After the other proceedings had been completed, and the Officers and Council had been elected, the President proceeded to address the Meeting.

ANNIVERSARY ADDRESS OF THE PRESIDENT,

SIR HENRY T. DE LA BECHE, V.P.R.S. & L.S.

GENTLEMEN,—In accordance with the practice established for twenty years by my predecessors in this Chair, I have now to address you on the progress of our Society and of our science. This is our fortieth anniversary, and the Report of your Council will have shown you that our numbers were never greater than at the present time. It has been stated to you that there has been a small excess of expenditure over income, but this has been shown to have arisen from an unforeseen circumstance, and the cause cannot again occur. Without it we should have been within our income, and even with it we still had a considerable balance in our bankers' hands, independently of our funded property. The communications to our Society have not deteriorated, and the discussions which have followed the reading of them have continued to preserve that character for good feeling, and desire to arrive at truth, for which they have long been known. Finally, the publication of your Quarterly Journal has been regular, and few months can now elapse between the reading of a memoir in this room and its appearance before the public, an advantage of no slight kind, and which cannot but be fully appreciated by the Fellows of this Society.

Among the seven deaths which have deprived the Society of its ordinary fellows since the last Anniversary, we have to lament that of Mr. CHANING PEARCE. He was born at Bradford, Wiltshire, on the 18th of July, 1811. His desire to collect organic remains commenced with his infancy, and it was with difficulty that his nurse could withdraw him from the heaps of stone or clay near Bradford, whence he obtained and brought to his father various fossils. He probably acquired this desire from his parent, who, before him, was accustomed to search for specimens of the *Apiocrinites*, commonly known as the Bradford *encrinite*. This disposition to obtain organic remains grew with his growth, and by the time his apprenticeship to his father, as a surgeon, expired, he had formed a large collection of them. He subsequently went to London, and was entered at Guy's Hospital, where he distinguished himself, and obtained a prize for anatomy. After passing his examinations, which he did with great credit, he proceeded to Paris and Switzerland for a short time, and upon his return joined his father in his medical practice in and around Bradford. Still continuing a zealous and active collector of organic remains, he availed himself of every opportunity which his residence in a district rich in those remains afforded. From the members of the oolitic series, particularly the great oolite, Bradford clay and Forest marble, in the immediate vicinity of Bradford, he obtained an

abundant harvest of ancient organic forms, and his opportunities for procuring specimens of that beautiful fossil, the *Apiocrinites Parkinsonii*, were so good and frequent, detecting them upon the very layers of rock on which they lived, that he was enabled to effect important exchanges with collectors in other parts of the British Islands and in foreign countries, thereby greatly enriching his museum, so that at length it might be considered one of the finest private collections of organic remains in this country.

Besides a communication to the London Geological Journal on the *Belemnoteuthis*, Mr. Channing Pearce contributed three short papers to this Society, one in 1842, on the Mouths of the Ammonites, &c., from the Oxford clay, Wilts, and two in 1843, the first on the Locomotive powers of the Family *Crinoidea*, and the second on a new Encrinure from the Dudley limestone.

Finding it necessary to abandon the medical profession, Mr. Pearce, in 1845, took Montague House, Lambbridge, near Bath, built a convenient museum for his extensive collections, and in this placed saurian remains only a fortnight before his death. He suffered severely from calculi, composed of the phosphate and carbonate of lime, which he occasionally expectorated. He expired, with perfect calmness, on the 11th of May 1847.

We have here to deplore the loss, from among our Foreign Members, of one who, during a life extended beyond the ordinary number of years, occupied himself with our science and its applications, and who for a long period has been ranked among the most distinguished geologists. ALEXANDRE BRONGNIART, the son of the well-known architect of the Invalides, Alexandre-Théodore Brongniart, was born in Paris in 1770. In his early years he was fortunately associated with men who could appreciate his talents, and at that important period of his life was so situated as to benefit by the conversations of Franklin, and obtain his first ideas of chemistry from those of Lavoisier, and so well did he learn from the latter, and so clear was his mode of expressing himself, that it is recorded that when only fifteen years of age, Lavoisier himself was the gratified attendant at a chemical lecture by the young Brongniart. To chemistry and mineralogy he was always attached, giving courses upon them from the age of seventeen years until three years before his death. Few have exceeded him in the length of time devoted to instruction. He taught for sixty years, and during fifty years was a public professor.

Alexandre Brongniart early completed his studies at the École des Mines at Paris, and in 1788, then only eighteen years of age, was one of the founders of the Société Philomathique established in that city. In 1790 he visited England, where the mines and picturesque beauties of Derbyshire made a strong impression upon his mind. It was during this visit that he acquired data for a memoir on enamelling, his first appearance in a career connected with the manufacture of porcelain, and other fictile substances: for which he was afterwards so much distinguished. He became the assistant of his uncle, who was demonstrator of chemistry at the Jardin des Plantes, and also studied at the École de Médecine, where

he took honours. He subsequently was attached to the army of the Pyrenees as pharmacien. The opportunity afforded by fifteen months' residence among the Pyrenees was not neglected by the young Brongniart, and he there not only studied the botany and zoology of those mountains, but their geological structure also. So ardent was his pursuit of science, that he fell into dangers which his youth prevented him from seeing, and he was thrown into prison, suspected of having favoured the escape of the naturalist Broussonnet, who fled through the Brèche de Rolland from a death with which he was threatened. Liberated on the 9th Thermidor, he returned to Paris, and, at the recommendation of Fourcroy and Coquebert de Montbret, was attached to the mining department, as an Ingénieur des Mines. Soon afterwards he became Professor of Natural History at the École Centrale des Quatre-Nations, and a contributor to the best scientific journals of the time.

In 1800 M. Brongniart was named director of the porcelain manufacture at Sèvres, at the recommendation of Bertholet, and continued in this appointment until his death, thus devoting his energies to, and promoting the welfare of that establishment for forty-seven years. His well-known '*Traité élémentaire de Minéralogie*,' appeared in 1807, he being charged with composing this treatise at the time that the Imperial University was organised. This work became the text-book for the lectures which M. Brongniart, as coadjutor with Haüy, delivered at the Faculté des Sciences, and which he continued at the Muséum d'Histoire Naturelle, when he was called upon to succeed his distinguished predecessor, Haüy.

M. Brongniart did not confine himself to the study of mineral substances. He long continued to occupy himself with zoology, and to him is due the division of Reptiles into four orders, the *Saurians*, the *Batrachians*, the *Chelonians* and the *Ophidians*. All palæontologists are acquainted with his treatise on the *Trilobites*, a work which was received with so much favour at the time (1822), and which paved the way for so many other labours upon these remarkable crustaceans, which in the earlier geological periods swarmed by myriads, ceasing, however, to form part of the marine fauna of our globe even at a very remote epoch.

When Cuvier was called to Paris, M. Brongniart was among the first to appreciate his talents, and to his union with that great man geologists owe that important work, — important under so many aspects, — the '*Essai sur la Géographie Minéralogique des Environs de Paris*,' presented to the Institute in April, 1810. The advance in geology made by the appearance of these labours is too well known to those whom I now address to render any account of them needful. They form one of those great resting-places in the progress of knowledge, whence the cultivators of science start with renewed vigour.

In 1815 M. Brongniart was admitted into the Academy of Sciences, succeeding Desmarest. In 1817 he travelled in Switzerland, the Alps and Italy, accompanied by his son, Adolphe Brongniart, at the time of his father's death, the President of the Academy of Sciences, and so well known to us all for the aid he has afforded to our science by

his works on fossil botany. One of his distinguished pupils, M. Bertrand Geslin, was also of this party. The result of these travels was, among other things, the then startling announcement that the dark limestones of the Montagne des Fis, in Savoy, could only be regarded as an equivalent of the cretaceous rocks of Northern France and England. We are accustomed to such comparisons now, but thirty-one years since geologists were not prepared so readily to receive announcements of this kind.

