Address delivered at the anniversary meeting of the Geological Society of London, on the 21st of February, 1840 : and the announcement of the award of the Wollaston medal and donation fund for the same year / by the Rev. Professor Buckland.

ADDRESS

DELIVERED AT

THE ANNIVERSARY MEETING

OF THE

GEOLOGICAL SOCIETY OF LONDON,

On the 21st of FEBRUARY, 1840;

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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AWARD

OF THE

WOLLASTON MEDAL AND DONATION FUND

FOR 1840.

(Extracted from the Proceedings of the Geological Society, Feb. 1840.)

The Wollaston Medal having been awarded to Prof. Dumont, of Liége, for his Memoir, Map, and Sections on the Geological Constitution of the Province of Liége, published in 1832; and one year's interest of the Wollaston Fund to Mr. James De Carle Sowerby, in order to facilitate the continuation of his researches in Mineral Conchology; Dr. Buckland, on presenting the Medal to Dr. Fitton, who had been requested by M. Dumont to receive it on his behalf, said:—

Dr. Fitton,

I am highly gratified that it has become my duty on the present occasion, to commit to your care as the Representative of our common friend, Professor Dumont, the Wollaston Gold Medal, which has been awarded to him by the Council of this Society for his Memoir on the Geological Constitution of the province of Liége published at Brussels in 1832.

The grounds of our tardy recognition in 1840, of the merits of a work published so long as eight years ago, are the same that in 1830, prompted the Judges appointed by the Academy of Brussels, to select this Memoir as most worthy of the Prize then proposed by that Academy, for the best Geological description of the province which has formed the subject of M. Dumont's successful labours.

In the work thus doubly crowned, the Author has described the mineralogical and zoological characters of the rocks which occupy

this district, and determined in minute detail, the relative places in order of succession, and the superficial extent of each subordinate division of the several formations. He has also illustrated the same by an accurately coloured Geological Map, and by coloured Sections, showing the general disposal of the strata in their original order of deposition, and the extraordinary derangements and disturbances that have subsequently thrown them into a state of almost inextricable confusion. In the execution of this work, M. Dumont has evidenced unusual powers of discriminating and accurate observation, combined with a high capacity of reducing the minutiæ of local details under the dominion of enlarged and masterly theoretical generalizations. Advancing at the early age of twenty one, to a task of gigantic labour, in a region where the unexampled disturbances, and almost incredible complexity of its component strata had baffled the sagacity of the most experienced geologists, this extraordinary youth at once withdraws the veil of confusion which had hitherto disguised the stratigraphical arrangements of his native province, and as it were, by an intuitive touch, reduces to order the entangled and almost incredible phænomena of dislocation, contortion, and inversion which had perplexed his predecessors in the same field of observation.

In addition to the scientific value of M. Dumont's exact and laborious researches, in illustrating a high and difficult problem in positive geology, his work assumes a place of great statistical and commercial importance, as describing the structure and contents of a rich and productive carboniferous district containing eighty-three beds of valuable coal; and its practical utility has been fully shown, by the fact of a second edition having been required to supply the demands of the landed proprietors, and persons practically interested in the operations and products of the coal mines.

The geological tribunal of Brussels, including the highly distinguished geologist Omalius d'Halloy, at once appreciated duly, and rewarded as they deserved, these brilliant discoveries; but the phænomena represented on M. Dumont's map and sections were so unusually complex and improbable, that the geologists of England could not but forbear to admit their reality, until it was fully confirmed by our personal examination, with the aid of that new light which M. Dumont's discoveries had thrown upon them.

The result of such inquiry has been a full corroboration of M. Dumont's representations, and at this late hour we at length come forward with the homage of our tardy but sincere acknowledgements; a duty too long delayed, from the exercise of precaution in its administration, but for this very reason now become more urgent, when the grounds for conscientiously discharging it have passed the ordeal of severe and critical investigation. It is for this great work then on the geological constitution of the Province of Liége, such as in 1832 it issued from the hands of a young, and then unknown individual, and apart from any more recent attempts to identify the Belgian formations with those of England, that our Society has awarded to M. André Hubert Dumont their Gold Wollaston Medal for the present year; in testimony of their admiration of the almost precocious talents then displayed by him, and of their sense of his worthiness to fill the distinguished scientific position to which he is now advanced, as Professor of Mineralogy and Geology in the College of Liége.

Dr. Fitton, on receiving the Medal from the hands of the President, said, that he had been requested by M. Dumont to express his great regret that unavoidable duties prevented his appearing in person on this occasion. M. Dumont's letter states with deep feeling his sense of the honour which the Geological Society of London has thus conferred upon him, and his hope that he may soon be enabled to come into England, for the purpose of extending his personal acquaintance with the members of this Society, and of being enabled, with the aid of their knowledge, to perfect the comparison of the ancient strata of Belgium with those of this country. The Society could not but anticipate great advantage to Geology from the application of M. Dumont's talents to the comparative inquiries to which his letter alludes.

On presenting the prize awarded to Mr. James De Carle Sowerby, Dr. Buckland said:—

It is with no small pleasure that I rise to perform the duty of placing into your hands the award that has been made to you by the Council of the Geological Society, of one year's interest of the Wollaston Fund, in order to facilitate the continuation of your researches in Mineral Conchology.—The services are great which have been

rendered to Geology by the extremely useful and well-timed work on fossil shells, which was many years ago begun by your excellent father, and continued by him to the end of his life, and has been since conducted by yourself; and the association of his name with that of Dr. Wollaston, recalls to my mind, as it must to the minds of most of my hearers, pleasing and grateful recollections of the benefits which during their lives they both conferred on this Society, and which their works will have extended to all our contemporaries and successors in this department of scientific inquiry. It was your father's peculiar merit to be one of those accurate and enthusiastic observers of nature, who have in modern times contributed so much to remove from science the rugged and austere aspect under which it used to be presented; and who by facilitating to every one the means of advancing pleasantly in its pursuit, have, in an essential manner, promoted, and given popularity to the study of Botany and Conchology.

It is to Mineral Conchology, which he so especially promoted, that we who are occupied with the investigation of the structure of the earth, have in modern times been mainly indebted for evidences which have led to the establishment of many of the most important stratigraphical distributions, that have been founded on the successive changes in animated nature which are made known to us by the study of fossil shells. It was on this foundation that Cuvier and Brongniart established their important divisions of the marine and freshwater strata of the Tertiary formations, which have since been more minutely distributed by Mr. Lyell into the eocene, pliocene, and miocene series, according to their relative numbers of extinct and recent species of fossil shells. It was on a similar foundation that Mr. William Smith rested his identification of the Secondary strata of England. It is on the same basis of conchological evidence that Mr. Murchison has founded his fourfold subdivisions of the Silurian portion of the Transition rocks; and it is chiefly to the illumination which this branch of Palæontology has shed upon the changes that took place on the surface of the earth, whilst its strata were in process of formation, that we owe the rapid advances in geological knowledge which have been made since the commencement of the present century. To this rapid progress, arising from the introduction of the evidences of mineral Conchology, your own

publications and those of your family have largely contributed; you have further co-operated materially in advancing our inquiries by your personal assistance, at all times cheerfully and liberally rendered, to all your fellow labourers in the same fields of scientific research, who stood in need of your aid, for the elucidation of minute distinctions in the characters of fossil organic remains, which have at this time become so important an element in geology. The volumes of the Transactions of this Society, and other publications by many of its Members, including myself, bear further testimony to the importance of your labours, in illustrating our works with drawings and engravings of fossil shells and plants, expressing their characters with a degree of accuracy and truth, which no pencil or burine but those of a scientific artist could possibly accomplish; and I am sure I give utterance to the feelings of all our fellows now around me, when I thus publicly acknowledge the services you have rendered both to ourselves, and to the science we cultivate; and express the satisfaction with which we thus publicly recognise the value of your exertions.

Mr. Sowerby then expressed himself in the following terms:

Sir,

I hardly know what to say, so deeply do I feel the unexpected and kind award bestowed upon me by this Society, but I must assure you, that I am extremely grateful for the honour done me. When, Sir, you spoke of my father, you excited feelings most dear to me, and I have long felt that I have experienced more consideration than I have deserved, in consequence of the esteem that has ever been attached to his memory. But I must have been a most ungrateful son had I not, after his persevering and kind instructions, done something for the advancement of Natural History. What little I have performed, especially for Members of this Society, has been for the love of Science; and I feel far more than amply rewarded by the honourable present I have just received at your hands. You have stated, Sir, that you take a pleasure in associating the name of Wollaston with that of Sowerby; I shall never forget the kindness and patience with which Dr. Wollaston communicated information. When the reflecting goniometer was first completed by him, he spent several hours one morning with me in his study mea-

suring the cleavages of various minerals related to hornblende and augite which I took to him for his opinion; and at another time he indulged me with an equally long lesson on the chemical examination of minute portions of minerals. Little did I think at that time that I should ever share encouragement continued by his bounty, after his departure from this world; but I have lived to feel that his benevolence lives beyond the grave.

Sir, I receive this award as a trust reposed in me, and hope that I shall not be found wanting in carrying out the object the Council has in view.

I beg sincerely to thank the Society for the confidence placed in me.

ADDRESS

TO THE

GEOLOGICAL SOCIETY,

Delivered at the Anniversary, on the 21st of February, 1840.

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

CORRESPONDING MEMBER OF THE INSTITUTE OF FRANCE,

PRESIDENT OF THE SOCIETY.

GENTLEMEN,

BY the Report just read, you have seen that the state of our Society is one of steady and salutary progression; forty-three new Members have been added to the List of our Fellows, from which seventeen have been removed by death, or resignation, leaving our actual number 768, with an increase of twenty-six during the last year. The vacancies that have occurred upon our foreign list have been supplied by three highly distinguished cultivators of science on the Continent, each preeminent for his successful labours in high departments of our subject, namely:

Major Puillon de Boblaye, in Positive Geology,

Professor Adolphe Brongniart, in Vegetable Palæontology,

Professor Gustave Rose, in Crystallography and Mineral Analysis.

We are rich in property, though our funds are, at this moment, low, but they will speedily be repaired by the sale of two large and costly parts which have been added to our Transactions.

The Reports of the Library and Collections in our Museum are satisfactory. The chief additions to the former consist of presents from Authors and Members of the Society. Our principal benefactor has been Mr. Greenough, who has given us a Collection of the older Authors,—supplying many of our deficiencies in the

Literature of Geology and Mineralogy. Considerable progress has been made in the arrangement of the Cabinets by our Sub-Curator, Mr. Woodward, under the superintendence and directions of Mr. Lonsdale; one hundred and sixty drawers of rock specimens and fossil remains having been labelled, and in part catalogued, since the meeting of last year. It is satisfactory to find that the number of persons who come to study our Collections has been much increased.

Our entire establishment continues to receive the inestimable advantages it has long enjoyed, from the zealous superintendence, and scientific acquirements of our Curator, Mr. Lonsdale.

Our Wollaston Medal has been awarded to Professor Dumont, for his Map, Sections and Memoir on the Geological Constitution of the Province of Liége, published in 1832. And one year's interest of the Wollaston Fund has been presented to Mr. James De Carle Sowerby, to facilitate the continuation of his researches in Mineral Conchology.

More than a quarter of a century has now elapsed since I became a Member of this Society; and fifteen years have passed since I was first placed, by your kindness, in the honourable position of filling this Chair, at that important period of our history when we received the national recognition of a Royal Charter. I shall never cease to consider it one of the brightest rewards of my labours in geology, that my name is enrolled in that charter, as the first President of the Society in its corporate capacity.

Since that important epoch, our chartered body has received from the Government of the country the valuable sanction and advantage of an establishment in the very convenient apartments of Somerset House, which we now occupy. The number and character of the scientific labourers who have joined our ranks, and the volumes added to our Transactions, since these events, show that such encouragements have not been conferred on a society disposed to slumber under the sunshine of prosperity; but that, aided by these advantages, we have endeavoured to maintain a steadily progressive course, in the great work of illustrating the physical structure of the earth.

It is not my duty, on the present occasion, to notice geological

memoirs or subjects which belong to years preceding that wherein I entered upon my present office. The usual practice rather confines me to the most remarkable events of the last twelve months, during which I have had the honour to fill this chair.

MUSEUM OF ŒCONOMIC GEOLOGY.

Among the most important of these events, we recognise with gratitude, and confident anticipation of great advantage, both to science and the arts, the establishment, by Her Majesty's Government, of an institution hitherto unknown in England, namely, a Museum of Œconomic Geology. This is to be freely accessible to the public at stated periods, in the Department of Her Majesty's Woods and Forests, and Public Works, for the express object of exhibiting the practical application of geology to the useful purposes of life. In this Museum a large store of valuable materials has already been collected and arranged, chiefly by the exertions, and under the direction of Mr. De la Beche. In it will be exhibited examples of Metallic Ores, Ornamental Marbles, Building-stones and Limestones, Granites, Porphyries, Slates, Clays, Marls, Brickearths, and Minerals of every kind produced in this country, that are of pecuniary value, and applicable to the arts of life. Information upon such subjects, thus readily and gratuitously accessible, will be of the utmost practical importance to the miner and the mechanic, the builder and the architect, the engineer, the whole mining interest, and the landed proprietors. The establishment will contain also examples of the results of Metallurgic processes obtained from the furnace and the laboratory, with a collection of Models of the most improved machinery, chiefly employed in mining. A well-stored Laboratory is attached to this department, conducted by the distinguished analytical chemist, Mr. Richard Phillips, whose duty it already is, at a fixed and moderate charge, to conduct the analysis of metallic ores, and other minerals and soils submitted to him by the owners of mines or proprietors of land, who may wish for authentic information upon such matters.

The pupils in this laboratory are already actively employed in learning the arts of mineral analysis, and the various metallurgic processes.

A second department in the Œconomic Museum will be assigned to the promotion of improvements in Agriculture, and will contain sections of strata, with specimens of soils, sub-soils, and of the rocks from the decomposition of which they have been produced.

To this last-mentioned collection proprietors of land are solicited to contribute from their estates labelled examples of soils, with their respective sub-soils; and all persons who wish for an analysis of any sterile soil, for the purpose of giving it fertility, by the artificial addition of ingredients with which nature had not supplied it, may here obtain, at a moderate cost, an exact knowledge of its composition, which may point out the corrective additions which it requires. This portion of the Museum will more especially exhibit the relations of geology to agriculture, in so far as a knowledge of the materials composing the sub-strata may afford extensive means of permanent improvement to the surface.

MINING RECORDS OFFICE.

