth will be inseparably connected with his name, in which his genius had the greatest scope, and from his successful accomplishment of which he has received the admiration and approbation of the nation, is the restoration of the ancient royal palace of Windsor Castle to the style of its founder, Edward III. No sooner had he begun this great national work in 1824, than the Royal Academy granted him the full honours of an Academician, and on the day of laying the first stone of these restorations, his royal patron, King George IV., conferred on him authority to change his name to Wyattville. This honour, marking the commencement of these great works, was but a foretaste of that entire confidence and approbation with which His Majesty distinguished him, and which received their public acknowledgement in the first act the King performed on returning to inhabit the Castle, namely, on December 9th, 1828, conferring on him the honour of knighthood.

Thus publicly distinguished by the approbation of George IV., Sir J. Wyattville went on with these restorations during the remainder of this king's reign, and through that of King William IV., whose condescending friendship and full confidence he also enjoyed. Her Majesty Queen Adelaide also introduced him to her brother, the reigning Duke of Saxe Meiningen, for whom he made many designs, and from whom he received the Grand Cross of the Ernestine Order of Saxe Meiningen.

Honoured and adorned with these trophies of his art, he brought his works to their completion in the reign of her present

Majesty, who granted to him for life the use of the Winchester Tower, as a residence in Windsor Castle, an honour he had first received from King George IV., and again from his late Majesty. He terminated his career in London on the 18th of February, 1840, aged 74, and was buried in St. George's Chapel, Windsor.

As an architect, his most remarkable quality was *judgment*, a perfect knowledge of the purposes of his art, and great command of the resources by which they may be accomplished. He possessed great taste, more especially in Gothic architecture, and had a refined perception of the picturesque.

During the last ten years of his life, Sir Jeffery Wyattville spent much of his time in preparing for publication a series of plans and views, illustrative of the present state of Windsor Castle. They were nearly completed at the time of his death, and are now in progress of publication by his son-in-law and his executors: two numbers, with twenty-eight engravings, have been published; the remaining number, accompanied by an archæological essay, will shortly appear.

He was a man of honour and honesty, and extraordinary talent in his profession. A memoir of his life has been printed by Mr. John Britton, with a print from a picture by Sir T. Lawrence, 1834.

Nicholas Aylmer Vigors, Esq., M.A., Honorary D.C.L., F.R.S., M.R.I.A., F.S.A., F.L.S., F.H.S., F.G.S., M.R.I., M.P., &c., was in 1803 admitted a Gentleman Commoner of Trinity College, Oxford, in which his son is now a graduate; but before the expiration of sufficient time for taking a degree, he became an officer in the Guards, and served with the army in Spain.

Returning to Oxford, he took his first degree of B.A. in 1817, and M.A. in 1818, and in 1832 was created an Honorary D.C.L.

The department of science to which Mr. Vigors particularly devoted himself was Ornithology; but although not much versed in the researches of positive Geology, he duly appreciated the value of our science in its relation to Zoology, as supplying a large contingent to the whole amount of the animal kingdom; fully feeling how imperfect every view of Zoology must necessarily be that takes no account of that large extinct portion of the several classes of animals, of which our only knowledge must be derived from Palæontology.

In 1825 Mr. Vigors was one of the most efficient fellow-labourers with Sir Stamford Raffles and Sir H. Davy, in laying the foundation of the Zoological Society of London, a Society which has now its agents and correspondents in every quarter of the world; and by his zealous and active co-operation with the first members of this Society, in the office of secretary during its earliest years (from 1826 to 1833), he has been largely instrumental in accelerating the recent rapid diffusion of exact knowledge in Zoology throughout the country.

At the formation of the museum of the Zoological Society, he presented to it the whole of his valuable collection; an act of liberality which was duly acknowledged by the Society, when, in 1833, he resigned the office of secretary to attend to the duties of his seat in parliament.

Before the foundation of the Zoological Society, he was a most active promoter of the Zoological Club of the Linnæan Society, established Nov. 29, 1823, on the celebration of the second centenary of the birthday of Ray. He was also the first institutor and editor of the Zoological Journal, which continued until the Zoological Society commenced the publication of its Transactions and Proceedings, when the Zoological Journal ceased, and its supporters transferred their contributions to the publications of that Society.