It was in 1824 that M. Brongniart visited Norway and Sweden, where his attention was alike directed to the more ancient and more modern rocks and accumulations.

The works of M. Brongniart corresponded with the range of his mind, and we find him alike advancing our knowledge of mineralogy, geology, zoology, palæontology, and of the employment of mineral substances for the use of man and the ornament of his works.

The last work of M. Brongniart, commenced in 1830 and completed in 1844, entitled '*Traité des Arts Céramiques*,' presents us with the most valuable information on this head ever accumulated, treated in the manner which might be expected from one so perfectly conversant with his subject, studied during so many years, and so well illustrated by the splendid museum of fictile and vitreous manufactures which he founded at Sèvres.

The kindness of M. Brongniart to all in any manner connected with him, is proved by the affectionate regard entertained so generally for him. While so well-informed, and occupying deservedly so high a place among men of science, he was always modest. Those who knew him well describe him as most frank, and so desirous of being scrupulously just, that the fear of partiality was often too strong upon him. His mind was at all times ready to receive truth, and he was anxious to regard subjects from different points of view. He considered minerals both as regards their chemical composition and crystalline structure, and in geology, though as one of the authors of the mineral geography of the environs of Paris, it might be expected that he would hold the value of organic remains as not slight, he carefully avoided giving them exclusive importance.

I cannot close this notice of our losses by death without advert-
ing to that of one, who though not placed among even the easier classes of society, but who had to earn her daily bread by her labour, yet contributed by her talents and untiring researches in no small degree to our knowledge of the great Enalio-saurians, and other forms of organic life entombed in the vicinity of Lyme Regis. MARY ANNING was the daughter of Richard Anning, a cabinet-maker of that town, and was born in May, 1799. While yet a child in arms (19th August, 1800), she narrowly escaped death, when with her nurse taking shelter beneath a tree during a thunderstorm, which had scattered a crowd collected in a field to witness some feats of horsemanship to be performed by a party travelling through the country. Two women, with the nurse, were killed by the lightning, which struck the tree beneath which they considered themselves safe; but the child, Mary Anning, was by careful treatment revived, and found not

to have sustained bodily injury. From her father, who appears to have been the first to collect and sell fossils in that neighbourhood, she learnt to search for and obtain them. Her future life was dedicated to this pursuit, by which she gained her livelihood; and there are those among us in this room who know well how to appreciate the skill she employed, (from her knowledge of the various works as they appeared on the subject,) in developing the remains of the many fine skeletons of Ichthyosauri and Plesiosauri, which without her care would never have been presented to comparative anatomists in the uninjured form so desirable for their examination. The talents and good conduct of Mary Anning made her many friends; she received a small sum of money for her services, at the intercession of a member of this Society with Lord Melbourne, when that nobleman was premier. This, with some additional aid, was expended upon an annuity, and with it, the kind assistance of friends at Lyme Regis, and some little aid derived from the sale of fossils, when her health permitted her to obtain them, she bore with fortitude the progress of a cancer on her breast, until she finally sunk beneath its ravages on the 9th of March, 1847.

GEOLOGICAL SOCIETY OF LONDON.

With respect to the progress of Geology during the past year, and more especially in this country, it may be desirable in the first instance to take a survey of the manner in which our Society may have contributed towards it. For this purpose we may conveniently divide the general subject into—

1. Investigations respecting the accumulation of mineral matter now taking place on the surface of the earth, mechanically and chemically, by aqueous and igneous means.

2. Researches connected with the mode in which mineral matter has been accumulated in previous geological times.

3. The manner in which the remains of animal life at present existing may be entombed amid the accumulations of mineral substances now in progress.

4. Ancient life, or Palæontology.

5. Observations respecting the mode in which the remains of ancient life may have been mingled with the mineral deposits of former geological periods.

6. Descriptions of the superposition of rocks, their supposed equivalents in different regions, and general classifications of them.

7. The movements which the mineral masses may have sustained subsequently to their accumulation.

8. The various mineral changes and modifications these mineral masses may have suffered since their accumulation, either before or after any movements they may have sustained.

Under the first head there has been nothing communicated to the Society during the past year, except an incidental notice by Captain Vicary in his paper on the geology of parts of Sinde, wherein, describing the deposits at the harbour of Kurrachee, he mentions the

gain of the sea on the land. The prevalent in-shore wind, while blowing at times with considerable force, constantly drives dry sand into the harbour, tending to fill it up, the outflow of the tide only carrying back to the sea a part of the sand thus blown in; on the land side also every fall of rain, forming a temporary flood, leaves detritus. As no river now flows out of the harbour, tidal action alone (except during the temporary effects of rains) has to contend with the causes filling up the space inside the sands, and thus the continuation of the mud-flats occurring within the present harbour becomes exposed outside to the action of the sea; the sands which formerly protected the mud-flats, while river-action afforded a sufficient supply of detritus to be piled up in banks, being driven over the flats inwards.

Respecting the manner in which mineral matter may have been accumulated in former geological times, Mr. Lycett, describing the great oolite as it occurs in the neighbourhood of Minchinhampton, observes that even a cursory glance at the sections of that vicinity show the beds to have been accumulated in a shallow sea, where strong currents prevailed, the surface and mineral character of the deposit continually changing. "Heaps of broken shells," he adds, "piled in uncertain laminated beds, are intermixed with occasional rounded fragments of rock, (foreign to the neighbourhood,) of abraded madrepores, dicotyledonous wood, crabs'-claws, &c." He further remarks upon the apparent denudation of some shelly beds, the cavities left by the removed portion being filled with clay, on the common false bedding, on the non-conformity of certain beds in juxtaposition, and upon the barren or less fossiliferous character of other beds.

He gives a very detailed account of the beds he describes under the head of the compound great oolite, included in a thickness of about 130 feet, not neglecting their very changeful character. This description constitutes a valuable addition to our information respecting the local mineral structure of a part of the oolitic series, which, taken as a whole, in its range from the coast of Yorkshire to that of Dorsetshire, affords a most excellent opportunity for the study, over a limited area, of modifications and changes in physical conditions during the lapse of a certain portion of geological time. No doubt parts of these deposits have been so removed by denudation that we lose their contact with the older accumulations which bounded them in one direction; and, on the other hand, they are so covered up by more modern deposits, that a stripe only remains of the old oolitic area. Enough, however, is still exposed to reward examination; and a careful comparison of its mineral character, with the mode in which mineral matter is accumulated at the present day, will be found highly instructive, more particularly if we extend our view to those other parts of Europe where deposits of equal date may be exposed. We have elsewhere endeavoured to point out the modifications observable in the lower part of the oolitic series, when the Mendip Hills in Somersetshire, and other places extending into South Wales, in all probability, after forming islands and shores, were so depressed beneath the sea-level as to be covered up by the oolitic ac-

cumulations ; and we may now add, that the Geological Survey has not lost sight of the physical history of these deposits during its examination of them, while at the same time every attention is given to their zoological modifications and changes. We may here call attention to a more careful study of the oolitic grains than is sometimes given. Whole masses of them are no doubt concentric concretions round a minute nucleus, sometimes even appearing to surround a small crystal of carbonate of lime ; but others, though of the same general shape externally, are merely rolled pieces of corals and of shells, much resembling the coarser coral sands familiar to those who have examined coral reefs, or shores adjacent to coral accumulations. Often both kinds are mingled together in a common drift, diagonally laminated, with larger portions of corals and broken shells, the flat parts of the corals and shells commonly parallel to the false bedding, thus pointing to the pushing action of moving water along a sea-bottom, the careful study of which readily shows the direction whence and to which the water moved. Indeed the mechanical aggregation of a large proportion of the calcareous beds is very striking, while the chemical production of others is equally apparent. By the careful consideration of these differences in the limestones, of the sandstones and of the clays, not forgetting the friction marks from moving water, and the trails and other traces of the various molluscs and other animals which have moved on surfaces, for the time, exposed, the geologist will find his labours well rewarded by an insight into the manner in which mineral matter has been deposited over a few thousand square miles at this geological period.