A third department, which it is proposed to add to this establishment, is an office, for the preservation of such records and documents relating to subterranean operations throughout the country, as are important to be preserved for the information of future generations.

To the keeper of these records will be assigned the duty of arranging the documents which may be transmitted to him from all parts of the kingdom, by any engineers, mineral surveyors, and proprietors of mines and coal works, who may be willing to send them; particularly maps, sections, and under-ground plans, which will record the state of each mine, when it is abandoned, for the information of those who at a future period may be disposed to bring it again into operation. This office will be accessible to all persons interested in obtaining the information it will afford. To this collection several engineers of most extensive experience in the mines of Newcastle and Cornwall have promised large contributions.

The keeper will make copies of documents of this kind, which proprietors of mines, who cannot conveniently part with the originals, may lend, for the purpose of being preserved in this national collection.

The public importance of such a records office was submitted to the Lords of Her Majesty's Treasury by a Committee of the British Association for the Advancement of Science, assembled at Newcastle in August, 1838; it being notorious that great losses of life and destruction of property have resulted both at Newcastle and in other coal mines throughout the kingdom, from the imperfect preservation of records of the operations previously conducted in them, and that still greater losses will inevitably ensue hereafter, unless advantage be taken of the experience of living engineers and coal proprietors, who are willing to place in a public national repository copies of the documents they possess relating to their respective mines.

In 1834, the attention of the public was called to this subject by Mr. T. Sopwith*, an eminent civil engineer and mine surveyor at Newcastle; and this gentleman is preparing a practical book of instructions on the subject of drawing geological and mining plans, the conducting of subterranean surveys, and examining mineral districts, with a view to the preservation of such information respecting the state of each mine at the period when it may be abandoned, as may be useful when further proceedings are afterwards commenced therein, or in its vicinity.

A museum of œconomic geology, comprehending institutions of this kind, demonstrates, even to the unlearned, the advantages that result from science in its application to the extraction of the treasures which Providence has laid up in the rich storehouses of the interior of the earth; and by exhibiting the results obtained from the elaboration of these materials, by the industry of man, in the workshop and at the forge, will afford a full and satisfactory reply to the question so often raised by persons to whom the value of the truths of pure science and philosophy, pursued for their own sake, are unintelligible,—and by whom everything is appreciated merely according to its immediate subserviency to the acquisition of wealth, or its ministration to the daily necessities or conveniences of human life.

BUILDING-STONE COMMISSION.

Another event which marks increasing attention to the practical importance of geology, is the publication of a Report to the Commis-

* See Sopwith on Isometric Drawing, p. 50, *et seq.*

sioners of Her Majesty's Woods and Forests, from a Commission appointed by the Lords of the Treasury; containing the results of an inquiry into the qualities and durability of the various Building-stones of this country, with a view to the selection of the best material to be employed in erecting the New Houses of Parliament.

The results of this inquiry have been arranged in Tables, which represent the composition, colour, weight, size, cost, durability, &c., of all the most important kinds of stone that have been used in ancient edifices in England; the Commissioners having judiciously appealed to that which is the most severe test of the durability of any stone, viz. the existing condition of the decorated architecture in our most ancient buildings.

The Norman portions of the Church of Southwell, in Nottinghamshire, constructed of magnesian limestone, in the twelfth century, have been found to afford an example of stone which combines strength and durability with applicability to ornamental carved work, in a degree surpassing all other kinds of stone that have been employed in the most ancient fabrics of this country; the sharpest of the mouldings and carved enrichments of that church being throughout in as perfect a state as when first executed. The keep of Koningsburgh Castle, near Doncaster, built also of the magnesian limestone in that vicinity, offers another proof of the durability of certain beds of this formation, exceeding that of any other building-stone in Great Britain, which is equally fit for ornamental purposes. But there are also varieties of magnesian limestone, such as that of which York Cathedral is built, which are in far advanced stages of decay, where they have been used for mouldings and architectural decorations.

The general result of this elaborate inquiry into the durability of the different varieties of magnesian limestone is, that the stone resists decomposition in proportion as it is more perfectly crystalline; a result, the cause of which is further illustrated by the experiments of Professor Daniell, which show that the nearer the magnesian compounds approach to *equivalent* proportions of carbonate of lime and carbonate of magnesia, the more crystalline they are.

No investigation has been made by these Commissioners as to the capabilities of granite, porphyries, and other kinds of stone, which are inapplicable to the decoration of edifices without enormous expense.

The Report is followed by valuable tabular lists of the most remarkable ancient fabrics in England, specifying the materials of which they are constructed, and their various conditions of preservation or decay, as they are respectively built of sandstone, or of oolitic, shelly, or magnesian limestone.

To these are added tables of the chemical analysis, weight, cohesive power, specific gravity, and power of absorbing water, of many of the building stones most largely employed in England.

I consider this Report as of the highest value, in showing the general advantages which may be derived from connecting scientific knowledge with practical arts; and I trust we shall hear no more of such discreditable and unfounded assertions as, not long ago, passed uncontradicted, at a meeting of an architectural society in London, that Stonehenge is made of statuary marble.

GEOLOGICAL COMMITTEE OF ENGLISH AGRICULTURAL SOCIETY.

The appointment of a Geological Committee, by the English Agricultural Society, at their meeting in Oxford, in July last, shows the sense entertained by that numerous body of landed proprietors, and cultivators of the soil of England, of the important services which may be rendered to them, by the application of geological knowledge to the improvement of the productive capabilities of the land.

It is well known to geologists that an almost unbounded supply of mineral manure may be found in the sub-strata, which in very many districts are composed of ingredients different from those of the surface. So constant are the characters of many of the beds of the geological groups which pass in long and narrow bands from one side of England to the other, that a single experiment, carefully conducted, on any one stratum of each formation, with a view to ameliorate its soil, by an admixture of the ingredients of some other adjacent stratum, will afford an example which may be followed with similar results in distant parts of the kingdom, through which this same stratum passes, in its course across the island.

Experiments, therefore, conducted by the owners and occupiers of land, under the advice of this Geological Committee, aided by the facilities for the analysis of soils now afforded by the laboratory of the Museum of Œconomic Geology, may shortly enable us to

realize at least some share of the success that attended Lavoisier's application of chemistry to agriculture in France*.

SCHOOLS OF CIVIL AND MINING ENGINEERING IN THE UNIVERSITIES OF DURHAM AND LONDON.

The increasing demand for education in practical science has been recently provided for in the University of Durham, by the establishment of a course of instruction in Civil and Mining Engineering, with lectures in the Mathematical sciences, Chemistry, Metallurgy, Mineralogy, Geology, Surveying, Mapping, and Drawing, in addition to Ancient and Modern Languages. To theoretical instruction in such parts of these branches of knowledge as bear more especially on Practical Engineering, are added at Durham occasional surveying excursions, both in the field and underground, conducted by a practical civil engineer. More than thirty young men have, during the last year, been actively engaged in this new department of academical study.†

The locality of Durham, upon the margin of the great Newcastle coal field, and in the vicinity of the lead mines of Alston Moor, and Weardale, is in a peculiar degree favourable for a school of mining and civil engineering; enjoying advantages of position similar to those of the great Saxon school at Freyberg, near the mining districts of the Ertzgebirge and the Hartz.

The University of London also is taking measures to institute examinations of Candidates for certificates of proficiency in Civil Engineering, and the arts and sciences connected with Mining.

In University College, London, courses of preparatory experimental lectures and exercises in Natural Philosophy have, during the last year, been provided for the students in that establishment, who are destined for the Profession of Civil Engineers.

And in King's College, London, a course of lectures in Civil Engineering, and Sciences applied to Arts and Manufactures, is at this time attended by more than fifty students, who have the opportunity of adding practical to theoretical knowledge in a workshop and laboratory established for their use.

* It was said of Lavoisier, that in ten years he doubled the produce of his land in grain, while he quintupled the number of his flocks. No doubt this report is much exaggerated.

† See Durham University Calendar, 1839, p. 10.

SCHOOL OF MINES IN CORNWALL.

Another proof of the direction of public attention to the collateral branches of our science has, within the last twelve months, been afforded by the establishment in Cornwall, of a school for the instruction in Sciences and Arts connected with MINING, of young men who are to be engaged in conducting the important subterranean operations of that county. The want of such a school had been pointed out by Mr. John Taylor, in his Prospectus of a School of Mines in Cornwall, February 7, 1825, and in his Records of Mining, published in 1829. It has at length been instituted chiefly through the exertions and at the expense of Sir Charles Lemon. This incipient school, and the University of Durham, form almost solitary examples in England, of such scientific establishments as are nearly universal in the mining districts of the Continent. The experiment has begun in Cornwall with Courses of Lectures in Mathematics, Mechanics, Chemistry, and Mineralogy, by three professors; and a course of instruction, by a practical surveyor, in Algebra, Drawing, and the Use of instruments: and during the next year, still further additions are contemplated.

POLYTECHNIC SOCIETY OF CORNWALL.

To the zealous exertions of Sir Charles Lemon, and of many intelligent and active individuals at Falmouth, the county of Cornwall is also indebted for the establishment of a Polytechnic Society, which, during the few years of its existence, has been attended with extraordinary success. One of its chief objects is to encourage, by rewards, the invention and improvement of machinery, of which so large an amount is essential to the working of the mines Another object is to collect materials for expressing the quantity and value of the mineral and other produce of the county; and to construct tables indicating the diminished longevity, and diseases, which, in a peculiar degree, affect the Cornish miners, and do not prevail amongst those employed in Collieries. It appears, from a paper published in the Sixth Annual Report of this Society (1839), that the average duration of a miner's life is less, by many years, than that of the agricultural labourer in the same district; the apparent causes of this frightful evil being the inevitably imperfect

ventilation of many of the veins or lodes in which the miner works; and, partly, the extreme fatigue of ascending from great depths by ladders, instead of being lifted by machinery, as the workmen are from coal pits: these pits also are usually susceptible of more perfect ventilation, than the metalliferous lodes in Cornwall.

The attention of this Society is strenuously directed to the discovery of remedies for these tremendous evils, which affect no fewer than a population of 28,000 persons; that being the proportion of the inhabitants of Cornwall, who are occupied in working the mines.

LOCAL MUSEUMS.

Another circumstance which marks the progressive advancement of public feeling as to the value of geology, is the increasing disposition to form local museums in our provincial towns.

At the meeting of the British Association, at BIRMINGHAM, in August last, after a strong expression of opinion, in the Section of Geology, as to the benefit likely to accrue to science from the establishment of Provincial Museums, for the local productions of each neighbourhood, the justness of the suggestion was so fully recognised, that, in the adjacent town of Dudley, before five days had passed, a public museum had arisen from contributions, out of the cabinets of private collectors in that town; presenting to the Association a more perfect assemblage than was ever seen, of the exquisite organic remains found in the limestone of that district, which has long been the classic type of a formation widely and abundantly distributed over the globe.

About this time also a provincial museum was formed at BRADFORD, in a district abounding in splendid examples of the vegetable remains which pervade the Yorkshire coal field; where the extensive collieries now wrought will furnish abundant materials for a collection, destined to illustrate the history of the extinct forms of vegetable life, which have produced the coal.

The museum at LEEDS, also, possesses a valuable collection of fossil vegetables from the coal field in its neighbourhood; and the WEST RIDING GEOLOGICAL SOCIETY, formed under the auspices of Earl Fitzwilliam, on the plan of holding quarterly meetings at different towns of the Riding in succession, is diffusing a taste for Geology, and affording ground for appreciating its practical importance, to

numbers of intelligent persons, whose local occupations, and property in the coal and iron mines, will enable them to enlarge the fossil Flora and Fauna of our country.

ROYAL INSTITUTION OF SOUTH WALES.

From the first Annual Report of the Royal Institution of South Wales, published during the last year, we learn that the Swansea Literary and Philosophical Institution, hitherto supported by the town and neighbourhood, has been expanded, under Royal patronage, to the whole southern division of the Principality; and is now establishing its Museum and Lecture Rooms in a large and commodious edifice in the town of Swansea, under the presidentship of Lewis Weston Dillwyn, Esq.

The position of this Institution, in the midst of a great mining and manufacturing district, is peculiarly favourable for collecting facts illustrative of geological phænomena, more especially those of the Coal formation; and much has already been done by Mr. Logan, to develope, with extreme accuracy and minuteness of detail, the stratigraphical succession of the rocks composing this formation; and to show the number and nature of the events which attended their original deposition, as well as the subsequent derangements that have affected them. Mr. L. L. Dillwyn, also, is attempting a classification of the coal plants of the South Wales Bason; with a view to ascertain, by means of a comparative collection in the Swansea Museum, whether there exists any specific difference between those of the upper and lower beds of the carboniferous series.

BRITISH MUSEUM.

The accessions lately made to the British Museum form another subject, of high importance in our Review of the Geological Proceedings for the past year. At the head of these is the purchase, from Mr. T. Hawkins, of an additional series of the remains of fossil *Saurians* from the Lias formation; which, added to his former collection, already placed in this national repository, present an unrivalled series of species in the extinct families of *Ichthyosaurus* and *Plesiosaurus*, once inhabitants of Britain. Equally important was the acquisition, in a former year, of the unique collection of still more

gigantic and not less monstrous Reptiles, from the Wealden formation of Kent and Sussex, obtained by purchase from Dr. Mantell. The possession of these several collections places the Museum, where it ought to stand, at the head of all existing repositories of organic remains, almost exclusively the productions of England; and it is due to his late exertions, whilst Chancellor of the Exchequer, that I should bear this public testimony to the services which Lord Monteagle has rendered to science, by supplying the means of placing these unrivalled collections in our national repository; where their constant presentation to the view of its thousands of daily visitors cannot fail to attract increasing attention to the wonderful discoveries of Palæontology.

These important public events, occurring beyond our walls, and having a direct and immediate tendency to enlarge the field of our labours, form an epoch in the history of our science, and place Geology before the country in a new and more widely popular aspect than it had occupied before. The past year has been also distinguished beyond all precedent, by the number and value of the GEOLOGICAL MAPS it has produced.

GEOLOGICAL MAP OF CORNWALL AND DEVON.