Mr. Vigors appears to have been the first who applied to Ornithology the principles of classification advocated by Mr. William S. M'Leay, in his *Horæ Entomologicæ;* and his papers illustrative of this new method of investigation are published in the Linnæan Transactions and the Zoological Journal. His "Observations on the Natural Affinities that connect the Orders and Families of Birds," were communicated by the Zoological Club of the Linnæan Society, and read before that Society in December 1823*.

In the beginning of this memoir he recognizes the assistance which has been afforded to Zoology by the sister science of Geology, in adding the remains of a former world to enrich the stores and supply the deficiencies of the present time, increasing the materials of zoology to an extent, which the most sanguine views of its cultivators could scarcely have anticipated. To the fifteenth volume of

* Linn. Trans., vol. xiv., p. 935.

the Linnæan Transactions he contributed, in conjunction with Dr. Horsfield, a Description of the Australian Birds in the Collection of the Linnæan Society, arranging them according to their natural affinities, with general Observations on the Zoology of New Holland. His sketches in Ornithology, and observations on the leading affinities of some of the more extensive groups of birds, form a series of instructive and valuable memoirs in the Zoological Journal; in the second volume of which, p. 391, in a memoir on the arrangement of the genera of birds, he published a tabular sketch, representing a summary of his views of the affinities and analogies of the generic groups he proposes to establish in this family. These masterly essays give evidence of an acute and delicate perception of the distinctions of species, combined with powerful comprehensive views of the relations of genera to each other, and to the families which combine to make up the entirety of the animal kingdom. They are also interspersed with a variety of illustrations from ancient authors, which show him to have had considerable taste and extensive knowledge of classic literature. In 1811 he published his "Inquiry into the Nature and Extent of Poetic License," an ingenious and elaborate work, of which a second edition appeared in 1813. His later works in Natural History appear in the Transactions of the Linnæan and Zoological Societies, and in the Zoological Journal.

In Mr. William Maclure we have lost an early and useful labourer in the field of geology, to whom we owe the first connected and systematic accounts of the structure of North America reduced to a comparison with that of Europe.

He was born at Ayr in 1763, and educated in that town. In 1782 he visited New York, and returning to London became a partner in an American mercantile house. He visited France several times between 1782 and 1796, when he went to Virginia and closed his business there as a merchant. In 1803 he returned to Britain, and was appointed a Commissioner for settling the claims of the United States against France. From Paris, as a centre, he afterwards made scientific tours over a large portion of Europe.

In 1807, returning from Europe, he commenced single-handed the Herculean task of exploring the geology of the United States; and after several years of labour, during which he crossed the Al-

leghany Mountains not less than fifty times, he produced a geological map of the whole country, which, though it gives only the Wernerian classes of rocks, forms a most valuable outline, and is a monument of great industry, perseverance and intelligence*.

His first observations on the geology of the United States, accompanied by the first geological map of that country, were read to the American Philosophical Society in Philadelphia, Jan. 20, 1809, and published in the sixth volume of their Transactions, part 1. In these Transactions also (vol. i. New Series) he published a second paper, read May 10, 1817, upon the same subject, with a geologically coloured map and sections, in which his views were improved and corrected by eight years' additional observations in the United States, and by a geological tour over a great portion of Europe.

This admirable paper was reprinted at Philadelphia in 1817, in a separate 8vo volume, entitled, "Observations on the Geology of the United States of America, with remarks on the effect produced on the nature and fertility of soils by the decomposition of the different classes of rocks."

On this important subject, of the connexion of geology with agriculture, Mr. Maclure has clearly shown that the fundamental basis of the agricultural resources of every country must rest on the condition which its soil derives from the rocks or strata that have supplied the materials of which it is composed; and wisely profiting by his suggestions, the different governments of the United States have caused geological surveys to be made of their respective districts; fully aware that not only the agricultural condition of every country must depend on the nature of its soil; but its future capabilities of becoming the site of extensive manufactures must also mainly depend on the presence or absence of subterraneous stores of fossil fuel.