Mr. Nicol, in his communication to the Society on the Silurian rocks in the south of Scotland, where they occupy an area estimated at 4000 square miles, examined into the manner in which the various beds composing it may have been accumulated. Though igneous rocks, such as felspar porphyries and the ordinary hornblendic varieties, commonly termed trappean rocks, are present in the conglomerates, sandstones and slates, noticed under the head of greywacke or Silurian Rocks, they would, by the descriptions of Mr. Nicol, rather appear to have been intruded among the beds formed in water, after the deposit of such beds, than thrown among them while accumulating. It is shown, that in tracing the general mass from its northern border in Peeblesshire and the Lothians, south through Selkirkshire and Roxburghshire to the confines of England, and across the strike of the beds, that the coarser varieties of rock prevail on the north in large irregular masses, while on the south the finer varieties predominate in thinner, more regular, and more distinctly stratified beds, whence Mr. Nicol concludes that the deposits generally have been derived from the north. Examining the beds themselves he finds a mixture of clay-slates, and sandstones and conglomerates, the former rarely exhibiting any of the cleavage so common in parts of Wales and the older Cumbrian districts. The grains of quartz in the sandstones are rarely larger than a pea, while the flat fragments of a clay-slate attain several inches in length. He discovered no traces of granitic rocks, gneiss, or mica-slate rocks in these beds.

Mr. Nicol then proceeds to show that this accumulation of beds was consolidated, squeezed and upraised anterior to the formation of the old red sandstone, and infers that the older deposits were formed into hill and valley, and probably, in part at least, rose above the sea into the atmosphere, when the conglomerates of the old red sandstone were collecting round them, tongues of old red sandstone now entering valleys of the older series. He also points out that the old red sandstone once covered the latter more extensively than we now find it, denudation having removed the greater part which once existed.

These researches of Mr. Nicol are highly valuable in enabling us to trace into Scotland evidences of the general disturbance of so much of the older palæozoic rocks prior to the date of the upper parts, at least, of the old red sandstone. Those familiar with the geology of Southern Ireland are aware, that there the conglomerates of the old red sandstone repose upon the upturned and frequently contorted beds of the older palæozoic rocks, and it is not difficult to see that the overlap of the higher over the lower parts of the old red sandstone, which commences in Herefordshire and runs through South Wales, is prolonged into Southern Ireland, the movements in the latter having been more decided and greater than in South Wales. If the higher portions of the old red sandstone overlapped the lower in Herefordshire and Shropshire, such extensions by overlap have been removed by denudation; but again, in North Wales, we find the old red sandstone, as a conglomerate, here and there appearing from beneath its covering of carboniferous limestone, the latter in its turn extending over and beyond the former, and both together covering the upturned and frequently-contorted beds of the older palæozoic rocks. Anglesea shows us the old red sandstone covered by mountain limestone, and even by coal-measures, thus overlapping older rocks further in that direction. In Cumberland and Westmoreland we have the well-known examples detailed to us by Dr. Buckland, and published many years since (1816) in our Transactions, and now we have the addition to our knowledge made by Mr. Nicol. Local circumstances, therefore, in Herefordshire and Shropshire would appear to have interfered with, or so modified the great contortion and upraising of the older palæozoic rocks, observable over an area comprising probably the greater part of Ireland, Northern Wales, Westmoreland, Cumberland and Scotland, that the old red sandstone, or its upper portions, did not there accumulate, as a conglomerate, over portions of them. In the direction of Devonshire there was apparently a comparative absence of crumpling and bending of beds at this time, and there deeper waters may have occurred, while littoral and river action were forming conglomerates in other parts of the area now occupied by the British Islands.

When we see conglomerates, in which the water-worn pieces of subjacent and adjacent rocks are often large, we necessarily look to an adequate cause for their production, and find little else than the grinding together of such pieces of rock on sea-beaches, or the throwing or thrusting forward of shingle and gravel by rivers, capable

of producing them, as we now find them. These conditions suppose dry land and seas of various depths, as at present, and therefore the view of Mr. Nicol, that in the district he describes the older palæozoic rocks may have formed such a portion of dry land, clothed with an appropriate vegetation and inhabited by fitting animals, while the old red sandstone was accumulating around it, may be considered as a fair inference from facts. Indeed it seems needful to extend this view to other parts of the British Islands at the same period, and even to suppose the sea to increase in depth in the direction of Devonshire and Cornwall, so that while shingles were accumulating round the dry lands, sands and mud were there drifted. The researches, begun by Mr. Griffiths, which have shown that the probable equivalents of certain North Devonian beds are found in Southern Ireland above the old red conglomerate, bear out this view. Mr. Nicol, while pointing out the absence of fragments of the so-called primary rocks in the older palæozoic rocks of the valley of the Tweed, infers that the igneous agencies which metamorphosed the rocks of the Scottish Highlands into gneiss and mica-slate also crushed and folded the older palæozoic rocks of the Tweed; and as fragments of the gneiss and mica-slates are included in the old red sandstone series of Central Scotland, that this happened at the time before-mentioned, namely anterior to the formation of the old red sandstone. When we regard the evidence respecting the intrusion of the granite of South-Eastern Ireland, connect it with the alteration of the rocks in contact with the granite, and look to the probable date of such intrusion, as far at least as known researches would seem to give it, other portions of the area now occupied by the British Islands would appear to have been exposed to similar geological action at the same period. We must not hence infer that all the British granitic intrusions were of the same date, for there is good evidence to show that the protrusion of the Devonian and Cornish granites was effected at a subsequent period, one posterior to the formation of at least a part of the palæozoic coal-measures, and probably to all those in our islands.

We cannot avoid calling attention to the striking general resemblance between the conglomerate accumulations of the old red sandstone around and over the upheaved and contorted beds of the older palæozoic rocks, and that of the new red sandstone series of England around and over the upturned and often bent and contorted beds of the newer palæozoic rocks, and indeed upon the upturned edges of the old red sandstones themselves. In like manner we have to infer dry land, with its coasts broken into bays and headlands, seas of different depths, the deposits in which were charged with peroxide of iron, and conditions unfavourable for the entombment and probably the existence of animal life in such seas. For both we have to suppose submergence of the land, and an accumulation of shingles over shingles upon coasts, as also occasionally conditions permitting the protrusion of shingle-banks far outwards. The extent to which all parts of the land may have descended is not clear; portions may here and there have remained from that time to the

present in the atmosphere, but we do know that the deposits of the time covered ground now high elevated above the sea. Patches of these now alone remain scattered at various distances from each other, and attest the denudation which the whole deposit has suffered in such situations from the combined action of atmospheric influences and of breakers wasting away the lands as they gradually rose above the sea, and indeed, in some cases, during many a rise and depression producing changes in the relative level of sea and land.