The first map which I shall mention, affords another example of the recognition by Government of the importance of our subject, by their having attached a geological department to the Ordnance Survey of England and Wales. The first fruits of this appointment are the splendid Maps of Devon and Cornwall, and a part of Somerset, coloured after the surveys of Mr. De la Beche; and it may be truly said of them, that they are more beautiful in their execution, more accurate in their details, and more instructive in the œconomical and scientific information they give respecting mines, than any maps yet published by any government in the world; affording documents to which we can at length with pride appeal, in reply to the reproach that has so long, with too much truth, been cast upon us, that England alone, of all the civilized nations, has abandoned to gratuitous individual exertions, and the liberality of amateurs in science, the great work of exploring and delineating the mineral structure of the country; and ascertaining

the nature and extent of the subterraneous produce, which lies at the foundation of the industry of its manufacturing population, and to which the nation owes no small portion of its wealth.

The statistical importance of this first portion of the Ordnance Geological Map of England will be duly appreciated only by those, who know the extent of the property embarked in the mining interests of the Western counties, and are aware that the annual value of the mineral produce of Cornwall and Devon alone has recently amounted to 1,340,000*l.*

In the chapter on Œconomic Geology, which forms part of the Memoir connected with his Map of Cornwall and Devon, Mr. De la Beche has placed, in a more prominent light than has ever yet appeared, the bearing of geological researches and mineral statistics upon political œconomy; and proves, by tabular documents, the important fact, that the average value of the annual produce of the mines of the British Islands amounts to the enormous sum of 20,000,000*l.**, of which about 8,000,000*l.* arise from iron, and 9,000,000*l* from coal.

Should this inquiry be extended through the endless departments of art, industry and commerce, which have their origin in the manufactories of metals, and in the power of steam, derived exclusively from the application of coal, the vast national importance of mineral statistics, and of models, maps and sections, on which alone their details can be effectually recorded, must be apparent to every one.

Still more extensive will be the statistical and political importance of the next portion of this great work, now in progress by the same highly accomplished geologist, which is to comprehend the coal and iron districts of Monmouthshire and South Wales.

GEOLOGICAL MAP OF ENGLAND.

You have this day the satisfaction to see suspended in your meeting room a new edition of Mr. Greenough's Geological Map of Eng-

* See Geological Report on Devon and Cornwall, p. 624, and note, 1839. In this estimate the value of the copper is taken in the ore, before fusion; that of the iron, lead, zinc, tin and silver, after fusion, in their first marketable condition — as pigs, blocks and ingots. The coal is valued at the pit's mouth.

land, which has for many years formed the glory of this Society. It is truly gratifying to observe how small a change this new edition exhibits, either in the general dispositions, which it represented nearly a quarter of a century ago, or in the complicated details of the boundaries of the different formations. Some alterations appear in the Greensand series, the Wealden, the Lias, and the New red Sandstone. The principal additions are the introduction of the Siturian divisions made in the slate rocks, by Mr. Murchison, in the border districts of England and Wales; and the new distribution very recently assigned to the slate rocks of Devonshire and Cornwall.

A great improvement also has been made by the substitution of an entirely new Map of Wales and Siluria, founded on the Ordnance surveys of those regions, of which no accurate physical map existed at the time of Mr. Greenough's first publication. Another improvement in the execution consists in the union of linear shadows with the colours representing the superficial extent of the strata. The combined effects of these *elements of expression*, judiciously employed, has been to exhibit, more distinctly, the subdivisions of formations, without destroying the unity of the general mass to which they belong. By the frequent introduction also of conventional signs, and figures of reference, Mr. Greenough has produced a more condensed assemblage of scientific information, of varied kinds, than has been put together in any map of equal extent yet published. Extreme attention has also been paid to the physical features of the country, and in the orographic details more than 500 heights are given. The hydrographic features also are delineated with scrupulous exactness.

GEOLOGICAL MAP OF IRELAND.

The last summer has witnessed the production of Mr. Griffith's large and splendid Geological Map of Ireland, containing the results of nearly thirty years' investigation, by that eminent geologist and civil engineer.

Mr. Griffith had supplied an outline of this map published in the Report of the Railway Commissioners for Ireland, 1838. It is obvious that the information thus conveyed, as to the nature of the materials of which the island is composed, affords the most solid

basis for sound calculation as to the future improvement of Ireland by the application of its natural resources.

GEOLOGICAL MAP OF A LARGE PORTION OF EUROPE.

During the last year we have also witnessed the publication of a beautifully coloured general Geological Map of Germany, France, and England, and parts of the adjoining countries, compiled from the larger original maps of Von Buch, Elie de Beaumont, and Greenough, by Professor Von Dechen, in one large sheet, published at Berlin.* This map exhibits the geological details of a larger continuous portion of the surface of the earth than has ever before been put together with so much exactness, and set forth on such eminent authority. It also presents to the statesman and political œconomist the most important portions of central Europe, under the new aspect of the natural divisions of the mineral formations, of which each country is composed; showing that in every region the nature and disposition of the substrata lie at the foundation, not only of its agricultural productiveness, but also of its capability of supplying the materials, which form the basis of its industry and arts. As an historical document, this map demonstrates the rapid progress of our science, and the state of maturity which it has attained.

Thus far I have occupied your attention with external matters of extraordinary interest in the history of our science, which show that geological knowledge is spreading its salutary influence, more widely and rapidly than heretofore, over the practical business of the country. I now proceed to consider the communications made to the meetings of our Society during the past year.

POSITIVE GEOLOGY.—DEVONIAN SYSTEM.

In the Home Department of Positive Geology, the most striking circumstance has been an announcement by Professor Sedgwick and Mr. Murchison of the conclusion to which they were led by Mr. Lonsdale's suggestion in December 1837, founded on the intermediate character of the fossils in the Plymouth and Torbay limestone, —that the greater part of the slate rocks of the south of Devon and of Cornwall belong to the old red sandstone formation.

* Schropp and Company, 1839.

The order of the observations which have led to this important result, is nearly as follows:—

In a paper read at Cambridge, during the winter of 1836–37, Professor Sedgwick considered the fossiliferous slates on both sides of Cornwall to be of the same formation, and coeval, or nearly so, with the calcareous rocks that lie between the slates of South Devon.

In 1836 and 1837 also*, Messrs. Sedgwick and Murchison proposed to transfer the culmiferous or anthracitic shale and grits (Shillot and Dunstone) of *North* Devon to the carboniferous system; withdrawing them from the grauwacke in which they had before been included, and thus assigning a much more recent date than heretofore to the strata which occupy nearly one third part of the map of Devonshire.

But the relations of the slates and limestones of *South* Devon still remained to be determined; the mineral characters of the former being different from those of the old red sandstone beneath the carboniferous group, in many parts of South Wales and in Herefordshire, while the true position of the limestones (e. g. those of Plymouth, Torbay, and Newton Bushell,) was doubtful. At this period (1837), the fossils of this district were examined by Mr. Lonsdale and Mr. Sowerby, to whom the organic remains, both of the carboniferous and Silurian systems, were familiar. It was soon perceived, that while some of the South Devonshire fossils approached to those of the carboniferous strata, and others to those of Siluria, there were still many species which could not be assigned to either system; the whole, taken together, exhibiting a peculiar and intermediate palæontological character. Mr. Lonsdale therefore suggested, that the difficulties which had perplexed this inquiry could be removed by regarding the limestones of South Devon as subordinate to slaty rocks, which represent the old red sandstones of Hereford, Wales, Scotland, and Ireland,—their true place in the series of Devonshire being intermediate between the culmiferous basin of North Devon, and the Silurian strata,—if the latter exist in that county.

* In August 1836, at the Meeting of the British Association at Bristol; and in a paper read before the Geological Society, May and June, 1837, now published in the Geological Transactions, Second Series, vol. v., Part 3.

The value of this suggestion was not at first appreciated; but after the lapse of more than a year, Mr. Lonsdale's views were adopted (March 1839) by Messrs. Sedgwick and Murchison*, who soon afterwards applied this new arrangement not only to the groups of Devonshire originally under review, but with a boldness which does credit to their sagacity, extended it to the whole of the slaty and calciferous strata of *Cornwall*, till then known only as grauwacke, clay-slate, or killas; assigning to those strata, likewise, the date of the old red sandstone, and resting this determination entirely on the character of the fossils. This change—the greatest ever made at one time in the classification of our English formations—was announced in a memoir read before the Geological Society in April 1839; the authors then also proposing for the whole series (including both the old red sandstones of Herefordshire, and the fossiliferous slates and limestones of South Devon and Cornwall,) the new name of "*the Devonian system*," and expressing their belief, that many of the groups hitherto called grauwacke, in other parts of the British Islands and on the continent, would ere long be referred to the same geological epoch.

The proposed alteration, therefore, will terminate the perplexity hitherto arising from the circumstance, that the *old* red sandstone of Werner has been frequently confounded with the *new* red sandstone formation of English geologists. It also explains the cause of the English old red sandstone having been rarely recognised on the continent:—for if the Devonian slates afford the normal type of this formation, whilst the marly sandstones and conglomerates of Herefordshire are abnormal exceptions in it, we see the reason why

* It is to be observed here, that Mr. Murchison, having previously shown that the fossils of the Silurian æra are distinct from those of the carboniferous period, had also pointed out "the vast accumulations" (in which few fossils had at that time been discovered) "then known to separate the two systems." He mentions especially, that "the *fishes* of the old red sandstone—entirely distinct as to form and species—are as unlike those of the Silurian system, as they are to those of the overlying carboniferous system:" adding, "that he has no doubt, although at present unprovided with geological links to connect the whole series, that such proofs will be hereafter discovered, and that we shall then see in them as perfect evidence of a transition between the old red sandstone and carboniferous rocks, as we now trace from the Cambrian, through the Silurian, into the old red system."—See Silurian System, p. 585, line 22, *et seq.*

their slaty continental equivalents, like the greater part of the South Devon slates, have been referred to the undivided Wernerian formation of grauwacke.

Mr. Austen, in a communication relating to the structure of the south of Devon, has identified the calcareous slate and limestone of the south of Cornwall with the limestones of this district, and considers that of Torbay among the newest deposits in the latter series.

The Rev. D. Williams also has communicated two papers respecting these disputed rocks, which he refers to the transition or grauwacke system, and endeavours to show that the strata of Devonshire can be distinguished into certain groups by their lithological characters.

Mr. De la Beche in his map of Devon and Cornwall, published in 1839, has adopted divisions of the strata, similar to those of Professor Sedgwick and Mr. Murchison, as to their order of sequence; applying, provisionally, to the culmiferous rocks the name of *Carbonaceous series*, and to the Devonian and Cornish slates the appellation of *Greywacke.*

We know also on the authority of Mr. De la Beche that tin mines are worked in carbonaceous rocks at Owlescomb near Ashburton, on the east side of the Dartmoor granite, and on its west side at Wheal Jewel near Tavistock. He further informs us that one of the richest tin mines now worked in Cornwall, namely the Charlestown mine, east of St. Austle, is in a fossiliferous rock containing Encrinites and corals, and that the same corals occur also near tin mines at St. Just; and in the neighbourhood of Liskeard the Rev. D. Williams has found slates which contain vegetable impressions, dipping under other slates which are intersected by lodes of tin and copper.

From these new facts, we learn that the killas and other slate rocks of Cornwall and the south of Devon do not possess the high antiquity which has till lately been imputed to them; and that tin occurs, as copper, lead and silver have long been known to do, not only in slate rocks that contain organic remains, but even in the coal formation.

Soon after the publication of the views of Messrs. Sedgwick and Murchison, a similar change was applied by Mr. Griffith to the south-west portion of his geological map of Ireland. In a paper

that accompanied the presentation of this map to us on 22nd of May last, he states that he has now coloured, as old red sandstone and carboniferous limestone, extensive districts of the counties of Kerry, Cork, and Waterford, previously considered of higher antiquity; imputing his former erroneous opinion to the identity in lithological character of the shales and grits of the old red sandstone and carboniferous systems, with the older rocks in the transition series.

Mr. Griffith has also demonstrated by sections the unconformable position of the carboniferous and old red sandstone formations, which overlie older and more highly inclined slates in the counties of Kerry, Cork, Waterford, and Wexford.

Mr. Charles William Hamilton has likewise adopted similar changes; and believes that the slates which occupy a large space between the Mourne Mountains and Dublin are equivalent to those near Cork, which he now transfers to the old red sandstone.

Mr. Greenough, in the new edition of his map of England, represents nearly the same boundaries and order of succession in Devon and Cornwall as we find in the maps of Mr. De la Beche and Messrs. Sedgwick and Murchison; but in his memoir connected with the map, adopting the name of *Carbonaceous series* for the culmiferous rocks, he substitutes that of *Upper killas* for the Devonian system of Sedgwick and Murchison, (including under that term the old red sandstone of Herefordshire,) and *Lower killas* for the slates inferior to the Silurian system, which they have termed Cambrian.

Mr. Greenough, in his memoir, also shows by quotations from Dr. MacCulloch, that the undisputed old red sandstone of the north of Scotland exhibits, at intervals, the same great changes of mineral character, that occur in the strata intermediate between the Carbonaceous and Silurian systems in the west of England and on the borders of Wales; and justly infers the inadequacy of any one term to characterize formations which vary so much in lithological composition, that at one place they present the condition of a fine-grained silky slate, at another of sandstone, and at a third that of coarse gravel and conglomerate rock.

Thus, with respect to the slate rocks of Devon, Cornwall and Wales, the difficulties are reduced to those of an unsettled nomen-

clature; whilst nearly all parties are in unison as to the fundamental fact of referring the slates of South Devon and Cornwall to the epoch of the old red sandstone formation. The term grauwacke, however, I rejoice to think, will not be condemned to the extirpation which has been threatened from the nomenclature of geology; it may still retain its place as a generic appellative, comprehending the entire transition series of the school of Freyberg, and divisible into three great subordinate formations:—the Devonian system of Sedgwick and Murchison being equivalent to the upper grauwacke, the Silurian to the middle grauwacke, and the Cambrian system to the lower.

In this threefold distribution of the vast series of strata which have hitherto been indiscriminately designated by the common term grauwacke, we are, as it were, extending the progressive operations of a general inclosure act over the great common field of geology; we propose a division, founded on measurements, surveys, and the study of organic remains, analogous to that of the secondary strata, from the chalk downwards to the coal formation, established by William Smith, and to the separations of the once undivided territory of the great tertiary system, effected by Cuvier and Brongniart, Desnoyers, Lyell, and Deshayes.

To the uninitiated in geology, rectifications in the distribution of strata upon so large a scale may seem calculated to shake confidence in all the conclusions of our science; but a contrary inference will be drawn by those who know that these corrections have never been applied to conclusions established on the sure foundation of organic remains, but to those rocks only of which the arrangement had been founded on the uncertain character of mineral composition.

COAL FORMATION.