Mr. Maclure's publications upon the geology of this most important part of the Western Hemisphere are marked with the finest appreciation of the just philosophical principles of geological research, and a spirit of combination and generalization of the largest and boldest character, yet never running wild. His map, which presents the synoptical result of the whole, is unrivalled by anything

* See Hitchcock's 'Elementary Geology,' 1840, p. 283.

produced before that time. Adopting the Wernerian arrangement, he is far superior to Werner in the philosophical character of his mind; his colours represent primitive, transition, secondary, and what he calls alluvial, which are mostly tertiary, on the east of the Alleghany chain. Under this class he has included the lower cretaceous formations of New Jersey, which he remarks may probably prove to be secondary. The great simplicity of the structure of America, and more extensive continuity of its formations as compared with those of Europe, greatly facilitated his task; his map is therefore a very near general approximation to what would even now be given; his secondary rocks include what would now be called Silurian and Carboniferous, and he notices the absence of the chalk of Europe and of the Jura limestones. Of course he could not enter into the distributions of the Silurian and Carboniferous groups; but he observes, that a red sandstone seems the basis of the whole, and this he calls old red. The more exact local description of portions of the Carboniferous and Silurian groups, and the identification of the lower cretaceous deposits of greensand in New Jersey and skirting the Mississippi below the junction of the Ohio, are the principal materials of importance which have subsequently been added to his spirited and masterly original sketch. His introductory remarks show that he was equally well acquainted with the general outline of the geology of Europe.

He declines entering on the subject of organic remains, not as unaware of its importance, but because they "had not yet been examined." In his preface occur some remarks which may show how unjustly the earlier geologists have been charged with too great inclination to depart from the ordinary laws of nature: "In all speculations on the origin, or agents, which have produced the changes on this globe, we ought," he says, "to keep within the boundaries of the probable effects resulting from the regular operations of the great laws of nature, which our experience or observation have brought within the sphere of our knowledge." It is remarkable that Mr. Maclure mentions galvanism as an agent which may have co-operated in changing and metallizing rocks: "A galvanic pile," he says, "may be formed in the stratifications of a mountain, as well as in a chemist's laboratory."

His treatise ends with two chapters on the probable effects of the decomposition of different classes of rocks on the nature and fertility of soils; being an attempt to apply geology to agriculture. He is the father of American, much more than Smith is of English, geology; and American geology is especially important, because in America and in Russia we have two of the largest classes of formations, the Silurian and carboniferous, developed at the distance of half an hemisphere. We may, with good cause, congratulate ourselves that this comparison will shortly be consummated by the distinguished author of the 'Silurian System,' whom we have this day elected to be our President for the ensuing year.

In 1822 Mr. Maclure published some speculative conjectures on the probable changes that may have taken place in the geology of the Continent of North America east of the Stony Mountains (Silliman's Journal, vol. vi. p. 98), in which he considers that a very extensive lacustrine condition of the upper country prevailed before these waters were discharged by the gorges that give exit to the present great rivers, and observes, that "the large masses of granite, some of them weighing tons, which are scattered over the secondary strata between Lake Erie and the Ohio, while there is not an atom of granite in place nearer than the north side of the Lake, would seem to point at the only mode by which they could probably be transported—viz. by supposing the Lake extended thus far, and that large pieces of floating ice from the north side might have carried those blocks with them, and dropped them as the ice melted in going south; the fact of few or no blocks being found south of the Ohio, shows that the southern sun melted the ice before it got so far. (Silliman's Journal, 1823, vol. vi. p. 102.)

It must be no less gratifying to the family of Mr. Maclure than it is to the great scientific family of the investigators of nature throughout the world, to learn that the Academy of Natural Sciences of Philadelphia has appointed a member of their body to deliver a discourse in commemoration of their venerable and respected President and benefactor; to whom, "as the pioneer of American geology, the whole country owes a debt of gratitude, and in his death will acknowledge the loss of one of the most efficient friends of science and the arts;" and who, "as the patron of men of science,

even more than for his personal researches, deserves the lasting regard of mankind*."

Mr. William Maclure died, 23rd March 1840, at San Angel, near the city of Mexico, where, during some years, his declining health had obliged him to seek a more genial climate than the United States, and has left a large property to the Academy of Natural Sciences at Philadelphia, of which he was President†.