Regarding palæontology we have received several communications. The first paper read was from Mr. Salter on the structure of *Trinucleus*, with remarks on the species, in which the author, after adverting to the name as that of Llwyd, given so far back as 1698, and revived by Sir Roderick Murchison, describes this genus, the individuals composing the species of which are so abundant in the Silurian rocks, especially in the lower division of them. Mr. Salter more particularly points out the peculiar perforate border as a highly interesting part of these animals. It would be difficult to explain the author's description without the aid of his figures, but he endeavours to show that the punctate or plicated fringes are only modifications of each other, adding that these perforate or spinous fringes are not essential, but only supplementary parts of the head; the width of the head, without the fringe, being exactly that of the body; so that when the animal is doubled up, the fringe projects freely on all sides. Mr. Salter then proceeds to consider a subject of much importance, especially when the Trilobites of different and distant localities are under consideration, namely the identity or distinctness of Trinuclei referred, or to be referred to the species *T. Caractaci* (Murchison). From the examination of specimens, he considers that *Trinucleus ornatus* of Sternberg, *T. tessellatus* and *T. Bigsbii* of Green, *T. Caractaci* of Murchison, *T. elongatus* and *T. latus* of Portlock, and *T. Goldfussii* of Barrande, are all the same species, for which he would preserve the name of *Trinucleus ornatus*, that having been first given by Sternberg. Of this species four distinct varieties are admitted:—1. *Sternbergii* (Salter); 2. *Caractaci* (Murchison); 3. *elongatus* (Portlock); 4. *favus* (Salter). Five species of the genus *Trinucleus* are known to Mr. Salter, namely *T. ornatus*, Sternberg, *T. seticornis*, Hisinger, *T. granulatus*, Wahlenberg, *T. fimbriatus*, Murchison, and *T. radiatus*, Murchison.

Mr. Lyell in his paper on the coal-field of Eastern Virginia has figured certain bivalves found in the carbonaceous shales associated with the main coal seam. They are discovered in multitudes, dividing the shale into thin laminæ like plates of mica, and resemble *Posidonomya*, and more than any other *P. minuta*. He also figures and describes, chiefly from notes supplied by Prof. Agassiz and Sir Philip Egerton, ichthyolites obtained from the same coal-field. These consist of *Dictyopyge macrura* (*Catopterus macrurus* of Redfield), the most abundant species; a second species of *Dictyopyge*, and a *Tetragonolepis*.

Our Foreign Secretary, Mr. C. Bunbury, has given us detailed descriptions of fossil plants from the same coal-field, and brought to

this country by Mr. Lyell. He enumerates—1. *Tæniopteris magnifolia* (a fern first noticed by Prof. Rogers); 2. *Neuropteris linnææfolia* (n. sp.); 3. *Pecopteris Whitbiensis*; 4. *Pecopteris* (Aspidites) *bullata* (n. sp.); 5. a questionable *Pecopteris*; 6. *Filicitus fimbriatus*; 7. *Equisetum columnare*; 8. *Calamites arenaceus* (Rogers); 9. another *Calamite*, probably the young plant of the above; 10. *Zamites obtusifolius* (Rogers); 11. *Zamites gramineus* (n. sp.?). 12. a questionable *Sigillaria* or *Lepidodendron*; 13. casts of small portions of a decorticated stem a little like those of some *Lepidodendra*; 14. a doubtful *Knorria*; and 15. indeterminable fragments of a plant apparently with verticillated grass-like leaves. Figures accompany the descriptions Nos. 2, 4 and 6 of the above-mentioned fossil plants.

To Sir Philip Egerton, who has so successfully studied fossil fish, the Society is indebted for a communication on the Nomenclature of the Fossil Chimæroid fishes, in which he rectifies errors previously committed, and proposes to divide these fossil fishes into four genera, namely *Ganodus* (Egerton), *Ischyodus* (Egerton), *Edaphodon* (Buckland), and *Elasmodus* (Egerton). The first genus contains ten species, all from the Stonesfield oolite; the second nine species, from the chalk marl and greensand, the gault, the Portland beds, the Kimmeridge clay, the Caen oolite, and the lias; the third genus contains seven species, from the Bagshot sands and Bracklesham beds, the *molasse* of Switzerland, the chalk, and greensand; the fourth, two determinable and one unnamed species, from the Sheppey and Bracklesham beds, and from one unknown locality. Thus, these remarkable fishes have existed from the time of the lias to the present day, and the researches of Sir Philip Egerton have shown their range through geological time, established three new genera, and added no less than thirteen new species to the same number of species previously figured or described by Dr. Buckland, Prof. Agassiz, and Prof. Owen.

In his microscopical observations on the structure of the bones of *Pterodactylus giganteus* and other fossil animals, Mr. Bowerbank gives a detailed account of his researches into the forms of the bone-cells of man, and of recent or fossil birds, reptiles and fishes, and considers that these forms furnish characters sufficiently distinct to permit their classification; thus while the proportion of the length to breadth in the bone-cells of man are represented to be as 1 to 4, that of the albatros is as 1 to $6\frac{1}{2}$, of a fossil bone of a bird from the Wealden 1 to $5\frac{1}{4}$, of the *Thylacotherium Prevostii* 1 to $4\frac{1}{8}$, of the common frog 1 to $11\frac{3}{4}$, of the *Boa constrictor* 1 to 11, and of a *Pterodactyle* jaw 1 to 11: other examples are given, as also considerable detail, requiring the plates for their proper appreciation. Mr. Bowerbank considers that the aid of the microscope may thus be most advantageously employed to determine the class of animals to which doubtful fossil bones may belong. From his researches he refers certain bones from the chalk, considered to be those of birds, to the *Pterodactyle*, and states that they confirm the views taken by Professor Owen respecting the mammalian character of the disputed remains discovered in the Stonesfield slate.

In his paper on the so-called nummulite limestone of Alabama, Mr. Lyell cites the opinion of Professor E. Forbes and Mr. Lonsdale that the supposed nummulites were in reality zoophytes, referable to the genus *Orbitolites*. Professor Forbes observes that the *Orbitolites complanata* of the Paris tertiary series is very nearly allied to the American fossil (*Nummulites Mantelli*), and that the *Orbitolites elliptica* of Michelin (from Nice) and that author's *Orbitolites Prattii* are nearly-allied species. He refers also to disciform bodies discovered by Mr. Beete Jukes in Australia, in great numbers upon marine plants resembling *Zostera*, and when dead in great abundance in mud from various depths under seventeen fathoms, considering them as belonging to the same generic group with the tertiary *Orbitolites*. Mr. Lyell also quotes the opinion of M. d'Orbigny that the American specimens sent to him are referable to his genus *Orbitoides*, one nearly allied to *Orbitolina*. In consequence of these determinations Mr. Lyell concludes that the fossil in question will henceforth be known as *Orbitoides Mantelli*, retaining the specific name first given to it by Dr. Morton. As *Orbitolites* have been frequently taken for *nummulites*, the strict determination of them is important geologically.

Our colleague Professor Owen has presented us with an account of the fossil remains of mammalia referable to the genus *Palæotherium*, and to two genera, *Paloplotherium* and *Dichodon*, hitherto undefined, from the Eocene sand of Hordle, Hampshire. He is led to suspect that the species of *Palæotherium* represented by a lower jaw and teeth may be distinct from the *Palæotherium medium* of Cuvier, while the distinctive position of another lower jaw is more doubtful, and he consequently registers the Hordle fossils provisionally under the name of *Palæotherium medium*. After describing in great detail the specimens which have afforded him the data for the genus *Paloplotherium*, carefully comparing them with all that is known respecting allied forms, Professor Owen notices a subject of much interest with respect to the entombment of some of these mammalian remains. He states, after mentioning the effects of force on a head of *Palæotherium* due to pressure before the rock in which it was inclosed had hardened, that there are other marks of violence, as if a crocodile had seized the animal, a young one, for his prey, the skull exhibiting marks as if produced by two distinct bites, the head having been turned half round between them. "At all events," he observes, "it is plain that the violence inflicted upon the head of this young pachyderm has been received before the skull became imbedded in the eocene mud, and that the matrix hardening around it has preserved the evidence of the nature of the injuries received to this day. The points of the great canine teeth of old crocodiles," he adds, "not unfrequently become so blunted as would produce such crushed and depressed fractures without penetrating more deeply."