The Society has received from Professor Ansted a paper on the Carboniferous and Transition Rocks of Bohemia, a country which he visited last summer, directing especial attention to the district between Prague, Luditz and Pilsen, which he has illustrated by sections made from personal observation. Above the fundamental granite and gneiss he found extensive deposits of grauwacke, on which lie, in unconformable superposition, disconnected patches of

the coal formation. The age of this coal is well known, from the fossil Flora of Count Sternberg, who resided in the midst of it near Swina, to be identical with that of the great Coal formation of England. Mr. Ansted gives information also as to the action of trap rocks in producing disturbances of the strata in this district; and respecting dislocations, by which the grauwacke is several times placed on a level with the coal measures, whilst in some cases the strata are inverted and the coal measures laid beneath the grauwacke.

We have received an interesting communication from Mr. Hawkshaw respecting a remarkable disclosure made in the Bolton Railway, six miles north of Manchester, of five fossil trees in a position vertical to the plane of the strata in which they stand. The roots are imbedded in a soft argillaceous shale immediately under a thin bed of coal. Near the base of one tree, and beneath the coal, more than a bushel of hard clay nodules was found, each inclosing a cone of *Lepidostrobus variabilis*. The bark of the trees was converted to coal, from one quarter to three quarters of an inch thick; the substance which has replaced the interior of the trees is shale; the circumference of the largest of them is $15\frac{1}{2}$ feet at the base, $7\frac{1}{2}$ at the top, and its height 11 feet. One tree has spreading roots, four feet in circumference, solid and strong. By the care of Mr. Hawkshaw these trees have been preserved, and a covering is erected over them. The attendant phænomena seem to show that they grew upon the strata that lie immediately beneath their roots.

Mr. Barber Beaumont, in a communication respecting these same trees, considers that no drifted plants occur in coal fields, and that all the vegetables which are now converted into coal, grew upon swampy islands covered with luxuriant vegetation, which accumulated in the manner of peat bogs; that these islands, having sunk beneath the sea, were there covered with sand, clay and shells, till they again became dry land, and that this operation was repeated in the formation of each bed of coal. In denying altogether the presence of drifted plants, the opinion of the author seems erroneous; universal negative propositions are in all cases dangerous, and more especially so in geology: that some of the trees which are found erect in the coal formation have not been drifted, is, I think, established on sufficient evidence; but there is equal evidence to show that other trees, and leaves innumerable which pervade the strata

that alternate with the coal, have been removed by water to considerable distances from the spots on which they grew. Proofs are daily increasing in favour of both opinions: viz. that some of the vegetables which formed our beds of coal grew on the identical banks of sand and silt and mud, which being now indurated to stone and shale, form the strata that accompany the coal; whilst other portions of these plants have been drifted, to various distances, from the swamps, savannahs, and forests that gave them birth, particularly those that are dispersed through the sandstones, or mixed with fishes in the shale beds.

The cases are very few in which I have ever seen fossil trees, or any smaller vegetables erect and petrified in their native place. The Cycadites and stumps of large Coniferous trees on the surface of the oolite in Portland, and the stems of Equisetaceous plants described by Mr. Murchison in the inferior oolite formation near Whitby, and erect plants which I have found in sandy strata of the latter formation near Alencon, are examples of stems and roots overlaid by sediment and subsequently petrified without removal from the spots in which they grew. At Balgray, three miles north of Glasgow, I saw in the year 1824, as there still may be seen, an unequivocal example of the stumps of several stems of large trees standing close together in their native place in a quarry of sandstone of the coal formation.

In a paper on the sinking of the surface over coal mines, Mr. Buddle has shown that the depressions produced on the surface by the excavation of beds of coal near Newcastle-on-Tyne are regulated by the depth and thickness of the coal, the nature of the strata above it, and also the partial or total extraction of the beds of coal. The accumulation of water forming ponds in these superficial depressions, and the sinkings of a railway, have afforded accurate measures of the amount of the subsidences in question.

WEALDEN AND PORTLAND FORMATIONS.

In the north of Germany Mr. Roëmer, of Hildesheim, has identified beneath the Cretaceous system, the Purbeck stone and beds of the Wealden formation, with nearly all its characteristic shells, and three minute species of Cypris. He has also found the Portland sand and the upper and lower Green sand and the Gault clay, in the

north of Germany. He has, moreover, found the Wealden formation near Bottingen in the High Alps.

CHALK FORMATION.

In extension of our knowledge of the Chalk formation, the Rev. J. Gunn has sent us a short communication, accompanied by a lithograph representing the columnar disposition of some Paramoudras to the height of many feet one above another in the chalk of Norfolk. The history of these enormous urn-shaped flints, which were first noticed by Professor Buckland in an early volume of our Transactions, 1st series, vol. iv. p. 413. pl. 24., is still involved in much obscurity. Their form is most probably due to siliceous matter collected around and penetrating throughout the substance of gigantic spongiform bodies; but we have yet to learn the reason why they are occasionally placed in single vertical rows, almost like the joints of a basaltic column, sometimes nearly touching, but not articulating with one another.

A paper has been read by Mr. Henry Lawes Long on the occurrence of numerous *subterraneous chasms* or *swallow-holes* in the chalk on the west of Farnham, with observations on the drainage of the country near the west extremity of the highly-inclined ridge of chalk, called the Hog's Back, between Guildford to Farnham. The land-springs immediately on the north of Farnham descend southwards in open gulleys over tertiary strata, until they arrive at the narrow band of chalk which passes under Farnham Park, where they are suddenly engulphed in transverse fissures or swallow-holes, through which they pass under ground to a considerable distance, and again break forth on the southern side of the chalk. Seven of these swallow-holes occur near Farnham, from some of which the water emerges in sufficient force to turn a mill. They are probably connected with subterranean faults and transverse fractures, the origin of which was coeval with the elevation of the narrow band of chalk, which forms the Hog's Back, and which, near Farnham, is inclined at a high angle to the north. The water that now passes through the Farnham swallow-holes may tend to enlarge the chasms through which it takes its subterraneous course, by dissolving slowly the chalk of their sides in the small quantities of carbonic acid which rain-water usually contains.

Similar transverse fractures, on a greater scale, have given origin to the chasms, which, being enlarged by denudation into transverse valleys, afford outlets through the high escarpment of the chalk to the rivers that, rising within the Weald, flow through the escarpment of the north Downs into the valley of the Thames, and through the escarpment of the south Downs into the sea, viz. to the Wey, the Mole, the Darent, the Medway, and the Stour, through chasms in the north Downs; and to the Arun, the Aduz, the Ouse, and the Cuckmere, through chasms in the south Downs.

Dr. Mitchell has communicated a paper on Artesian and other wells, in the gravel and London clay in Essex, showing that water occurs under the London clay at various depths; the deepest at Foulness Island, being 460 feet. He attributes this inequality in part to unevenness in the surface of the subjacent chalk. On reaching the chalk a large volume of water usually rushes up. Artesian wells are now general in Essex, where they are of the greatest utility in districts that have no natural springs. He also gives an interesting list of localities, both of constant and intermitting springs, some of them very powerful, that burst out from the chalk.

Dr. Mitchell has also communicated an account of deleterious gases that occur in wells in the chalk and strata above it near London. The most abundant of these, namely, carbonic acid gas, issues very partially and only from certain strata, and produces sometimes effects fatal to persons employed in digging wells. Sulphuretted hydrogen is occasionally met with in chalk; and both sulphuretted hydrogen and carburetted hydrogen occur in beds immediately above the chalk.

SUPERCRETACEOUS FORMATIONS.

In illustration of the history of the Eocene division of the tertiary strata, Mr. Bowerbank has concluded, from his personal observations at White cliff bay in the Isle of Wight, that there are no well-defined zoological distinctions between the London and plastic clays, but that in the cliffs of this bay the same shells are common to alternations of these clays with one another. At Alum bay also he found many London clay fossils in beds of greenish grey sand and clay below the variegated sands and clays referred by Mr. Webster to the plastic clay. A similar rectification was sometime ago proposed by Professor Sedgwick.

We have also witnessed during the past year the commencement of a valuable publication by Mr. Bowerbank on the fossil fruits and seeds of the London clay, illustrated with very numerous and accurate engravings by Mr. James Sowerby.

The great attention the author has long paid to the remains of fruits and seeds which occur in such vast abundance in the Isle of Sheppy, whence he has collected not less than 25,000 specimens, place him in a position peculiarly advantageous for the object before him. In this work drawings will be given of the anatomical structure of many of these fossils, as seen under the microscope. The simple expedient Mr. Bowerbank has adopted of preserving these fruits in jars of water, has kept him in the entire possession of every specimen ever placed in his collection; whilst of the thousands of similar fossils that have been deposited in other collections, including that at the British Museum, nearly all have perished from the decomposition of the iron pyrites with which they are always penetrated.

Mr. Lyell has communicated to us a paper full of elaborate detail of facts, and of ingenious speculations respecting the Boulder formation, or drift, associated with freshwater deposits, in the mud cliffs of Eastern Norfolk. These cliffs are in some places 400 feet high, and consist of chalk, crag, freshwater deposits, drift mud and sand, stratified and unstratified;—with superficial accumulations of flint gravel. The centre of his observations is the town of Cromer; he considers the Boulder formation to have been accumulated on land permanently submerged, and not, by one or many, transient advances of water over dry land, and therefore proposes, as Mr. Murchison and others have already done, to substitute the term of Drift for that of Diluvium, which many other writers have assigned to it. The Drift, or Diluvium, is of two kinds; one composed of sand, loam, clay, and gravel, all regularly stratified; the other consisting of clay, not divided into beds, and containing boulders of granite, trap and other rocks.

This clay is known on the east and north-east coast of Scotland by the name of Till. He considers the stratified Drift and Till to be contemporaneous formations, and compares the latter to moraines formed at the termination of glaciers. He imagines that drifted masses of ice, charged with earthy matter and fragments of rock, may have deposited the Till as they melted in still water, and the

occasional intercalation or juxta-position of stratified materials is ascribed to the action of currents on materials also falling from melting icebergs.

Mr. Lyell refers the complicated bendings and tortuous foldings of many beds of this formation near Mundesley and Cromer to lateral pressure from drifting ice, especially where extremely contorted beds repose upon undisturbed and horizontal strata. But he admits that some of them may be due to landslips of ancient date, and which had no connection with the present line of cliffs. At the bottom of the boulder formation, and immediately above the chalk, extensive remains of a buried forest occur, the stools of the trees being imbedded in black vegetable earth. From the position of this forest a vertical subsidence of several hundred feet and a subsequent rise of the land to the same amount is inferred. This forest and a bed of lignite are connected with fluviatile or lacustrine deposits, which occur about the level of low water below the drift; but at Mundesley they are partly above it, and the freshwater shells which they inclose being nearly all of British species show that they, as well as the contemporaneous drift, all belong to the newer Pliocene period.

In an Address formerly delivered from this chair, in 1836, and in a subsequent edition of his "Principles of Geology," as well as in is "Elements" Mr. Lyell has called our attention to some differences of opinion which had been expressed by several eminent conchologists as to the number of fossil shells of the crag of Norfolk and Suffolk which could be identified with living species. So great was the discordance of the results at which M. Deshayes, Dr. Beck, and others seemed to have arrived, that their announcement was calculated materially to impair our confidence in the applicability of the chronological test so much relied on by Mr. Lyell for the classification of the tertiary formations; namely, that derived from the proportional number of recent and extinct species discoverable in each deposit. In the hope of arriving at some definite conclusion on this important point, Mr. Lyell visited Norfolk and Suffolk during the last year, and having obtained a considerable collection from the crag near Norwich and Southwold, he instituted, with the assistance of Mr. Searles Wood and Mr. George Sowerby, a thorough comparison between them and recent species. The fossil shells of

this formation, which the author calls the Norwich crag, are partly marine, and partly freshwater, and indicate a fluvio-marine origin, and the proportion of living species was found to be between 50 and 60 per cent. This deposit, therefore, the author refers to the older Pliocene period. A similar examination was then made of 230 species of shells from the Red Crag in Mr. Wood's museum, and it was found that 69 agreed with living species, being in the proportion of about 30 per cent This group therefore Mr. Lyell ascribes to the Miocene era. A collection of 345 species of Coralline Crag shells in Mr. Wood's cabinet was then compared in like manner, and sixty-seven were determined to be identical with recent species, being about 19 per cent. Mr. Lyell, therefore, considers that the Coralline Crag is also Miocene, although belonging to a more remote part of that period than the Red Crag. Having obtained from M. Dujardin a collection of 240 shells from the Faluns of Touraine, he found with Mr. George Sowerby's assistance that the recent shells were in the proportion of twenty-six per cent., so that he has now come round to the opinion long ago announced by M. Desnoyers, that upon the whole the Crag of Suffolk corresponds in age with the Faluns of Touraine, both being Miocene, although the species in the two countries are almost entirely distinct, those of England having a northern and those of France a sub-tropical character. I am also informed by Mr. Lyell, that out of 400 marine and freshwater species, from the Eocene strata of the London and Hampshire basins, Mr. G. Sowerby was scarcely able to identify two per cent. with living shells. It is satisfactory therefore to observe that the test of age derived from the relative approach to the recent Fauna is in perfect accordance with the independent evidence drawn from superposition. We ascertain for example by superposition that the freshwater strata of the mud cliffs of East Norfolk rest on Norwich crag, and are the newest formation of all. They are then followed in the descending series by, 1st, the Norwich, 2ndly, the Red, and 3rdly, the Coralline Crag, beneath which is the London Clay. The same order of sequence is indicated by the organic remains considered independently, and simply with reference to the degree of their correspondence with the existing Fauna.

It has been known for many years, that near Bridlington, in Yorkshire, sand and clay containing marine tertiary shells had been ex-

posed on the coast. From an examination of the shells collected there by Mr. Bean, Mr. Lyell finds the deposit to agree in age with the Norwich Crag.

I cannot conclude these remarks without observing, that some part of the confusion and apparent inconsistency of the opinions of different conchologists, respecting the age of the Crag, must have arisen from the intermixture of fossils derived equally from the Norfolk and Suffolk beds, or from strata, some of which now turn out to be referable to the Older Pliocene, others to the Miocene period.