Professor BLUMENBACH died at Göttingen on the 22nd of January 1840, in the 89th year of his age: he was born at Gotha, May 11, 1752, and early imbued with a taste for natural history and medicine by his father, a native of Leipsic, who died in 1787, in the office of Pro-rector and Professor in the Gymnasium at Gotha. At the age of 17, A.D. 1769, he began his academical career at Jena by the study of literature under Baldinger, and of natural history and archæology under his relative Professor Walch, and three years after proceeded to Göttingen to complete his studies, where he immediately became intimate with Heyne, Professor Büttner, and Michaelis, whose son was then a fellow-student in medicine. The rich collection of voyages and travels to which he had access in the library of Professor Walch, suggested to him, as the subject of his exercise for his Degree of Doctor, a dissertation on the native varieties of the human race, which became the first germ of his future extensive researches in Anthropology, in which he derives the three great varieties of the human family from a primary stem of the Caucasian race. His first public employment was a gratuitous undertaking to arrange the cabinet of natural history which the University had purchased from Professor Büttner, which soon brought him favourably to the notice of the minister and curator of the University. In 1775 he was appointed a Private Teacher in Natural History; in the following year an Extraordinary Professor, and in 1778 an Ordinary Professor of Medicine and Natural History in the University of Göttingen.

In 1784 he became a Member of the Royal Society of Göttingen; in 1788, a Counsellor; and in 1812, perpetual Secretary of the

* Silliman's Journal, vol. xxxix. July 1840, p. 212.

† Besides the works above mentioned he published an "Essay on the Formation of Rocks," and a work in three volumes, entitled "Maclure's Opinions."

Class of Physics and Mathematics in the same Society. In 1816 he was appointed a Member of the Superior Council of Medicine, and in 1821, a Commander of the Guelphic Order. His talent as a lecturer, and profound knowledge of medicine, anatomy and natural history, soon made Göttingen a centre of attraction to the students of all Germany; nor did this attraction cease during a brilliant career of more than fifty years. In 1784, his celebrated lecture on the eyes of the White Negro* awakened an intense interest throughout the scientific world, and, together with his Inaugural Essay upon the native varieties of the human race, became the nucleus of his future works on the Natural History of Man.

In 1790 appeared the first Decad of his collection of skulls of different nations, a subject which continued among the most favourite themes of his study, from its first commencement in his Inaugural Dissertation, to his last essay upon a Macrocephalus in 1833.

On the celebration of the Jubilee of his Doctoriat, Sept. 19th, 1825, the company of the most distinguished naturalists and medical practitioners of Germany then assembled at Göttingen resolved, on the suggestion of Rudolfi, to testify their gratitude for the benefits they had individually received from his oral instructions and published works, and to perpetuate the memory of this remarkable assembly, by the foundation of a travelling Fellowship in honour of Blumenbach, and by a medal†, bearing on its obverse three skulls of the European, Ethiopic and Mongolian races.

The expressions of piety, gratitude, and affection which are recorded in the elder Sömmering's celebrated Inaugural Dissertation give utterance to feelings, in which the pupils collected around him during more than half a century have, without exception, participated.

He was the great precursor of Cuvier in comparative anatomy, and was the first to demonstrate the value of this science in its relation to pathology, and to convince mankind of the truth of the observation of Haller—that physiology has been more illustrated by comparative anatomy than by the dissection of the human body,

* De oculis Leucaethiopum et iridis motu. Soc. R. Gott., v. vii. p. 29—62.

† With the following inscription, "*Naturæ Interpreti, Ossa Loqui Jubenti, Physiophili Germanici,* 19 Sept. 1825."

so that henceforth this subject must become an essential part of medical education.

The present is not the fit occasion to enter into a discussion of the unrivalled merits of his lectures on pathology, comparative anatomy, natural history, and physiology; nor to set forth the number and nature of his multifarious publications on these subjects, and also on archæology, literature, and the fine arts, which, during a period of sixty years, enriched the Commentaries of the Royal Society of Göttingen, and the medical, literary and philosophical periodicals of Germany; nor does the time permit me to enter on an analysis of his lucid and instructive Manuals, which were soon translated into foreign languages, and became the text-book of teachers of comparative anatomy and physiology throughout Europe; I shall rather call your attention to his acute perception of the value of organic remains in relation to geology, as affording evidence of past changes and revolutions which have affected the surface of the globe.

In his two celebrated Essays on the Archæology of the Earth, 1801 and 1806, he expresses his concurrence with Leibnitz in comparing the petrified remains of organic bodies to the documents which historians discover in medals, inscriptions, and monuments of ancient art; and regards them as affording no less certain chronological evidence of physical changes during the construction of the earth, than we extract from coins and medals respecting events which they record in the history of mankind.