To the extinct crocodile the remains of which are common in the same beds in which the *Palæotherium* was found, Professor Owen assigns the name of *Crocodylus Hastingsiae*. He afterwards presents us with a detailed account of the teeth and lower jaw of an extinct

species of mammal belonging to the section of hoofed quadrupeds, and forming the type of a new genus to which he gives the name of *Dichodon*.

In another communication Professor Owen notices the occurrence of the fossil remains of the *Megaceros hibernicus* (commonly known as the 'Irish elk') and of the *Castor europæus* in the pleistocene deposits forming the brick-fields at Ilford and Grays-Thurrock, Essex, thus confirming his statements as to the occurrence of the remains of the so-called Irish elk in England. He also remarks that the remains of the *Megaceros*, found in England, have been mistaken for those of *Bos*, and points out the difference between the teeth of the great Bovines and *Megaceros*. The teeth of the *Bos longifrons* being smaller than those of *Megaceros* are readily distinguished by their size.

Professor Owen observes that the *Bos longifrons* coexisted with *Megaceros* in Ireland, and with *Megaceros*, *Rhinoceros*, *Elephas*, *Hyæna*, &c. in England, and that the remains of *Bos longifrons* have been found in ancient places of sepulture, and are so associated with British and Roman works "as to leave little doubt of its having survived, as a species, many of the mammals with which it was associated during the pleistocene period." The Professor conceives that as yet no good evidence has been adduced to show the coexistence of man and the *Megaceros*.

We have also to record the reading of another communication to the Society by our colleague, Professor Owen, one entitled "A description of teeth and portions of jaws of two extinct Anthracotherioid quadrupeds, *Hyopotamus vectianus* and *H. bovinus*, discovered by the Marchioness of Hastings in the cocene deposits of the N.W. coast of the Isle of Wight, with an attempt to develop an idea of Cuvier's on the classification of pachyderms by the number of their toes." After a careful detail and comparison of teeth, the Professor points to a general type of configuration ("a quadrate crown with four principal pyramidal and more or less triedral lobes divided by deep valleys, not filled up by cement, but in some genera interrupted with minor tubercles and ridges,") which "characterises a great natural group of *Ungulata*, most of the members of which are extinct, but which tend to fill up, in the zoological series, the wide interval that now divides the Peccari or the Hippopotamus from the Ruminants." "The generic or subgeneric modifications of structure," adds Professor Owen, "at present recognised in this great natural group, are signified by names given to the partially restored genera:—

"*Anthracotherium*.

"*Hyopotamus*.

"*Merycopotamus*.

"*Hippohyus*.

"*Chæropotamus*.

"*Adapes*.

"*Dichodon*.

"*Hyracotherium*.

Calicotherium.

"*Dichobunes.*

"*Anoplotherium.*

"*Hippohys* and *Chæropotamus* seem to have stood nearest to the existing *Peccari* and the Hog tribe: *Anthracotherium* or *Merycopotamus* were perhaps more nearly allied to *Hippopotamus*. Cuvier thought the *Anoplotherium* to bear a close affinity to the Camelidæ, and *Dichobunes* seems to have approached the Musk-deer (*Moschidæ*)."

In this communication Professor Owen shows that to his catalogue of extinct British mammals we have now to add two quadrupeds, one as large at least as the tapir, the other as the boar, with the full complement and kinds of teeth characteristic of the typical *Ungulata*,

$$\text{viz. :—in } \frac{3-3}{3-3}; c \frac{1-1}{1-1}; p \frac{4-4}{4-4}; m \frac{3-3}{3-3} = 44.$$

In the second part of this memoir, Professor Owen enters upon large and general views, combined with the needful comparisons, respecting the *Ungulata*, the characters of which are given as follows:—

I. *Artiodactyla*. Hoofed quadrupeds with toes in even number, as two or four, and which have a subdivided or complex stomach, and a moderate-sized simple cæcum. Ex. *Ox*, *Hog*, *Peccari*, *Hippopotamus*.

II. *Perissodactyla*. Hoofed quadrupeds with functional toes on the hind foot in uneven number, as one or three, and which have a simple stomach, and an enormous or complex cæcum. Ex. *Horse*, *Tapir*, *Rhinoceros*, *Hyrax*.

III. *Proboscidea*. Resembling the preceding in having toes in uneven number (5), a comparatively simple stomach, and an enormous cæcum, but combining, with a long proboscis, so many peculiarities of structure as to merit the rank of a distinct group of *Ungulata*.

Professor Owen, endeavouring to see, as he says, whither and how far the thread of comparative anatomy may guide us in the maze of the affinities of the recent and extinct animals with hoofed extremities, observes, "It is evident at the first glance that the known genera cannot be ranged in a single linear series in the order of their natural affinities: it will be equally evident," he continues, "by the digital, the osteological, dental, and visceral characters adduced, that the horse is not the next of kin to the camel or ox, even among existing genera, but that the proboscideans apart, all the other ungulate quadrupeds are divisible into natural, and, upon the whole, parallel series, having respectively the *Anoplotherium* and *Palæotherium* as their types, which genera, so far as our actual knowledge extends into the dark vistas of the past, were their first, or amongst their earliest representatives on this earth. The known families or genera of the odd-toed and even-toed hoofed quadrupeds respectively headed by these two extinct genera, may be ranged as follows: but much additional special knowledge must be obtained before their order of juxtaposition can be precisely determined."

UNGULATA.

	<i>Artiodactyla.</i>	<i>Perissodactyla.</i>
Ruminantia.	Anoplotherium.	Palæotherium.
	Chalicotherium.	Paloplotherium.
	Dichobune.	Lophiodon.
	Cainotherium.	Coryphodon.
	Xiphodon.	Tapirus.
	Moschus.	Macrauchenia.
	Antilope.	Nesodon.
	Ovis.	Hippotherium.
	Bos.	Equus.
	Cervus.	Elasmotherium.
	Camelopardelis.	Hyrax.
	Camelus.	Rhinoceros.
	Merycotherium.	Acerotherium.
	Merycopotamus.	
Non-Ruminantia.	Hippopotamus.	
	Dichodon.	
	Hyracotherium.	
	Hyopotamus.	
	Anthracotherium.	
	Hippohyus.	
	Chæropotamus.	
	Adapis (?).	
	Dicotyles.	
	Phacochærus.	
	Sus.	

It is difficult to contemplate a catalogue of this kind without being impressed with the important aid which Geology and Comparative Anatomy have afforded to each other. To those who in years past were struck with the discoveries of the great author of the 'Ossements Fossiles,' and have traced the addition after addition since made to our knowledge of the forms of vertebrate animals which have existed prior to our day; delighting alike in contemplating the linking together of these forms by fresh researches, and the history they afford us of the additions to, and changes in terrestrial animal life effected upon the earth's surface in such comparatively recent geological times, these labours of our colleague cannot but afford the highest interest. Let us hope that the researches of geologists may present him with an abundance of materials for thought and description, and that the meetings of this Society may continue to be enriched by his communications.

We have next in the order of papers to refer to a communication from Mr. Richard Brown, in which he considers that he has discovered evidence, in the palæozoic coal-field of the island of Cape Breton, of the connection of *Stigmaria*-form roots with a stem of *Lepidodendron*. An interesting figure accompanies his description of a fossil plant, supposed to belong to the *Lepidodendra*, found above the Sydney

main coal. This is a subject well-deserving of attention. That the plant named *Stigmaria fucoides* is a root, may now be considered as an opinion somewhat commonly adopted. The geological inferences thence arising are highly important, more especially when we refer to the conditions under which our palæozoic coal has been usually formed.