From an examination of some fossil shells, identical with recent species collected by Capt. Bayfield from the most modern deposit near the Gulf of St. Lawrence, and near Quebec, Mr. Lyell infers, that the climate of Canada was colder than now during the era immediately antecedent to our own times. The shells, which were determined by Dr. Beck, differ in great part from those now living in the Gulf of St. Lawrence, agree more nearly with arctic genera and species, and resemble those which Mr. Lyell collected at Uddevalla, in Sweden; whereas, if the living shells most abundant in the Swedish and Canadian seas are contrasted, they differ almost entirely. From notes sent by Capt. Bayfield, it appears that at different depths in the stratified sand and clay containing the fosils shells, near Quebec, insulated boulders are numerous, which, it is presumed, have been brought down at distant intervals by drift ice, and have dropped to the bottom of the sea as the ice melted.

While Mr. Lyell, by the aid of Dr. Beck's determination of fossils, had adopted these views respecting the climate of Canada, Mr. James Smith, of Jordan Hill, had been led by independent observations to a similar conclusion respecting the climate of Scotland during the Newer Pliocene era, arguing from the arctic character of the Testacea found in the raised beds of the valley of the Clyde, and other localities. In the first of two papers communicated by this author, he regarded all the deposits abounding in recent shells in Scotland and Ireland as belonging to one group; but in his second memoir he contends that there are two distinct formations on the Clyde, in the older of which there are from ten to fifteen per cent. of extinct or unknown species of shells, which he refers to the Newer

Pliocene system of Lyell; whereas all the species found in the newer, which he calls Post-tertiary, exist also in the present seas. During this Post-tertiary period, which is considered to have been anterior to the human epoch, an elevation of at least forty feet took place on the shores of the Clyde. Mr. Smith affirms that the Till, or unstratified accumulation of clay and boulders, belongs not to the Post-tertiary, but to the older Pliocene division.

IGNEOUS ROCKS.

The principal communication we have received on rocks of igneous origin has been from our Secretary, Mr. W. I. Hamilton, who has read an interesting paper on the north-west part of Asia Minor, from the Peninsula of Cyzicus to Koola, with a description of the Katakekaumene. Between Cyzicus and Koola the principal stratified rocks are schist, with saccharine marble, compact limestone resembling the scaglia of Italy and Greece, tertiary sandstones, and tertiary limestones. The igneous rocks are granite, peperite, trachyte and basalt. The tertiary limestones are referred to the great lacustrine formation which occupies so large a part of Asia Minor. Hot springs burst forth near Singerli from a porphyritic trap rock. The Katakekaumene is a volcanic region, extending about seven miles from north to south, and from eighteen to nineteen east and west. It presents two systems of volcanic craters and coulées: the older of them are placed on parallel ridges of gneiss and mica slate, and the newer in the intervening valleys; hence he argues, that when the latter eruptions took place, the lines of least resistance to subterraneous expansion were in the valleys. The streams of lava from the more recent cones are bare and rugged, like the coulées in central France. Three periods of eruption are traced: the first, having produced basalt, which caps the plains of white limestone, and was ejected before the formation of the valleys; the second, marked by currents of lava from the more ancient system of volcanos in action since the formation of the valleys; the third resembling the coulées of Etna and Vesuvius, and mentioned by Strabo, but of which there is no historical tradition as to the period when they were in activity.

We have a notice by the Rev. W. B. Clarke of a shower of ashes that fell on board the Roxburgh off the Cape de Verd islands in

February, 1839, the cause of which was not apparent. The sails were covered with a fine powder, resembling the ashes of Vesuvius, which was probably derived from an eruption in the Cape de Verd group.

PALÆONTOLOGY.

In the department of *Palæontology* Prof. Owen has, during the past year, contributed many papers, with his usual zeal and ability, to the elucidation of this most essential and perhaps most generally interesting branch of our subject. At the head of these we must place his determination of a tooth and part of a jaw of a fossil monkey, of the genus *macacus*, with part of the jaw of an opossum, and the tooth of a bat, in Eocene strata of the English tertiary formation. These remains were found at Kingston, near Woodbridge in Suffolk, by Mr. Colchester, in strata which Mr. Lyell has referred to the London clay; thus proving the existence of quadrumanous, marsupial, and cheiropterous animals in this country during the Eocene period. We have now evidence of fossil Quadrumana in the tertiary formations, not only of India and Brazil, but also of France and England; respecting which Mr. Owen has observed, that they appear under four of the existing modifications of the quadrumanous type: viz. the tailless ape (*Hylobates*), found fossil in the South of France; the gentle vegetable-feeding *Semnopithecus*, found fossil in India; the more petulant and omnivorous *Macacus*, found in Norfolk; and the platyrrhine *Callithrix*, found in Brazil. This genus is peculiar to America, and its extinct species is of more than double the stature of any that exists at the present day. This geographical distribution of Quadrumana adds further weight to the arguments derived from the tropical aspect of vegetable remains that abound in the London clay at Sheppy, showing that great heat prevailed in the European part of the world, as well as in India and South America, during the Eocene period.

The probability of high temperature is further corroborated by Mr. Owen's recent recognition of four petrified portions of a large serpent (*Palæophis Toliapicus*), eleven feet long, and in several points resembling a boa, or python; and also of a bird allied to the vultures (*Lithornis vulturinus*), all from the London clay of the Isle of Sheppy; wherein the occurrence of fossil Crocodilians and Testudinata, and of fossil fruits, having a tropical aspect allied

to cocoa-nuts and many other fruits of palms, has been long known. Can we account for these curious facts without supposing that at the Eocene period of the tertiary epoch, the very clay on which London now stands was in the condition of a nascent spice-island, its shores covered with basking reptiles, and the adjacent lands waving with cardomums and palms, and thuias and cypresses, with monkeys vaulting and gamboling upon their branches, and gigantic serpents entwined around their trunks; the seas also swarming with sting-rays and saw-fishes, with chimæras and enormous sharks? for all these together with countless shells of pearly nautili occur among the fossil remains of the numerous extinct species of fishes, which, during the early ages of the tertiary period, crowded the tepid seas of our now humid and chilling climate.

Mr. Owen has also determined the character of a new genus of Pachydermatous animal (*Hyotherium*) intermediate between the Hyrax, hog, and Chæropotamus, found in the London clay at Herne Bay, near Margate, by Mr. Richardson.

Mr. Lyell having submitted to Mr. Owen some fossil teeth from the Red Crag of Newbourne in Suffolk, they proved to be referrible to the leopard, bear, hog, and a large kind of deer, and afford the first example of mammalian remains being found in England in any of those divisions of the Crag which Mr. Lyell, in a paper already alluded to, has ascribed to the Miocene period; these genera are known to occur in the Miocene formations of France and Germany. The numerous Mammalia in the fluvio-marine crag of Norwich, are decidedly of a later date; among these Mr. Lyell enumerates the teeth and jaw of *Mastodon longirostris*, a tusk of an elephant with serpulæ attached, and bones of a horse, hog, and field-mouse; there occur bones of birds, many fishes, and numerous shells, partly marine, and partly fresh-water and terrestrial.

The recent discoveries in Brazil by Dr. Lund of extinct Mammalia, that probably lived in some late portion of the tertiary epochs, form a new and important chapter in Palæontology. The largest of these are referrible to more gigantic forms than at present exist of families now peculiar to South America—*e. g.* to Sloths and Armadillos; just as most of the fossil mammalia of New Holland belong to families and genera which are still peculiar to that country. In a paper on one of these animals from Buenos Ayres, Mr. Owen

has shown that the bony armour, which several authors have referred to the Megatherium, belongs to the Glyptodon, an animal allied to the Armadillo, and of which a head containing teeth, and attached to a tessellated bony covering of the body and tail, resembling those of an Armadillo, has been lately found near Buenos Ayres, and is figured by Sir Woodbine Parish in his interesting work on that country, 1838.

The Glyptodon differed from the Megatherium in the structure and number of the teeth, and from all known Armadillos in the form of the lower jaw, and the presence of a long process descending from the zygoma; and approached in both these respects to the Megatherium. The teeth differ from those of Armadillos, in having two deep grooves both on the outer and inner surface, are more complex than those of any known Edentate, and indicate a passage from that family into the Toxodon. The ungual phalanges are wholly unlike those of the Megatherium, and most nearly resemble those of Dasypus, but are short broad and flat, and seem to have been covered with hoof-like claws. The form of the foot most nearly resembled that of the fore foot of the Mole. Having appropriated to the Glyptodon the armour supposed to belong to the Megatherium, Mr. Owen next proves that the latter animal was unprovided with any such bony covering, arguing from a comparison of its vertebral column and pelvis with that of the Armadillo; and from the absence of the oblique processes, which in the loricated Edentata resemble as to form and use the *tie-bearers* in carpentry, that support the weight of a roof. The vertebral conditions of the Megatherium are nearer to those of the Sloths and Ant-eaters. We have accounts of twelve skeletons of Megatherium, not one of which was found to be accompanied by bony armour. Cuvier considered the Megatherium more nearly allied to the Ant-eaters and Sloths than to the Armadillos.

Captain Martin has found that many parts of the bottom of the English Channel and German Ocean contain in deep water the bones and tusks of Elephants. They have been dredged up between Boulogne and Dungeness, in the mid-sea between Dover and Calais, and at the back of the Goodwin Sands; also mid way between Yarmouth and the coast of Holland. In 1837 a fisherman enclosed in his net a vast mass of bones between the two shoals called

Varn and Ridge, that form a line of submarine chalk-hills between Dover and Calais. Captain Martin says these bones do not occur on the top of banks or shoals, but in deep hollows or marine valleys. Sir John Trevelyan possesses the molars of a large Elephant from gravel in the bed of the Severn, near Watchet, and we have long known that the bones of Elephants occur in great abundance in the oyster grounds off Yarmouth.

In subterranean Ornithology three important discoveries have been made during the past year; the first in the Eocene formation by Professor Owen, who has recognised the fossil Vulture before alluded to in the London clay of Sheppy; the second, by Lord Cole and Sir P. Egerton, who have acquired from the chalk of Kent the humerus of a bird most like that of an Albatross, but of larger and longer dimensions; the third by Professor Agassiz, who has found in Switzerland, a nearly entire skeleton of a small bird (not unlike a Swallow), at Glaris, in the indurated blue slate beds of the lower region of the chalk formation. We know that the bones of a Wader, larger than a Heron, have been found by Mr. Mantell in the Wealden formation of Tilgate Forest; and that the Ornithichnites in the New Red Sandstone of Connecticut have been referred to seven species of birds.

We have an interesting accession to our knowledge of the anatomy of the Ichthyosaurus in Mr. Owen's description of the hinder fin of an *Ichthyosaurus communis*, discovered at Barrow-on-Soar by Sir Philip Egerton; this fin distinctly exhibits on its posterior margin the remains of cartilaginous rays that bifurcate as they approach the edge of the fin, showing in this respect a new approximation to the fin of a fish, and more fully justifying the propriety of the name Ichthyosaurus. Traces are also preserved of scutiform compartments on the integument of the fin. It is singular that this structure should never have been observed in any of the numerous specimens from Dorset and Somerset that have come under our notice; whilst at Barrow-on-Soar, from whence the paddle in question was derived, even the fibres of the skin and folds of the epidermis are sometimes accurately retained*.

Mr. Owen's first part of his report on fossil Saurians, read at the British Association at Birmingham in August last, forms the com-

* See Buckland's Bridgewater Treatise, Pl. 10.

mencement of a most important addition to the history of extinct reptiles. His recent investigations in Odontography have also supplied to the geologist a new and most efficient instrument of investigation, enabling him to distinguish genera of extinct animals by the microscopic structure of their teeth; and as, of all fossil remains, the teeth are the parts most perfectly preserved, and in the case of cartilaginous fishes the teeth and spines are generally the only parts that have escaped decomposition, this method assumes an especial importance in fossil Ichthyology, as affording exact characteristics of animals long swept from the surface of the earth, and whose very bones have been obliterated from among the fossil witnesses of the early conditions of life upon our planet. By this microscopic test applied to the family of Sharks, Mr. Owen has confirmed the views of Agassiz respecting the affinities between the living Cestracion and the extinct genera Acrodus, Ptychodus, Psammodus, Hybodus, Cochliodus; in the case of animals also of the higher orders, he has settled the much-disputed places of several extinct gigantic Mammalia by the same unerring test. Thus he has shown the supposed reptile Basilosaurus to be a Cetaceous mammifer, allied to the Dugong; the Megatherium to be, as Cuvier had considered it, more nearly allied to the Sloth than to the Armadillo; and the Saurocephalus to be, as Agassiz had supposed it, an osseous fish.

Dr. Malcolmson, in a memoir on the Old Red Sandstone of the north of Scotland, has done important service in showing that the rocks composing that group are divided into three formations, the two lower of which are clearly distinguished from each other by their fossil fishes. The cornstone or central formation is charged with numerous remains of Ichthyolites, including *Holoptychus nobilissimus*, a new species of Cephalaspis, and other forms not yet described. The lower division, consisting in this region of conglomerates, shales and sandstone, is characterized by the genera Dipterus, Diplopterus, Cheiracanthus, &c., of Agassiz, as well as by the occurrence of a singular Ichthyolite, which seems to offer close analogies to certain forms of Crustacea. By help of these Ichthyolites, the author has been enabled to connect certain strata of Orkney and Caithness, and determine their relations to the beds of Old Red Sandstone containing fossil fishes in the basin of the Tay, and in the border counties of England and Wales, where they had been described by Mr. Murchison.

Mr. Williamson, in a notice on the fossil fishes of the coal-fields of York and Lancaster, says that these coal measures are very rich in Ichthyolites, which abound so much at Middleton colliery, near Leeds, that the workmen have given to one bed the name of fish coal; they are usually in fine bituminous shale above and below the coal, and most frequent in the roof immediately above it, where, as at Burdie House, near Edinburgh, there is a thin seam of coprolitic matter; they are rarely mixed with any great quantity of vegetable remains. In the lower measures of Lancashire they are associated with Goniatites and Pectens, and in the higher measures of Lancashire and Yorkshire with freshwater shells allied to Unio, and with Entomostraca. Exact observations as to facts of this kind are of inestimable importance, for it is only by careful induction from a sufficient number of such-like phænomena, and from similar details as to the local distribution and condition of animal and vegetable remains in the marine and fluvio-marine and lacustrine deposits which compose the carboniferous series, that we shall arrive at a solution of the grand problem of the formation of coal.

CRUSTACEANS.

The Rev. T. B. Brodie has discovered in the Wealden formation near Dinton, in the vale of Wardour, the remains of Coleopterous and Hymenopterous insects, and a new genus of *Isopodous Crustacea* in the family Cymothoidæ. The Isopods are clustered densely together; the lenses in their eyes are sometimes preserved; there are also traces of legs, but of no antennæ. With them he has found a large species of Cypris. The insects are chiefly small Coleoptera; there are several species of Dipterous, and one Homopterous insect, and the wing of a Libellula. Mr. Brodie's discovery is the first yet made of insects in the Wealden formation, and also the first example in a secondary formation of Isopods that approximate in form to the Trilobites of the Transition series.