He judiciously explains the occasional discovery of human bones and works of art in contact with the relics of extinct species; and views the changes that occur in the fossil remains of the successive strata as true indications of consecutive changes in the past condition of the globe.

> "Mundi naturam totius ætas
> Mutat, et ex alio terram status excipit alter."
>
> LUCRET.

The frozen rhinoceros of Pallas, and remains of herds of extinct elephants on the ice-bound shores of Siberia; the bones of the same extinct species of elephants and of rhinoceros, mixed with those of lions and hyænas in the caverns of the Hartz, and in the gravel beneath the very town of Göttingen, led him to infer, as we have now

additional reasons for doing, the former existence of a nearly tropical and uniform condition of climate over the now temperate and frigid portions of northern Europe, wherein these animals were formerly indigenous; and in further evidence of high temperature in these northern latitudes, he appeals to the quantities of fossil amber so abundant in the north of Germany, and to the extinct species of insects which the amber so frequently contains.

He had carefully inspected in the Museum of Schaffhausen the fossil remains of Œningen, and recognized their proximity to the existing flora and fauna of Switzerland; among these he enumerates small rodent animals, birds, frogs, numerous aquatic insects, and leaves and blossoms of plants, which more recent discoveries have referred to a freshwater formation of the Meiocene period.

He had distinctly recognized the fossil beaks of extinct cuttle-fish in the muschelkalk of the Heimberg, and the septa and siphon of the Orthoceratites of Clausthal; and from the family of Ammonites, which he knew to be numerous in species beyond most other fossil shells, he had selected that remarkable example from the Himalaya mountains called the Salagram*, specimens of which were subsequently placed in our museum by the great oriental scholar Mr. Henry Colebrook. The Salagram is a hollow cavity or mould bearing the impression of Ammonite, included in concretions of lias from the bed of the Ganges near Patna, which Indian superstition has sanctified as a mystic symbol of the Metamorphosis of Vishnu. (Specimen Archæologiæ Telluris, § 10.)

He duly appreciated the differences between the remains of the copper-slate, and muschelkalk and transition limestone within the limited vicinity of Göttingen; and further observed the degrees of perfection in the structure of fossil animals, receding gradually into more and more simple forms of organization, as he traced them backwards from the extinct Mammalia of the caverns to the remains of molluscous and radiated animals in the transition rocks; and though his premises were few, he rightly drew from them conclusions, less extensive, but similar to those which forty years of further observation over large portions of the earth have more fully established, as to the antiquity of the globe.

* This specimen was given to him by the chaplain of a Hanoverian regiment who brought it from India.

His love for archæology led to his making a collection of antique gems. He had also a collection of engravings by the older masters, and of ancient woodcuts, which he valued as indices of the progress of science at the time when they were made.

Blumenbach was a wise and good and profoundly learned man; born with considerable talent, and well educated from his childhood, he passed his whole life in the best literary and scientific society; and being placed in an influential academical position, he poured forth daily, during more than half a century, from his rich reservoirs of knowledge unceasing streams to instruct and benefit mankind. His biographer Mark (Göttingen, 1840) enumerates more than a hundred distinct publications of his on various subjects, among which are some biographical sketches of professors and other distinguished men. He possessed a happy, lively and cheerful disposition; was a man of most punctual and temperate habits, ate always the same moderate quantity of food, and was never intoxicated in his life. He abandoned smoking at 66; at 86 he left off taking snuff; and could read small print without spectacles at 88. Blumenbach seemed born for the express functions of a Professor; from morning till night, his academic duties were his daily occupation and delight; and the works of his leisure hours are a register of the progress of discovery in many branches of natural science during more than half a century in which he flourished. As a lecturer his style was familiar, playful, and not unfrequently jocose, always animated and sometimes eloquent, leaving a clear understanding and deep remembrance of the matter he wished to impress upon his hearers; he was the personal friend, as well as preceptor, of all his pupils, of whom great multitudes have expressed their gratitude in dedications of their works to the teacher from whom they derived the rudiments of their knowledge.

In 1791 he visited London, which he named the sixth quarter of the world, and was honourably received by Sir Joseph Banks and the Royal Society, where he assisted at the opening of six mummies, respecting which he published a paper in the Philosophical Transactions; he was also honoured with a command to visit King George the Third at Windsor. In 1803 he accompanied the King of Bavaria on a tour to the Hartz and Magdeburg. In 1806 he went to Paris

on diplomatic business connected with the University of Göttingen, and was introduced by Lacepede to the Emperor Napoleon. At the celebration of the centenary jubilee of the University of Göttingen, in 1825, the King of Hanover forgot not to visit the house of his old preceptor, which, in 1786, he had so often frequented as a student together with his two royal brothers, the Duke of Sussex and the Duke of Kent.