Mr. Sharpe, in his paper on the fossil remains of Mollusca from the Palæozoic Formations of the United States contained in the collection of Mr. Lyell, besides a comparison between the older fossiliferous accumulations of North America and of Europe, and a list of the published species of Mollusca recognised in that collection, enters into a more detailed examination of some of the species contained in that list. He thus passes under review *Avicula Boydii*, *A. quadrula*, *A. naviformis*, *Leptaena demissa*, *L. depressa*, *Orthis carinata*, *O. parva*, *Pentamerus galeatus*, *Spirifer biforatus*, *Sp. macronotus*, *Sp. plicatus*, the genus *Strophomena*, *Terebratula aspera*, *T. unguiformis*, and *Porcellia ornata*.

The same collection afforded Mr. Sharpe the data for a new genus, belonging to the Brachiopodous Mollusca and named by him *Trematis*, an account of which formed another communication to the Society. In general appearance this shell is similar to *Orbicula*, in which genus it has hitherto been placed. It "differs from *Orbicula* in the punctated structure of its shell, and in having the valves united by a hinge, while it is distinguished from *Terebratula* and the other hinged forms of Brachiopods by the ligament passing through the ventral valve. It thus forms a connecting link of great interest between several genera." The species of *Trematis*, described as *Orbicula*, are considered Lower Silurian fossils. Three American and one English species are described by Mr. Sharpe.

Appended to the communication of Prof. Sedgwick on the Fossils of the Skiddaw Slates, is an account by Mr. McCoy of those fossils, in which, after noticing the occurrence of *Graptolites sagittarius*, he describes a graptolite as new under the name of *G. latus*, and also as hitherto unnoticed, two species of fucoids, *Chondritis informis* and *Ch. acutangulus*. He also considers that there are sufficient data on which to found a new genus, under the name of *Palæochorda*, describing two species, *P. minor* and *P. major*.

Those present at our last ordinary meeting in this room must have been gratified by the exhibition of the mass of bones of the Dinornis and other fossil birds of New Zealand, collected there by Mr. Walter Mantell, son of our colleague, Dr. Mantell, who at the same meeting communicated a paper to us on these bones, chiefly however with a view of illustrating their mode of occurrence in the deposits of New Zealand. The collection of bones was the finest hitherto made and transmitted to this country. "It consists of between 700 and 800 specimens, the bones belonging to birds of various size, and periods of growth," some, Dr. Mantell observes, "of aged individuals and others of very young animals, in which the epiphyses of the long bones are still distinct from the shaft."

As Prof. Owen was the first to make us acquainted with the gigan-

tic birds known to the natives of New Zealand as the Moa, and to which he assigned the name of *Dinornis*, the views of this comparative anatomist, since so well borne out by abundant proof, being founded on a mere shaft of a thigh-bone a few inches long, with both extremities deficient,—a beautiful illustration of the chain of inferences so strikingly pointed out as available by the great Cuvier,—Dr. Mantell, in the true spirit of science, at once placed the collection at the disposal of the Professor for examination.

As far as the researches of Prof. Owen have as yet extended, the bones sent home by Mr. Walter Mantell are referable to five genera, the crania and mandibles of four of which were previously unknown. The first genus is the *Dinornis*, “now restricted by Prof. Owen to the birds which possessed a skull and beaks essentially different from any form either recent or fossil.” The form of the cranium, especially of the temporal and occipital regions, is wholly unlike any hitherto observed in the class of birds, and approaches that of reptiles. Of this genus seven species have been determined, namely, *Dinornis giganteus*, *D. robustus*, *D. ingens*, *D. casuarinus*, *D. geranoides*, *D. curtus*, *D. didiformis*. Some of the bones of this genus, even those of young birds, were of colossal proportions.

The second genus is *Palapteryx*; the third, *Apertornis*; the fourth, *Notornis*; and the fifth, *Nestor*, a genus of nocturnal owl-like parrots, of which only two living species are known, one (*N. hypolepius*) restricted to New Zealand, the other (*N. productus*) to Phillip Island, one not more than five miles in extent. What further researches may find in this collection, which also contains fragments of egg-shells, remains to be ascertained: enough, however, has already been accomplished to afford most important additions to our knowledge of those remarkable birds, the Moas, some of which, at least, may have lived to a period comparatively as recent as the first entrance of man upon the New Zealand islands; thus occupying a place of somewhat the same kind with the Dodo in geological history.

To the mode of occurrence of these bones we shall have to refer hereafter in its place, but we must not here omit the remarks of Dr. Mantell, accompanying this communication, respecting the present grouping of peculiar forms of animals and plants upon different areas of dry land, constituting centres or foci of creation of certain organic types; nor those bearing upon peculiar faunæ and floræ, the remains of which are found entombed in various fossiliferous deposits. He calls attention to the fauna of New Zealand, in which the class of birds so prevails, to the almost entire exclusion of mammals and reptiles; and associating this fauna with the flora of the same country, wherein ferns, club mosses, &c. predominate to the almost entire exclusion of the graminaceæ, compares the whole with the fossils discovered in the carboniferous and triassic rocks. Dr. Mantell then adverts to the peculiar fauna and flora of Australia and Tasmania, to which allusion is elsewhere made, and their bearing upon the European deposits of the oolitic time, remarking also upon the reptilian character of the fauna of the Gallapagos Islands, distant from other lands. Quoting Mr. Darwin as stating these islands to

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form a little world within themselves, most of the aboriginal creations being found nowhere else, and the land itself upon which they exist being the result of igneous action at a comparatively recent geological period, he refers us to the time of the Wealden, when we must have had lands in the area of the British islands replete with reptilian forms.

Dr. Mantell concludes that "throughout all geological time the changes on the earth's surface, and the appearance and extinction of peculiar types of animals and plants, have been governed by the same physical and organic laws; that the paroxysmal terrestrial disturbances, though apparently in the earlier ages involving larger areas, and operating with greater energy than the volcanic and the subterranean action of modern times, did not affect the established order of organic life upon the surface of the globe, and that, throughout the innumerable ages indicated by the sedimentary formations, there was at no period a greater anomaly in the assemblage of certain types of the animal and vegetable kingdoms than exists at the present time."

With respect to the manner in which organic remains have been mingled with mineral accumulations in former geological times, the memoirs presented to the Society accord with the increased attention of late years paid to this subject. Mr. Beete Jukes, in his notes on the palæozoic formations of New South Wales and Van Diemen's Land, when describing the sandstones (named Wollagong) associated with shales and a few beds of coal in the vicinity of Sydney, remarks, that as the higher beds and coal-seams are approached, the sandstones become charged with great quantities of fossil wood, the fragments with their edges rounded and worn, having evidently been pieces of drift-wood before they were enveloped by the sand of the sandstone rock. Mr. Beete Jukes was particularly struck with the resemblance of these fragments to common drift-wood on a beach, and could scarcely avoid considering them as such, until undeceived by finding them included in the solid beds. Assuming that in this case we have evidence of a littoral deposit, it would follow, that to account for a continued succession of beds so characterized,—and the sandstones with their associated shales and coal are estimated at 300 to 400 feet in thickness,—a continued and slow depression of the land, as regards the level of the sea, would be needed. The evidence, if any, in favour of the growth of the plants forming the associated coal is not given, but the shallow water or littoral character of the wood-bearing arenaceous deposit accords well with that of the coal accumulations of different geological ages known elsewhere.

In the same communication Mr. Beete Jukes states, that the igneous rocks of the Macquarrie Plains, above New Norfolk, in Tasmania, appear to him to have flowed in the open air, and while in a fluid molten state to have caught up, while living, the trees now so well known as found fossil in that district. It may be here observed, that while this might happen, the showering forth of lapilli and ashes from a volcanic vent would afford conditions very favourable for the entombment of trees in the position in which they grew, and

we know that by the binding together of the volcanic ashes of former geological times, chiefly by silica, rocks have been formed as solid as greenstone.