WORMS.

An addition has been made to fossil Helmintology by Mr. Atkinson of Newcastle-on-Tyne, who has found in slabs of micaceous slaty sandstone, from the carbonaceous series near Haltwhistle, tortuous casts of vermiform bodies of various sizes, some almost an inch in diameter, and several feet in length; the surface of many of these

is thickly marked by transverse rings and a longitudinal groove, similar to those in the largest recent marine sand worms, *e. g.* the *Leodice gigantea.* The integument of some of these worms containing *chitine*, like the covering of insects, seems to have endured long enough to fix impressions of the transverse rings upon the sand; and the habit of swallowing large quantities of earth and sand, which we observe in many recent worms, may explain the presence of the large portion of sand, now indurated to stone, which occupies the interior of the impression of the skin. Since many casts are found upon the same slab, these worms must have been very numerous at the bottom of the sea, when the sandstone was in process of formation. Similar impressions of Annelids on the Cambrian rocks are figured by Mr. Murchison in Pl. 27 of his great work on the Silurian System.

ICHNOLOGY.

About twelve years ago we witnessed the creation of a new department in geological investigations, viz. the science of Ichnology, founded on the evidence of footsteps made by the feet of animals upon the ancient strata of the earth; this new method commenced with the recognition of the footmarks of reptiles on the New Red Sandstone near Dumfries, and not long after (1834) was followed by most curious and unexpected discoveries in Saxony and America. The Chirotherium of Hessberg and Ornithichnites of Connecticut were among its early results. Our own country has during the last two years been abundantly productive of similar appearances in many localities.

In recent excavations for making a dock at Pembray, near Llanelly, in Pembrokeshire, tracks of deer and of large oxen have been found on clay subjacent to a bed of peat, the lower peat being moulded into the footsteps; similar impressions were also found upon the upper surface of the peat beneath a bed of silt, and bones both of deer and oxen in the peat itself. Footmarks of deer have been also noticed in Mr. Talbot's excavations for a harbour near Margam burrows on the east of Neath.

Near Liverpool Mr. Cunningham has successfully continued his researches begun in 1838, respecting the footsteps of Chirotherium and other animals in the New Red Sandstone at Storeton Hill, on

the west side of the Mersey. These footsteps occur on five consecutive beds of clay in the same quarry, the clay beds are very thin, and having received the impressions of the feet, afforded a series of moulds in which casts were taken by the succeeding deposits of sand, now converted into sandstone. The casts of the feet are salient in high relief on the lower surfaces of the beds of sandstone, giving exact models of the feet and toes and claws of these mysterious animals, of which scarcely a single bone or tooth has yet been found, although we are assured by the evidence before us of the certainty of their existence at the time when the New Red Sandstone was in process of deposition.

Further discoveries of the footsteps of Chirotherium and five or six smaller reptiles in the New Red Sandstone of Cheshire, Warwickshire and Salop, have been brought before us by Sir P. Egerton, Mr. I. Taylor, jun., Mr. Strickland, and Dr. Ward.

Mr. Cunningham, in a sequel to his paper on the footmarks at Storeton, has described impressions on the same slabs with them, derived from drops of rain that fell upon thin laminæ of clay interposed between the beds of sand. The clay impressed with these prints of rain drops acted as a mould, which transferred the form of every drop to the lower surface of the next bed of sand deposited upon it, so that entire surfaces of several strata in the same quarry are respectively covered with moulds and casts of drops of rain that fell whilst these strata were in process of formation.

On the surface of one stratum at Storeton, impressed with large footmarks of a Chirotherium, the depth of the holes formed by the rain drops on different parts of the same footstep has varied with the unequal amount of pressure on the clay and sand, by the salient cushions and retiring hollows of the creature's foot; and from the constancy of this phænomenon upon an entire series of footmarks in a long continuous track, we know that this rain fell after the animal had passed. The equable size of the casts of large drops that cover the entire surface of the slab, except in the parts impressed by the cushions of the feet, record the falling of a shower of heavy drops on the day in which this huge animal had marched along the ancient strand; hemispherical impressions of small drops, upon another stratum, show it to have been exposed to only a sprinkling of gentle rain that fell at a moment of calm.

In one small slab of New Red Sandstone found by Dr. Ward near Shrewsbury, we have a combination of proofs as to meteoric, hydrostatic, and locomotive phænomena, which occurred at a time incalculably remote, in the atmosphere, the water, and the movements of animals, and from which we infer with the certainty of cumulative circumstantial evidence, the direction of the wind, the depth and course of the water, and the quarter towards which the animals were passing; the latter is indicated by the direction of the footsteps which form their tracks; the size and curvatures of the ripple-marks on the sand, now converted to sandstone, show the depth and direction of the current; the oblique impressions of the rain drops register the point from which the wind was blowing, at or about the time when the animals were passing.

Demonstrations founded solely upon this kind of circumstantial evidence were duly appreciated, and are well exemplified, by the acute author of the story of Zadig; who from marks he had noticed on the sand, of its long ears, and teats, and tail, and from irregular impressions of the feet, declared the size and sex, recent parturition and lameness of a bitch he had never seen; and who from the sweeping of the sand, and marks of horse-shoe nails, and a streak of silver on a pebble that lay at the bottom of a single footstep, and of gold upon a rock against which the animal had struck its bridle, inferred that a horse, of whose existence he had no other evidence, had recently passed along the shore, having a long switch tail, and shod with silver, with one nail wanting upon one shoe, and having a bridle studded with gold of twenty carats value.

In addition to the commencement of Mr. Bowerbank's publication on the Fossil Fruits and Seeds of the London Clay, before alluded to, we have hailed with satisfaction the announcement, by Professor Henslow and Mr. Hutton, of their intended continuation of the Fossil Flora of Great Britain, conducted for some years by Dr. Lindley and Mr. Hutton, and lately suspended.

A Dictionary of the terms and language of geology has long been a desideratum to young students, to whose early progress the technical terms of the science have hitherto presented formidable impediments. This want has been recently supplied by two publications of this kind, one by Mr. George Roberts, author of the History of Lyme Regis; the other by Dr. Humble.

During the last year the Society has received no communication on Mineralogy; and almost the only volume that has been published in England on this much-neglected subject, has been a small but highly elaborate treatise on Crystallography by Professor Miller, of the University of Cambridge. In this treatise the author has adopted the crystallographic notation proposed by Professor Whewell in his paper on a General Method of calculating the Angles of Crystals, and the laws according to which they are formed, published in the Transactions of the Royal Society of London, 1825; and Professor Neuman's method of indicating the positions of the faces of a crystal by the points in which radii, drawn perpendicular to the faces, meet the surface of a sphere. The expressions which have been thus obtained are remarkable for their symmetry and simplicity, and are all adapted to logarithmic computation, and for the most part new.

NOTICE OF DECEASED MEMBERS.

In proceeding to speak of the losses which, during the past year, our science has sustained by death, I shall offer my first tribute of respect to the memory of one, whom a predecessor of mine in this chair has justly called the father of English geology; since to his discoveries we owe the first diffusion of exact knowledge as to the order of superposition of the secondary formations which occupy so large a portion of our island, and the first demonstration of that constancy of the organic remains, which he proved to be characteristic of the component strata of each different formation. It was the especial merit of Mr. WILLIAM SMITH to establish a series of types of these groups, many of which have been adopted as classical, in such a manner as will perpetuate his name among the original discoverers of the age in which he lived.

If, as it has been truly said, the honour of the first discoveries in tertiary geology belongs to France, where the labours of Cuvier and Brongniart gave to this great division of the strata of the earth a systematic arrangement before unknown, so the establishment of the types in secondary geology, from the chalk down to the new red sandstone, is due to England; and the discovery of the leading natural divisions of that important portion of them which consti-

tutes the oolite formations, was almost exclusively the work of Mr. William Smith.

His earliest publication was a treatise on irrigation, 1806, a subject on which his experiments gained him a medal from the Society of Arts.

In 1801 he printed proposals for publishing accurate delineations and descriptions of the natural order of the various strata that are found in different parts of England and Wales, to be illustrated by a small geological map*. This work was never completed, but it led to the publication of his large map, in 1815, for which the Society of Arts awarded him their medal and a premium of £50. In the same year also his stratigraphical collection of organic remains was purchased for the British Museum; this collection having formed the basis of his two separate volumes, entitled "Strata identified by their Organized Fossils," 1815, and "a Stratigraphical System of Organized Fossils," 4to, 1817.

During the six years which followed the publication of his map of England, he put forth twenty geological maps of English counties on a larger scale, and several coloured sections across the south of England, and a general Geological Section of England and Wales, from London to Snowdon.

Among his unpublished papers were found unfinished and in part printed, an introductory work on geology, and preparations for a volume on Œconomic Geology, both illustrating the originality of his views.

Mr. William Smith entered on the field of his honourable exertions as a Civil Engineer and Mineral Surveyor at a time when his labours in geology were but little appreciated, and almost solitary. Amidst difficulties and discouragements, and at intervals snatched from the duties of a laborious profession, he accomplished the gigantic work of a general mineralogical survey of England, founded almost entirely on his own personal observations, which he ultimately recorded in a map of fifteen coloured sheets, published by subscription in 1815.

Inevitable delays retarded the appearance of this work nearly to the time when a more detailed and perfect map, by a distinguished

* The original coloured copy of this map, dated 1801, was presented by Mr. Smith to our Society, and is now in the Museum.

president of this Society, eclipsed in some degree the fame which would have accrued to its author had it been published earlier, even in the less perfect form to which he had advanced it some years before. The sense entertained by this Society of the value of the scientific services of Mr. Smith, was marked by their award to him of their first Wollaston Medal, in 1831; and was accompanied by the just and eloquent eulogium pronounced on that occasion by Professor Sedgwick. In the same year also the British Association assembled at York made successful application to government for a pension, which was settled upon Mr. Smith for life; and at the meeting of this Association at Dublin, 1835, the University conferred on him the honorary degree of Doctor of Civil Law.

Mr. Smith was one of those remarkable persons whom strong natural sense and acute powers of observation occasionally enable to triumph over the disadvantages of a defective education. His attention was first called to physical inquiries, by the observing, when a boy, that a large stone which he was lifting under water in search of eels, could be moved with much more ease, than if the same stone had been on land. His juvenile curiosity was excited to learn the cause of an occurrence so surprising to him; and this first step led him, at the age of eighteen, to enter the profession of a surveyor and civil engineer. His early professional occupations from the year 1791 to 1799, whilst surveying collieries, constructing a part of the Somerset coal canal near Bath, and preparing reports respecting a supply of water for the Kennet and Avon Canal, and the trade it was likely to derive from carriage of stone and coal, &c., placed him in daily contact with geological phænomena especially calculated to illustrate the order of superposition of the English strata, and laid the foundation of his future discoveries.

By carefully noting the characters of the beds which he found in juxtaposition, and making comparative sections in various directions in the vicinity of Bath, he ascertained that an uniform order of succession pervades the groups exposed in the escarpments of the hills in that part of England, and that this uniformity is attended by a similarity in the organic remains of certain beds, which differ entirely from those of the groups above and below them; by diligently collecting and collating these remains, he drew the inference, that each group of strata contains extraneous fossils peculiar to itself.

His next step was to infer that the strata thus identified by himself in Somerset and Wiltshire were not of insulated and local occurrence, but formed parts of the great system of deposits extending over England; and thus, after many years of intense labour and continual travel, he succeeded in extending the principles first caught sight of in the neighbourhood of Bath, into that philosophical generalization which became the basis of his geological map of England.

Before Mr. Smith had quitted his occupations in Somerset and his residence at Bath, he indicated on a coloured map the geological structure of that neighbourhood. This document, dated 1799, is in the museum of our Society. He had also arranged his collections of rocks and their organic remains in the order of succession and continuity of the several strata; but neglecting to appropriate to himself the merit of these discoveries by immediate publication, he liberally imparted a knowledge of each, as it gradually arose, to his private friends, through whose oral communications they obtained such general currency, that their real author was frequently lost sight of or unknown. I was myself indebted to Mr. Smith, though at that time a stranger to me, for my first knowledge of the order of succession in the oolitic series. This I derived from information imparted to me by the late Rev. B. Richardson of Farley Castle, who had himself acquired it from Mr. Smith. A tabular view of the superposition of the English strata, written by Mr. Richardson, from the dictation of Smith in 1799, at the house of the Rev. Joseph Townsend, in Bath, and since also presented to this Society, forms a documentary proof of the extent of his discoveries before the conclusion of the last century.

In 1817 he planned the beautiful museum of Scarborough, in which he employed his original and instructive method of representing, by sloping shelves passing one beneath another, the inclined position of the strata; each shelf bearing the fossils that are respectively characteristic of the stratum it is intended to represent.

These works of William Smith undoubtedly place him in the position of an original discoverer, who was the first to establish, on an enlarged basis of evidence, the important facts of constancy in the order of superposition, and continuity in the horizontal extension of the strata of this island; and to prove that each of these

strata is characterized by organic remains peculiar to itself. But it must not be forgotten, that both in this country and on the continent, other investigators, many of them no doubt unknown to him, were simultaneously collecting similar evidence in support of this great physical generalization. It only enhances the value and confirms the accuracy of Mr. Smith's conclusions, that the results of other independent inquiries were found to be in perfect harmony with his own. It is known to all who are acquainted with the productions of the school of Freyberg, that Werner had pointed out the importance of petrifactions as affording a basis for the arrangement of geological formations, the same in principle, though confirmed by less extensive details, than those which Mr. Smith elicited from the oolitic series in England. Professor Jameson has expressly stated that Werner was aware that petrifactions are comparatively rare in the transition rocks, increasing in number in the newer series of that division, and becoming still more numerous in the Floetz formations: he had further remarked, that the animals of the earliest periods are of the lowest and most imperfect class, namely zoophytes; that in ascending through newer and newer formations, we meet with shells and fishes and marine plants, all different from any living animals and vegetables of the present earth; that in the newest formations we find the remains of existing genera with those of land animals and land plants.

Werner had also noted, in some detail, the order of succession of the strata of the Muschel-kalk of Germany, founding his divisions upon the changes he observed in the petrifactions it contains; and thus announcing the principle of making distinctions in strata upon the nature of their organic remains.