In Professor Blumenbach the world has sustained a loss of one of those men of extraordinary genius whose talents are destined to exert a large influence on the knowledge and opinions of the age in which they live, and to advance permanently the progress of those sciences to which they have devoted their attention.

M. J. M. Brochant de Villiers, Member of the Institute of France, Inspector-General of Mines, and Professor of Geology at the Royal School of Mines in France, and Foreign Member of the Royal and Geological Societies of London, was the heir of an ancient family, the members of which had held magisterial office and seats in the parliament of Paris. In early life he had applied himself to the study of the law, but the events of the Revolution having changed his destination, he became a student at the École Polytechnique, and in 1794 was the first pupil admitted to the École des Mines, upon its remodelled establishment, of which he afterwards became one of the most distinguished ornaments. In 1800, at the age of 22, he was appointed Engineur en Piéd, and published the first volume of his 'Treatise on Mineralogy,' in which he set forth an analysis of the principles of the Wernerian system, which had given so much celebrity to the school of Freyburg and were then but little known in France; and this work led to his appointment as successor to the Abbé Hauy in the office of Professor of Geology and Mineralogy at the École des Mines, at that time transferred to Pesay in Savoy. From this favourable position he made frequent excursions with his pupils into the adjacent regions of the Alps, and gathered materials for his classic descriptions of a portion of these mountains, till then considered as primitive, showing them to appertain to more recent formations, which he referred to the Wernerian transition system, and which subsequent observations have proved to belong in part to the secondary series.

On these excursions, he shared with his pupils the frugal repast of the châlet and the bed of straw, admitting them to the most unreserved and instructive communication with him.

In 1814, when Pesay was restored to the king of Sardinia, and the School of Mines again transferred to Paris, he returned with it, and continued to lecture on mineralogy and geology, each course occupying a year.

In 1823 he was charged with the great national work of superintending the construction of a geological map of France by two of his pupils, M. Dufresnoy and M. Elie de Beaumont, which he lived to see brought almost to the very point of publication. The following year he visited England, accompanied by M. Dufresnoy and M. Elie de Beaumont; and on this occasion he was fortunate in finding at home, in their respective districts, many of the most active geologists of this country, to whom it was a subject of gratification that they were permitted to conduct these distinguished visitors over many of the most instructive scenes of their special investigation, wherein are found some of the most interesting sections and most important features in English geology.

In 1824 he became Divisionary Inspector and Member of the Council of Mines: in the duties of this department his judgment and experience were of essential value to the public service; he introduced new and beneficial regulations for the general administration of the mines; he was also the cause of great improvements in the manufacture of glass at St. Gobin, being one of the most active directors of that celebrated establishment.

In 1833, M. Brochant assisted M. Elie de Beaumont and M. Dufresnoy in procuring an order from the government for the preparation of geological maps of the Departments, on a larger scale and with fuller details than the great geological map of France, now nearly completed*. His health had for a long time suffered, and his death was accelerated by excessive zeal in the discharge of his many public duties, which prompted him continually to exert himself beyond his strength, and terminated the career of his useful life at the age of 67, having long enjoyed the dignity of an Officer of the Legion of Honour, and Member of the Institute of France:

* A considerable number of these are already completed, and deposited in the Mining Archives at Paris.

he has carried with him to the grave the love and veneration of all.

He was a man of remarkable integrity and kindness of heart; he had a taste for literature and poetry; was a skilful, well-informed and judicious engineer; and performed with zeal the duties of a Professor for more than thirty years. At his death he was one of the oldest Members of the Council of Mines. He has left behind him fruits of his solid and useful labours, that will long be of service to his country.

Some years before his death, M. Brochant's health no longer permitting him to lecture, he appointed his pupils, MM. Elie de Beaumont and Dufresnoy, to perform his duties; the former in the geological, the latter in the mineralogical portion of his lectures: these gentlemen have since been confirmed in their office as permanent lecturers.