The communication of Mr. Anthony on the impression of the soft parts of an *Orthoceras* in a shale, frequently termed *marlite*, occurring interstratified with limestone in the group of the palæozoic rocks of North America, to which the name Hudson's River group has been given, affords us an additional example of the excellent preservation of organic remains, where a fine argillaceous sediment has accumulated upon them. The shale or *marlite* in question is described as occurring of unusual thickness where the Cincinnati Astronomical Observatory has been erected, and in it numerous fossils were discovered beautifully preserved; among others *Orthocerata*, frequently measuring more than three feet in length. The smaller specimens were found encased in a sac, this sac of an oval form, about twice the diameter of the enclosed *Orthoceratite*, enveloping its whole length, like it flattened, and with a longitudinal impression throughout. Mr. Anthony supposes that the *Orthoceras* was furnished with a fleshy body, like the *Sepia* and its kindred cephalopods, or perhaps like the *Belemnite* with its accompanying ink-bag. It will be in the recollection of the Society that Colonel Portlock figured similar appearances in 1843, the Silurian slates of Tyrone having furnished several examples; indeed he founded his genus of *Koleoceras* upon them, so that be the impressions surrounding the *Orthoceratites* what they may, when these remains have been covered over by fine sedimentary matter, similar appearances are observable both in America and in Europe.

Mr. Lyell, in his paper on the structure and probable age of the coal-field of Eastern Virginia, describes *Calamites* and *Equiseta*, especially the former, as found standing erect, and as not confined to one geological level, but as occurring at various heights in the series, and at points widely different. He considers that they were not drifted, but grew on the area where we now find them, and infers the constant proximity of land, the drainage of which may have supplied a body of fresh water. Mr. Lyell sees no character in any of the fossils of this coal-field inconsistent with the hypothesis that all the beds may have been accumulated in a lake, estuary or delta. The fossil plants are inferred to have been all terrestrial, while too little is known of the genus *Posidonomya* to permit us to reason on its habits; and as to the fish, Sir Philip Egerton informed Mr. Lyell that the *Tetragonolepis* of the British lias is accompanied by *Lepidotus*, a genus common in the freshwater strata of the Wealden rocks of England. The coal itself occurs in three or more distinct beds, the chief of which appears to be thirty to forty feet in depth, a thickness requiring the accumulation of a vast amount of vegetable matter to produce it. The mass of sandstones, shales, and remains of vegetation of which this coal-field is composed, reposes in a kind of basin-formed cavity on granite, hornblendic and other rocks of older date, the beds dipping inwards. The view taken by Mr. Lyell, that the plants grew where now found, having been covered up by mud and sand during a gradual subsidence of the whole region, is one in harmony with that

which, from an increased knowledge of facts, has now become so common with respect to the palæozoic coal deposits of Europe and North America; the view in this case, as we shall hereafter see, having reference to a coal accumulation formed at a less ancient geological date.

Mr. Prestwich, in his communication on the London clay, incidentally mentions that at Clarendon Hill and at the Cuffell cutting the shells of *Panopæa* are abundantly found in a vertical position, similar to that which the recent species assume in their living habitats at the present day, proving the quiescent deposition of these portions of the strata. He also states that Dr. Fitton had called his attention to the occurrence of *Panopæa* and *Pinna* in the same position in the lowest beds of the lower greensand. In the same clays with the *Panopæa*, Mr. Prestwich observed *Pholadomya* and *Pinna*, the latter attaining a large size at Cuffell, also in a vertical position.

It may be scarcely necessary to advert to the advantage, indeed necessity, of strictly observing the position in which organic remains are found in the rocks containing them, as also their distribution, the association of the different species, and the proportion of the individuals of different kinds, if we are to have sufficient data on which to reason correctly on their mode of occurrence, and upon the conditions under which ancient life may have existed during the lapse of geological time. The ordinary catalogues of organic remains seldom furnish us with any information of the kind, some rare species of mollusc occupying a place as important as those, the mode of occurrence, distribution and abundance of which really afford us the information required, and on which we should reason. While on this subject, it may be desirable to call attention to a table by Dr. Fitton, in the last volume of our Journal, and dated October 1847, wherein symbols are employed to show when certain species first appear, when repeated, when disappearing, or when only discovered in one bed, in a series of deposits of the Lower Greensand, exhibited in a coast-section from Atherfield Point to Black-Gang Chine in the Isle of Wight. This table not only contains a list of all the organic remains known in the Atherfield section up to the date of publication, but also presents us with a lithological detail of the various groups, amounting to sixteen, into which Dr. Fitton has considered it desirable to divide the succession of beds. An easy system of reference having been adopted, and the table being surmounted by two sections of the coast, a valuable mass of information is at once presented to our attention respecting a succession of sedimentary accumulations and the distribution of organic remains in them for a thickness of 808 feet.

Reasoning upon the equivalents of the tertiary deposits in the London and Hampshire districts, Mr. Prestwich observes, that he would not restrict the synchronism of the Bognor beds of Hampshire to the lower part only of the London clay of the London district, considering that the conditions which in the Isle of Wight area were favourable to the prolonged existence of the animals, the remains of which are characteristic of the beds of the London clay, were modified

as we approach the site of London by a greater depth of sea, whereby the shallow-water and littoral fauna of the Bognor deposits had its character altered by new forms, such as the Nautilus, Pentacrinites and other deeper sea animals, the remains of which abound in the London clay near London.

When we regard the mode in which organic remains may become mingled with the mineral matter in which they may be found, it is very important to consider the character of the latter immediately in contact with the former. Physical conditions can so readily have changed during the accumulation of a series of beds, that greater or less portions of subaqueous areas upon which certain kinds of animals may exist under the circumstances best fitted for them, may become so modified or even wholly changed as respects such conditions, that the animals become scarce or disappear; and yet a return of the needful conditions may enable germs borne from some locality where the physical circumstances have remained suitable to the existence of their parents, to establish themselves, and the mineral accumulations of the locality be again charged with the harder remains of this species as heretofore. Mud, under the needful conditions, can be accumulated in waters of very varied depths, and gravels which could, under ordinary circumstances, be only formed or accumulated in shallow situations or beaches, might be depressed, and not be covered by any other deposits, until the remains of animals, which could then be entombed, no longer belonged to the class of those which lived in shallow water. Indeed it might so happen that some of the animals inhabiting the bottom, after the depression of the gravel, might penetrate among the pebbles, particularly if large, so that in after geological times the upper portions of such a gravel may contain the remains of animals which did not live in the situations where the gravel was either formed or accumulated. Touching the chances of such changes of conditions, it may be observed, that there is no want among the coasts of the world of irregular fringes of gravel and shingle along lines of deep sea-coasts, where, if depressions of the land, relatively to the sea, did take place, such shingle accumulations might descend into seas to which little sand, and even little mud, could be for a long period borne, though no doubt from changes of physical conditions, such as the study of geology teaches us have often taken place, any such mass of shingles may finally become well covered by arenaceous and argillaceous accumulations.

That the mass of coal-bearing beds of the palæozoic period were accumulated in shallow water, a gradual subsidence of the land taking place, the coal-beds themselves being the remains of plants which have grown in the atmosphere and upon the subjacent deposits on which they repose, when the accumulations became such as to reach to the surface, has now become a common opinion. Still every additional good evidence on this point is not without its value. Mr. Richard Brown, in his description of an upright stem above the Sydney main coal, in the island of Cape Breton, wherein he concludes that *Stigmara* roots are attached to a stem of *Lepidodendron*, shows that this plant grew where it is now found, its roots spreading out above the

coal-bed, its stem rising vertically above the roots. From the arrangement of shale in nearly horizontal layers in the roots, fern-leaves being interposed between the layers of shale, Mr. Richard Brown infers that the roots were hollow before the mud, which now forms the shale, was accumulated round this plant. It may not be out of place here to remark on the frequent evidence we have in the palæozoic coal-measures of upright stems, some certainly those of large *Sigillaria*, which were hollow before they were completely entombed in the mud, silt, or sand now consolidated around and in their remains. These plants seem often to have continued standing while several feet of detritus were accumulated around them, the upper parts finally becoming too much decomposed to resist pressure upon them. The accumulations of mud, silt, or sand, as the case might be, with any plants drifted with them, then fell over into the hollow, and there often settled in layers, separated from the main accumulations outside by the bark, now found so commonly converted into coal.