The same principle had been previously caught sight of and partially elaborated by Lehman in Germany, and by other observers in France, where its application to tertiary strata received the fullest demonstration, in the great discoveries of Cuvier and Brongniart within the basin of Paris. In our just admiration of our countryman, therefore, we must not lose sight of the merits of his contemporary labourers on the continent; and whilst we honour him as the father of English Geology, let us also pay just homage to those who had started before him in the same course, wherein it was his undisputed merit to have arrived first at the goal.

Mr. W. Smith was born on the oolite formation at Churchill, in the county of Oxford, in 1769. When a child he was in the habit of collecting Terebratulæ from the oolite rocks in the fields of his native village, which he used as substitutes for marbles.

As an engineer he was employed in works of irrigation and drainage in many parts of England; as well as in stopping out the sea from breaches through which it had invaded the marshes of Norfolk, 1806, 1807, &c., and in the draining off the water of Mismer lake in Suffolk into the sea. He was the engineer also of the Ouse navigation in Sussex. In 1809 he was engaged in the restoration of the hot springs at Bath. In 1821 he recommended to Col. Braddyl to search for coal (beneath the magnesian limestone) on an estate in which is now situated the great South Hetton Colliery. No colliery in Northumberland had been worked, at that time, under the magnesian limestone.

Mr. Smith's principles of drainage have been applied with much advantage near Bath, Woburn, and in Norfolk. Finding the town of Scarborough to be very ill supplied with water, he excavated in the interior of the hill of Falsgrave Moor, two or three miles distant, a subterranean reservoir, in which he collected, from streamlets percolating that hill, sufficient water for the permanent supply of the town*.

From his early days to the latest period of his life he tells us that he had the habit of looking on the ground†.

Mr. Smith's last public employment was in conjunction with Mr. De la Beche and Mr. Barry, in the Commission for reporting on the best building-stone for the new House of Commons‡. During the

* An account of this curious work is published by himself in the Philosophical Magazine for June 1827.

† See a paper by himself on Quartz in Soils, published in Charlesworth's Magazine for July 1837.

‡ For more detailed accounts of the life of Mr. Smith, and of the amount and value of the services he rendered to Geology in England, I must refer to Dr. Fitton's masterly and candid investigation of this question in the Edinburgh Review, Vol. XXIX, p. 310, &c.; to Mr. Conybeare's Introduction to his Outlines of the Geology of England and Wales, 1822, p. 45; to the Address of Professor Sedgwick to this Society, 1831; and to a biographical notice by his nephew Professor John Phillips, in the Magazine of Natural History, New Series, 1839, p. 213.

later years of his life he resided near Scarborough superintending the estates of Sir John Johnson at Hackness; and dying at Northampton, in August 1839, aged seventy-one, after a few days' illness, at the house of his friend Mr. Baker, the historian of Northamptonshire, on his way to the Meeting of the British Association at Birmingham, was interred in the church-yard near the west end of the beautiful Norman church of St. Peter, in Northampton, which stands on the Oolite formation. He had often expressed a wish to be buried in this formation, on which he was born and educated, and the history of which he had so much elucidated. A monument will be erected to his memory in St. Peter's Church by subscription of members of the Geological Society of London.

It was not the least of the services which have been rendered to our science by Mr. Smith, that he was during many years the geological preceptor of his accomplished nephew Mr. John Phillips, in whom he has bequeathed to us a pupil, who has shown, by publications of the highest order in various departments of Geology, the soundness of the instructions received from his affectionate uncle.

Mr. Davies Gilbert was one of the earliest members elected into this Society, at its formation in 1808. During two years he served as a Vice-President, and for six years was a member of our Council; and though he communicated no papers, he took a lively interest in all our proceedings, and was ever prompt on all public occasions to promote the welfare and forward the great objects of our institution.

His paternal name was Giddy: he was descended in the line of both his parents from very respectable families in Cornwall, and on the maternal side of Davies, allied to the noble family of Sandys; in 1817 he assumed the name of Gilbert, on succeeding to the property of his wife's uncle, Mr. Charles Gilbert, of East Bourn, in Sussex.

Having been privately educated in Cornwall, he became, in 1785, at the age of eighteen, a gentleman-commoner of Pembroke College, Oxford, where, being of more studious habits and more mature attainments than is usual with students of his age, he associated chiefly with the senior members of his College. Dr. Parr, writing at this time to the late master of Pembroke, speaks of Mr. Giddy, then

twenty-three years old, as "the Cornish philosopher," and adds, that "he deserves that name."

To this College, as well as to the University, his affectionate and devoted attachment endured to his latest hour, and he became on several occasions a liberal benefactor towards improvements in Pembroke and its vicinity. During many years it was his great delight to pass a few days at Oxford, and he always considered the diploma Degree of Doctor of Laws, conferred on him by the University in 1832, as one of the most gratifying events of his life.

During his early residence his taste for chemistry and other branches of physical science had introduced him to the acquaintance of Dr. Beddoes, at that time a resident Member of Pembroke College, and who subsequently dedicated to him his pamphlet on mathematical evidence. This acquaintance was the remote cause of the first step in the public life of Sir Humphry Davy; when Mr. Giddy, who had discovered young Davy's genius for chemistry whilst yet a boy at Penzance, introduced him to Dr. Beddoes, to assist in his laboratory at Bristol, little dreaming that he should himself one day become the successor of this boy in the chair of the Royal Society.

Mr. Davies Giddy was elected a fellow of the Royal Society in 1791, and subsequently of the Antiquarian, Linnean, Geological, and Astronomical Societies of London. He was also an honorary member of the Royal Society of Edinburgh, the Royal Irish Academy, and of the New University of Durham. In 1814 he was elected first President of the Royal Geological Society of Cornwall and afterwards Vice-Patron of the Cornwall Royal Polytechnic Society, in both which offices he continued till the day of his death. He held the distinguished office of President of the Royal Society, during three years, from 1827 to 1830, and contributed several important papers to their Transactions; one upon the Mathematical Theory of Suspension Bridges (vol. 116, 1826, Part I., p. 202); also a Table for facilitating the Computations relative to Suspension Bridges (vol. 121, 1831, p. 341); a third paper, entitled Observations on Steam Engines (vol. 117, 1827, p. 25); and a fourth on the Efficacy of Steam Engines in Cornwall, with Investigations of the Methods best adapted for imparting great Angular Velocity (vol. 120, 1830, Part I., p. 121); likewise a paper on the nature of Negative

and Imaginary Quantities (vol. 121, 1831, p. 91). He also printed three Addresses as President of the Royal Society, 1828, 1829, 1830*.

In 1804 he was returned to parliament for the borough of Helston; and in 1806 for Bodmin, which place he represented till 1832. During that time he was continually called on by the House of Commons to serve on committees of inquiry touching scientific and financial questions, on which latter subject he published a letter, entitled "A plain Statement of the Bullion Question." He was Chairman of the Committee for rebuilding London Bridge, which he caused to be widened ten feet. The rectification of the national standards of linear dimensions and capacities, was undertaken upon his motion for an address to the Crown.

In his native county also, his authority was continually appealed to on scientific questions, and calculations of practical importance in the machinery of mines and steam-engines; and he was ever ready on all occasions to devote his time and talents to the service of his friends and of the public. In 1792, on the occurrence of a riot in Cornwall, whilst he was a young man, holding the office of sheriff, there being no soldiers in the county, he performed, for the last time that such an event has occurred in England, the military duty of calling out the *posse-comitatus*.

Few persons excelled Mr. Gilbert in bringing the results of much contemplative study to bear on the business of life; his strong point lay in the application of high mathematical knowledge to practical purposes, and in calculating the amount of effective power to be derived from the use of mechanical forces, judiciously combined. For the exercise of this talent his beloved native county offered unusual opportunities; it also afforded him abundant mate-

* Mr. Gilbert was also the author of the following papers in the Quarterly Journal of Science and the Arts: Observations on the properties of the Catenarian Curve with reference to Bridges by Suspension, vol. x. p. 230; On the Ventilation of Rooms, and the Ascent of Heated Gases through Flues, vol. xiii. p. 113; Investigation of the Methods used for approximating to the Roots of Affected Equations, vol. xiv. p. 353; Researches on the Vibrations of Heavy Bodies in Cycloidal and Circular Arches, vol. xv. p. 90; On the General Nature and Advantages of Wheels and Springs for Carriages, the Draft of Cattle, and the Form of Roads, vol. xviii. p. 95; On the Vibration of Heavy Bodies, vol. xx. p. 69.

rials for gratifying his taste for antiquarian researches; and the fruits of his labours as a biographer and local historian were presented to the public in 1838, in four 8vo vols.; this work is entitled The Parochial History of Cornwall, founded on the manuscript histories of Mr. Hals and Mr. Tonkin, with additions and various appendices by himself, and brings down the account of families and descent of property in that county from the death of those biographers, about the middle of the last century, to the present time. Mr. Gilbert's additions and criticisms form no small part of its value; he has introduced also copious scientific notices by Dr. Boase and other modern authors, relating to the geology of the county, a subject, he observes, of such recent origin, that the very word does not occur in Chambers's Encyclopædia printed in 1783. In acknowledgment of his indirect influence upon this science, I am bound to state with gratitude that my Bridgewater Treatise would never have existed, had not the appointment to write it been conferred upon me by Mr. Gilbert whilst President of the Royal Society.

Mr. Gilbert was an assiduous collector of ancient traditions, legendary tales, songs and carols, illustrating the manners, sports, and pastimes of the peasantry of Cornwall; and he was a writer of several anonymous letters and papers in the Gentleman's Magazine. He possessed great memory and powers of quotation and anecdote, enriched by vast stores of traditional information as to the personal history of many of the most distinguished individuals of his time, much of which will have perished with him. It has been truly said of him by a contemporary biographer, that "His most endearing talent was his power of conversation. It was not brilliant; it was something infinitely beyond and better than mere display; it was a continued stream of learning and philosophy, adapted with exquisite taste to the capacity of his auditory, and enlivened with anecdotes to which the most listless could not but listen and learn.

"His manners were most unaffected, child-like, gentle, and natural. As a friend, he was kind, considerate, forbearing, patient, and generous; and when the grave was closed over him, not one man, woman, or child, who was honoured with his acquaintance, but will feel that he has a friend less in the world. Enemies he can have left not a single one."

During the last twelve months his strength had been rapidly de-

clining, but he retained full possession of his intellectual faculties till within a few hours of his death; he breathed his last in the bosom of his family at East Bourne, on the 24th of December last, in the seventy-third year of his age. An exact and admirable representation of his finely-formed head and intelligent countenance is preserved in a bust by Westmacott in the Hall of Pembroke College, Oxford.

Sir John St. Aubyn, who died during the last year, was one of the founders and early Vice-Presidents of the Geological Society, and was among its most firm and valuable friends and supporters at that perilous moment of its existence when the struggles and opposition which attended its first establishment had nearly crushed it in the bud; he was also a liberal contributor to the supplies at that time requisite for its advancement.

He subscribed largely also to the funds then raised for the publication of Count Bournon's crystallographic work on Carbonate of Lime, and for enabling Dr. Berger to undertake his tours in Cornwall, preparatory to his geological description of that county.

The meetings held for the purpose of forwarding Count Bournon's work by some of the most distinguished mineralogists of that day, when collections in geology were rare, was one of the steps that brought together our first founders: many of them were till then strangers to each other, and being thus accidentally introduced, they resolved from thenceforth to cooperate for the furtherance of objects in which they felt a common interest, and became the germ of the Geological Society.

Sir John St. Aubyn was at this time occupied, like his friends Sir Abraham Hume and Mr. Greville, in making large and costly additions to his cabinet of simple minerals, the nucleus of which consisted of the specimens he had purchased of Dr. Babington in the year 1799, and which are described by Babington in his catalogue (one vol. 4to) published in the same year. These specimens had previously been the property of Lord Bute.

The position of his seat at Clowance, in the centre of the greatest mining district of Cornwall, afforded facilities for acquiring the most choice productions of that great repository of mineralogical treasures, and of these facilities he assiduously availed himself during many years. His other seat on the picturesque granitic pinnacle

of St. Michael's Mount in the bay of Penzance (the Ictis of Diodorus, from whence the Romans exported tin to Gaul), placed him in another position of high geological and mineralogical advantages; the granite veins that intersect the killas at the base of this classic mountain being among the first described and most instructive instances which Cornwall affords, of the important phænomena of the injection of granite into slate, and the metamorphic condition of the slate thence resulting; whilst a well-exposed tin vein at the base of the ancient fortress and monastery that crown this insulated mountain, affords specimens of Apatite, and is more richly studded with minute but perfect crystals of topaz than any other vein known to exist in this country. These easily accessible examples of phænomena, most highly interesting to the mineralogist and geologist, he carefully preserved for the inspection of the numerous visitors that are continually attracted to this spot—of threefold interest, to the antiquary, the artist, and the mineral philosopher.

A similar zeal for the preservation of interesting scientific objects induced Dr. Jenner to preserve, for the benefit of geological visitors, a rock which presented the rare phænomenon of organic remains intermixed with toad-stone, on the side of a trap dyke intersecting old red sandstone at Newport, near his residence at Berkeley.

To the nucleus formed by Dr. Babington's collection, Sir John St. Aubyn made large additions, not only from the productions of Cornwall, but also from foreign countries, particularly the mines of Germany and Hungary, many of which are no longer wrought. This collection was very rich in the ores of gold, silver, copper, and other metals, and particularly in native diamonds and gems. The arrangement of it was begun by Count Bournon, but subsequently completed after the system of Mohs.

In 1834 he presented the bulk of his collection to the Devonport Civil and Military Library, of which he had been annually appointed President from its formation in 1827 until his death; and a collection of Duplicates to the museum of Saffron Walden, near which place he then resided. He was an active member of the Geological Society of Cornwall, and of many scientific institutions in London; had a knowledge of Chemistry, Conchology, and Botany; and was a patron of the fine arts and a collector during his whole life.

In Brigadier Charles Silvertop the Society has lost the au-

thor of many interesting communications to our Evening Meetings on the Geology of Spain, the mineral structure of which, notwithstanding its proximity to France and England, and the long-continued military operations of both these nations upon its territory, is less known than that of any other portion of civilized Europe.

The unhappy circumstances of the country have long abstracted the attention of the Spaniard from researches of science, and the difficulties of travelling in the midst of civil commotions have deterred even the enterprising spirit of neighbouring geologists from endeavouring to fill up the lamentable blank which Spain still presents upon the scientific map of Europe.