At his burial on the 19th May 1840, funeral discourses were pronounced by M. Migneron, Inspector-General of Mines, and by his early friend and colleague, M. Alexandre Brongniat.

M. Philippe-Louis Voltz, Inspector-General of Mines, and Member of the Council of the Geological Society of France, was, like the immortal Cuvier, a native of Alsace, and for many years held an appointment in the direction of the mines of that province; which about two years before his death he quitted for a higher station in the Bureau des Mines, that required his residence at Paris, where he died, March 29, 1840.

Besides the usual accomplishments of his profession, he possessed a very accurate and extensive knowledge of organic remains, of which he has left proofs, in many valuable and ingenious monographs published in the 'Mémoires de la Société d'Histoire Naturelle de Strasbourg,' and in his labours to enrich and organize the museum of the capital of his beloved native province. In this museum it was the delight and glory of his life, and a continual gratification of his patriotic feelings, to devote, gratuitously, a large proportion of his time and talents to the setting in order one of the most perfect, and most methodically arranged collections of organic remains, especially those of the oolitic and new red sandstone or Triassic* series, that exists upon the continent.

* See Alberti's Monographie des bunten Sandsteins, &c. 1834.

In acknowledgement of his services to fossil botany in illustrating the flora of the new red sandstone formation, M. Adolphe Brongniart has dedicated to him the genus Voltzia, being one of the most characteristic forms of Conifers in that formation, and abounding in the Grès Bigarré at Sultz les Bains, on the east side of the Vosges near Strasburg.

In the 1st vol. of the 'Mém. de la Soc. d'Histoire Nat. de Strasbourg,' he published a valuable memoir descriptive of the character and contents of the new red sandstone at Sultz les Bains. He was also the author of some good technical papers connected with his profession, published in the 'Annales des Mines.' His observations on Belemnites, published in the 'Memoirs of the Society of Strasbourg,' and separately as a monograph in quarto, at Paris, 1830, is a masterpiece of exact demonstrative description and accurate reasoning upon the structure and relations of these internal shells of extinct Molluscs allied to the modern cuttle-fish; not less beautiful and exact are his representations and reasoning as to the *Belopeltis*, or dorsal lamina of Belemnites, published in the Strasbourg Memoirs. In 1836 he published a very ingenious memoir on the curious fossil shells long known by the name of *Trigonellites* and *Tellinites problematicus*, and recently called *Aptychus*, showing them to be the opercula of Ammonites. In the Solenhofen quarries he has recognized nine kinds of these shells, and altogether twenty-five species of them, which he reduces to three groups*. He shows the internal structure in each group of Aptychus to differ from that of every known shell, and to resemble that of opercula. He does not, however, infer that all the genera of Ammonites possessed opercula. I know not any more beautiful example of inductive reasoning and sound logical conclusions than those which pervade the argument pursued in M. Voltz's memoir on these problematic Tellinites, which have so long perplexed all preceding observers†.

All these works show M. Voltz to have been a Palæontologist of the first order, possessing great powers of exact observation, with a mind capable of pursuing processes of refined and difficult analysis,

* *Cornei, Imbricati, Cellulosi,* 'Journal de l'Institut,' 1 sec., Nos. 190, 196, 202, referable to three families of Ammonites.

† In 1829, M. Rüppell had shown that one of the forms of Aptychus from Solenhofen was the operculum of a Planulite.

and acute to discover analogies, and draw sound and logical conclusions from the oftentimes difficult and complex premises before him.

His name will endure, embalmed in his works among the many precious contributions which our day has added to the illustrations of the history of extinct organic beings that formed the ancient population of our globe.

GENTLEMEN,

I have now arrived at the close of my official functions in this Chair, the duties of which have been to me, during the last two years, a continual source of unmingled satisfaction. I have witnessed with delight the unanimity and energy which mark the course of your proceedings, and tend still further to exalt the high position as a science to which Geology is now advanced. It would indeed be painful to me, could I feel that, in quitting the Chair, in which your kindness has for the second time required my services, my connexion with this Society would in any way be loosened, or my exertions to promote its interests in the least degree abated. And in resigning my office to my friend and fellow-labourer in your service, Mr. Murchison, I know I consign it to him who yields to none of us in zeal for the welfare of this establishment, and whose more than European reputation, as the author of the 'Silurian System,' will reflect honour upon yourselves, who have this day placed him in the distinguished office of President of the Geological Society of London.

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