Brigadier Silvertop, though occupied in the professional engagement of arms, was not forgetful of the pursuits of science. He published the substance of his communications to this Society in a small volume, 1836, wherein he gives a sketch of the widely-disseminated deposits of tertiary beds in the provinces of Granada and Murcia, accompanied by a general view of the volcanic and other rocks of the same district, illustrated by sections, which represent the configuration of the ground, the relative height of the ridges, and the superposition of the strata. He died at Rennes, in June last, on his way to the Pyrenees and Italy.

Mr. Louis Hunton was the author of a paper printed in our Transactions on the Upper Lias and Marl-stone of Yorkshire, showing the limited vertical range of the species of Ammonites and other Testacea, and illustrating their value as geological tests. His observations are founded on the details of the section of Easington height, near Whitby.

Jens Esmark, Professor of Mineralogy in the University of Christiania, was one of the many disciples of the school of Freyberg, who imbibed from their master an enthusiastic devotion to his theories, which largely contributed to stimulate into activity that general spirit of geological inquiry, the expansion of which, during the present century, has produced such unexpected and extensive discoveries in the development of the structure of the earth.

In 1794, deeply imbued with the doctrines of Werner, he went to Vienna to prepare himself for a tour through Hungary; after this he remained some months at Chemnitz, and visited the other chief mining districts of Hungary, Transylvania, and the Bannat,

and crossing the Carpathians to Wielitzka and Cracow, returned to Saxony by the mines of Tarnovitz in Silesia.

In 1798 he published, at Freyberg, the result of his observations, in a small octavo volume, giving descriptions of the mines he visited, and their respective productions, and expressing his conviction of the truth of Werner's opinion as to the Neptunian origin of the pumice and obsidian (even that of the Lipari Island), as well as of trap and granite. A translation of his remarks on the Geological History of the Globe was published in the Edinburgh New Philosophical Journal (1827), vol. vi. p. 107. The most important portion of this paper consists in its bearing his evidence to show that the greater part of Norway has, at some period, been covered with ice, and that the granite blocks, so abundant in that country, have been brought to their present place by glaciers.

In 1829 Professor Esmark published a Tour in Norway*, containing many measurements of heights, and he was the first to measure the lofty mountain of Schneehätten. He also published various detached Memoirs on Mineralogy†.

He is said by Otte to have been the first discoverer of chromate of iron in Norway; and the Norwegian datolite, which was also discovered by him in 1806, was at that time named Esmarkite. He published a short notice on tellurium, in the 3rd vol., 1st series, of our Transactions.

His residence at Christiania, in the vicinity of iron, copper, and silver mines, and of the School of Mines and Agriculture at Konigsberg, gave full scope to his taste and talents, and also afforded occasion for the exercise of those courteous attentions which have, during many years, been gratefully acknowledged by scientific travellers in Norway.

He once came to England, and was a member of the Wernerian Natural History Society of Edinburgh.

He was an excellent chess-player; and in appearance, countenance, and the fine form of his head, resembled Mr. Davies Gilbert, whom it has been my painful duty to associate with him in the catalogue of the losses we have sustained during the last year.

Don Carlos de Gimbernat, Member of the Royal Academy

* Reis von Christiania nach Drontheim.

† In the Magazin for Naturnidenskaberne.

of Sciences at Munich, was the son of a physician of Barcelona, and, from political motives left his native country at the commencement of the French Revolution for Paris, where he passed many years. He had previously studied at Freyberg under Werner, and visited England, where he became acquainted with Townsend, our Spanish traveller, and with Dr. Hope, of Edinburgh; giving to the physical sciences the attention usually required of students for the medical profession, and continuing to cultivate them in his later years. He was more particularly attached to Chemistry, Geology and Mineralogy, and analysed the waters of many hot mineral springs, and found azote in all. The medical virtues which he ascribed to these springs, raised him high in the estimation of the Swiss.

M. Gimbernat published accounts of his discovery in the thermal waters of Aix in Savoy, Baden, and other warm springs in Switzerland, of a mucous organic substance, (formed, as he fancied, by chemical precipitation, from azote and carbonic acid,) which he thought was more nearly allied to animal than vegetable matter, and to which he gave the name of Zoogene; and he also supposed that he found the same substance in the thermal waters of Ischia, and in waters produced by the condensation of the steam disengaged from Vesuvius. A similar mucous substance, in the thermal sulphureous waters of Roussillon, was supposed by Professor Anglada, of Montpelier, to be a chemical product, from elements held in solution by the waters at the time they issued from the earth, and deposited by them in a flocculent form when they come in contact with the air. De Saussure, however, Decandolle, Dillwyn, and Daubeny*, founding their opinions on the structure it exhibits under the microscope, refer this gelatinous substance to minute Confervæ; but the more recent discovery, by Ehrenberg, of infusorial animals in the warm springs of Bohemia, gives some probability to the supposition that these may be mixed with Confervæ in the so-called zoogene of Gimbernat. The decomposition either of Confervæ or of Infusoria would afford the azote found in zoogene; but their presence would transfer the origin of this organic substance from simple chemical agency to the instrumentality of organic life. On quitting

* On Organic Matter in Sulphureous Springs, Linn. Trans., London, vol. xvi. 1833.

Naples, in 1820, he retired to Switzerland, where he fell into bad health and reduced circumstances, and died at Geneva in 1839*.

Frederick Mohs, Professor of Mineralogy in Vienna, was born at Gernrode, in the Harz Mountains, about 1770. He lost his father, a merchant, very early, and was expected to succeed him in the business; but his predilections for science, particularly for mathematics, had marked him out for higher destinies.

He began his studies, 1796-98, at Halle, and continued them in the mining institution at Freyberg.

We find him in 1802 at Vienna, occupied in describing the mineral cabinet of the banker Von der Nüll, where he first conceived those views which he afterwards developed in his system of mineralogy.

His fondness for geology and the art of mining induced him to visit Styria, Saltzburg, Carinthia, Carniola, Hungary and Transylvania, &c., and he received from the Austrian Government, in 1810, a commission to examine those parts of Passau, Austria, and Bohemia, where porcelain clay is found.

Having thus attracted the notice of the Archduke John, and undertaken a journey to Styria in 1811, he was nominated Professor of Mineralogy in the Johanneum, at Gratz.

In 1818 he visited England with Count Breüner, who had been his pupil at Gratz; his conferences at Edinburgh with Jameson, whom he had known at Freyberg, made a strong impression on the Professor, in favour of what he called the "natural-history-system" of mineralogy, which he in part adopted, and first made known to British mineralogists in 1820†, and afterwards more fully explained in 1821‡ and 1822 §.

On the death of Werner, in 1817, he was called to the chair of Mineralogy in the Mining Academy of Freyberg; but in 1826 went to reside at Vienna, as Professor of Mineralogy, and Superintendent of the Imperial Cabinet. In 1804 he published a volume of practical importance, containing "A Detailed Account, illustrated with a Ground Plan, of the Mines and Mining Operations

* A short notice on Sulphate of Soda is published by Gimbernat in our Transactions, vol. ii., second series, p. 331.

† Third edition of his System of Mineralogy.

‡ Manual of Mineralogy. § Encyclopædia Britannica.

at Himmelsfürst, near Freyberg." In this work he describes, not only the geological relations and mineral products of these mines, but gives full details as to the methods of working them; their buildings and machinery, ventilation and drainages, preparation of the ores, receipts, expenditure, &c.

His great work on Mineralogy, or "the Natural History of the Mineral Kingdom," is best known in this country by its translation, published at Edinburgh, with considerable additions, by his pupil, Mr. William Haidenger, in 1825, 3 vols. 8vo. In the method of arrangement proposed by Mohs in this work, he founds his classification solely on external resemblances and differences, and displays a most profound knowledge of all the productions of the mineral kingdom.

This devoted pupil, friend, and successor of Werner died in Italy, 20th September, 1839, at Agardo, near Belluno, having undertaken a tour into that country for the purpose of studying the phænomena of volcanos*. He was an honorary member of the Royal and Wernerian Societies of Edinburgh.

It has been said of Mohs, and may be said of many distinguished cultivators of this department of natural science, that he was too consummate a mineralogist to be a good geologist. The sustained attention to minute details, which is indispensable to the recognition of individual minerals, gives such a habit to the mind, that it cannot easily recoil from the state of tension, which is induced by the continual study of minutiæ, to that expanded condition which is essential to apprehend the magnificent generalizations of geology. For similar reasons, an extremely skilful delineator of botanic details would probably be incapable of expressing the grand and general features and effects of forest scenery, or landscape, from his habits of overstrained attention to the details of individual trees and plants that occupy the foreground of his picture.

Captain Alexander Gerard, of the Bengal Native Infantry, was one of three brothers, all distinguished by their enterprising spirit, and zealous scientific researches in the Himalaya Mountains, the sons of Dr. Gilbert Gerard, who wrote the well-known "Insti-

* His funeral was celebrated with much ceremony expressive of public respect, and attended by a long procession of miners, each bearing in his hand a burning torch.

tutes of Biblical Criticism," and grandsons of Dr. Alexander Gerard, author of works which have been translated into various European languages, and of a standard "Essay on Taste."

Having been born at the University of Old Aberdeen, in which his father was Theological Professor, he had early imbibed a thirst for knowledge and for scientific pursuits; and at the age of sixteen he entered the military service of the East India Company. Having considerable abilities as a surveyor, and being desirous of travelling, he soon got an appointment, and was sent to survey the province of Malwa, where he prosecuted his instructions under a burning sun, with great accuracy and constancy of purpose. He procured at his own expense the most costly instruments, and undertook several surveys in the Himalaya Mountains, suffering every vicissitude of heat, cold, hunger, and all the ills which could beset a traveller, with a degree of cheerfulness which was remarkable; but a residence of thirty years in India, passed chiefly in the endurance of these hardships, laid the foundation of that decay of health, which has lately brought him to a premature grave.

Captain Alexander Gerard was well known in the East as a scientific traveller, having, in company with his brother, the late Dr. James Gerard, penetrated the Himalaya Mountains through several passes before unknown to Europeans. While contributing, by his maps, to benefit geographical science, he never lost sight of what was novel and interesting in the geology, botany, and zoology of these stupendous regions, and various occasional papers have appeared from his pen, comprising valuable information on these subjects. We owe to this enterprising officer and indefatigable barometrical observer, our first knowledge of the structure of that portion of the Himalaya Mountains which forms the upper region of the Valley of the Sutlej, and is chiefly primitive. In this north-west extremity of India, on the frontier of China, he ascended to the astonishing height of 19,411 feet, on the mountain Tahigang, the summit of which he estimated at 22,000 feet above the sea.

A small collection of geological specimens made by him has been recently laid before this Society; it was formed in the district of Speetee, in Chinese Tartary, at the elevation of from 12,000 to 19,000 feet above the level of the sea, and between the latitudes 31° 30″ and 32° 30″ north, and longitude 77° and 79° east. On

the confines of Chinese Tartary, at the height of 16,200 feet, he found a region of limestone containing Ammonites. The same shells occur nearly at the same height near the Niti and Manná Passes. In Thibet he observed millions of organic remains, lying at extraordinary altitudes, and forming vast and rocky cliffs. At the elevation of 17,000 feet were seen detached fragments of rocks, bearing the impression of shells, which must have been derived from still higher peaks; one cliff was a mile in perpendicular height above the nearest level.

He first appears as the companion of Herbert in his survey of the course of the Sutlej, 1819. (Asiatic Researches, vol. xv. p. 339.) In the same vol. p. 469, he published observations on the climate of Subathu and Kotgerh. His labours in completing a geographical survey of the valley of the Sutlej are the subject of a paper by the late Mr. H. T. Colebrooke in the Transactions of the Asiatic Society of London, vol. i. p. 343. From the diary of this survey, Mr. Colebrooke selected notes of Geological observations; and from specimens then collected, duplicates were sent to our Society. Upon these notes, and on Captain Gerard's letters, written during his survey in the middle valley of the Sutlej, a sketch of the Geology of the Himalaya was prepared by Mr. Colebrooke and published in the Geological Transactions of London*.

The second volume of Sir W. Lloyd's recent narrative of a journey in the Himalaya, contains an account of Captain Gerard's attempt to penetrate on the north side of the Himalaya by Bekhur, to Garoo and the lake Manasarowara, near the source of the Sutlej. These letters are interspersed with many interesting geological observations respecting the mineral productions and nature of the rocks of the country over which he travelled. He found the inclination of the strata to be usually perpendicular to the direction of the range, presenting long continuous slopes on the side towards which they dip, and terminating abruptly in rugged precipices towards the axis of the mountain chain. Near Bekhur, at the north side of the Himalaya, on the margin of the great table land of Tartary, elevated 15,786 feet above the sea, he mentions the occurrence of gravel studded with Ammonites, not far from the Hookeo Pass, which presents mural precipices of limestone.

* Vol. i., second series, p. 124.

In one excursion in the Himalaya he fell in with the late Bishop Heber, who devotes a long and eloquent passage in his journal to the expression of his praise and admiration of the scientific talent and enterprising spirit of Captain Gerard. He was an excellent Persian scholar, and acquainted with several other oriental languages.

He performed many of his surveys under a burning sun, the thermometer ranging from 100 to upwards of 112 degrees. As many of his observations were required to be taken at mid-day, the consequences were frequent suffering and illness from strokes of the sun; but he continued his labours until his health totally failed. He died at Aberdeen in December last, at the age of forty-seven, having apparently sacrificed his life to the promotion of science, stimulated in his labours by the wish to benefit mankind, without the hope of worldly remuneration.

To his late equally zealous and indefatigable brother, Dr. James Gilbert Gerard, surgeon of the Hill corps stationed at Subathu, and the companion of Captain, now Sir Alexander, Burnes, in his perilous journey through Central Asia, we owe the discovery of extensive collections of fossil shells in the Himalaya mountains, at the height of 17,000 feet. The greater part of these closely resemble shells that occur in the Oolite formation of Europe, particularly Ammonites and Belemnites; whilst a few, *e. g.* Orthoceratites and Spirifers, are similar to shells we find in rocks of our Transition Series. The Rev. R. Everest has described and figured some of these in the eighteenth volume of the Asiatic Researches.

His third brother, Captain Patrick Gerard, is remarkable as the author of a Meteorological Journal, kept in 1819–20 at Kotgerh, Subathu, and the intermediate places in the Himalaya mountains, and recording hourly observations during nearly two years*.

* See Journal of Asiatic Society of Bengal, vol. ii. p. 615.

THE END.

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