Concluding that the evidence is good respecting the connection of *Lepidodendron* stems with *Stigmaria* roots, Mr. Richard Brown infers that all the large trees which flourished at this period were furnished with roots of a similar character, especially adapted to the soft muddy ground in which they grew.

In his memoir on the mineral character and fossil conchology of the Great Oolite near Minchinhampton, Mr. Lycett presents us with a list of 104 *Conchifera*, 44 *Monomyaria*, 7 *Brachiopoda*, 135 *Gasteropoda*, and 8 *Cephalopoda*, with 9 *Radiaria*, making a total of 317 species, discovered in the 130 feet of that member of the oolitic series as developed in that vicinity. It should however be observed, that about 128 of these species are considered to be undescribed, and that figures and descriptions of them are not given in the memoir. Mr. Lycett directs attention to the excellent preservation of the fossils in the locality he notices, one comprised within a radius of three miles, the external ligaments of the bivalves and coloured markings of the univalves being not unfrequently preserved. Though the area is so limited it is rich in organic remains, and Mr. Lycett remarks, that when collating the fossil forms in it with those from foreign countries, it is remarkable how few are found to be identical, though there is a strong family resemblance, and observes that the small size of the area described is advantageous so far as it exhibits the grouping or assemblage of contemporaneous species, free from the doubt which sometimes exists with respect to fossils collected over a more extended district. He then states that out of 127 species of univalves found, and exclusive of *Cephalopoda* and *Radiaria*, no less than forty-one are carnivorous, six others belonging to a genus (*Phasianella*) the recent species of which are both phytophagous and carnivorous, "thus presenting a proportion of species in the zoophagous tribes not very different from that which obtains in warm seas of the recent period." Our author then adverts to the scarcity of *Cephalopods*. Of *Belemnites* there is only one small species, and the individuals few; only two species of *Nautilus*; and *Ammonites* are so rare, that of five species Mr. Lycett has seen only four individuals. Referring to the abun-

dance of Cephalopods before and after the accumulation of the great oolite, he asks, if the distribution of families at this period was general or local, in the latter case dependent on conditions obtaining only within certain limited areas, so that, these ceasing, changes in the kind of animal life of the locality were effected also. After noticing the mineral character of the great oolite of Minchinhampton, he concludes that a littoral deposit, such as he considers this to have been, will account for the paucity of Cephalopods and the absence of species found over large areas where deeper and more tranquil water prevailed.

Detailing the mineral and zoological characters of the various beds observable in a large quarry on Minchinhampton Common, Mr. Lyceett mentions a soft shelly sandstone, six feet thick, resting on another shelly sandstone abounding in carbonate of lime, both of which exhibit numerous holes made by lithodomous molluscs, some of the holes still containing their shells. This shows pauses in the accumulations sufficient for the consolidation of beds, thus enabling these molluscs to bore fitting habitations for themselves. It is another instance, in a higher part of the oolitic series, of similar pauses, consolidation of beds, and boring by lithodomous molluscs, which we have elsewhere pointed out as observable in the inferior oolite at Ammerdown, near Kilmersdon, northward of the Mendip hills in Somersetshire, and at Doultling, on the south of the same hills. The boring by lithodomous molluscs into the carboniferous or mountain limestone of the Mendip hills, at the time of the accumulation of the inferior oolite beds, even through oyster shells, adhering now, as they did in the lifetime of the animals, to the subjacent carboniferous limestone, is well known. Their occurrence in the beds of the oolitic series is, however, still more geologically important, as it marks, though it may be locally, certain minor divisions in the geological time during which the series, up to the great oolite inclusive, was deposited. Similar borings, of the date of the inferior oolite, have been observed by Dr. Buckland and myself near Bridport, on the coast of Dorsetshire, and it would be well to search for evidence of this kind, or of any other, such as that seen in certain localities where the Bradford encrinites still adhere to the beds on which they grew, marking pauses in the accumulations known as the oolitic series generally.

Respecting the mode of occurrence of the Dinornis and other remarkable birds found fossil in New Zealand, and previously mentioned, Dr. Mantell has presented us with all the information which has up to the present time reached this country. This inquiry was attended with much difficulty, in consequence of the unsettled state of the orthography of the various localities where the fossil bones were obtained, and from the indefinite manner in which the collectors described those localities. They would appear to occur in gravel and other detrital beds cut through by the rivers, the bones being thus laid bare, and perhaps sometimes swept into other places, and again covered by mud and silt. In one locality they were found in peat exposed at low water, but covered at high tides. Again they are dis-

covered in heaps, as if the birds had been eaten and the bones thrown indiscriminately together. According to the Rev. Mr. Taylor, the bones of the Moa (*Dinornis*) are found in a bed which is elsewhere covered by marine and freshwater deposits. Dr. Mantell remarks that the bones obtained from the various localities he enumerates, excluding those whence Mr. Walter Mantell procured his specimens, were in a state similar to that in which the bones of the *Megaceros*, Elephants, and other animals are found in the superficial accumulations of England.

The bones obtained by Mr. Walter Mantell presented a different aspect, being light and porous, and of a delicate fawn-colour. The remains are beautifully preserved, not only egg-shells and mandibles, but even also the bony rings of the air-tubes being uninjured. They were entombed in a loose volcanic sand, beneath pebbles and rounded portions of igneous rocks. In the sands there were no vestiges of molluscs of any kind. Dr. Mantell supposes Waingonoro, the river near the embouchure of which the bones were obtained, for maps do not contain the name, to have its origin in the volcanic regions of Mount Egmont, many parts of which rise above the line of perpetual snow. Terraces of loam and gravel, of comparatively recent formation, occurring from 50 to 100 feet above the sea along the coasts of New Zealand, are considered to prove changes in the level of sea and land at no remote period. The present rivers of the country are represented as cutting through the beds in which the birds' bones are contained, a fact in accordance with the supposition that changes of level had been effected after the remains of *Dinornis* and other birds were entombed in the mud and silt, peat, or volcanic ashes, as the case might be, since the uprise of the land would cause so much increased fall through previous level or nearly level districts, that the rivers would attain greater velocities over given distances, and consequently greater cutting powers into old channels.

We can scarcely yet consider ourselves possessed of sufficient information to say how deep down among the geologically more recent accumulations of New Zealand the bones of the *Dinornis* and other associated birds may be found. More extended researches will no doubt show this: in the mean time the information collected is extremely interesting. The birds may have readily perished in various ways, including showers of volcanic ashes upon them and their haunts, partially strewn with their eggs. During a certain lapse of time, ending with the introduction of man to these islands, they may have existed in great numbers, the gigantic species especially, with their great beaks, being too powerful for any other animals then intermingled with them.

The notice by Mr. Grant Dalton of a large tusk of an elephant fished up in the trawl of an Ostend smack, about ten or fifteen miles off the island of Texel, affords an additional example to those on our own eastern coasts where remains of elephants have been obtained in a similar manner. It is interesting to consider, that by the action of the waves on the sea-bottom, within depths sufficient to remove

the mud, silt, or sand in which these remains have been entombed, they become mingled with the accumulations of the present time. Since bones have been thus detected with serpulæ adhering to them, and still alive, it will be evident, if these bones be again enveloped in detrital deposits, that they will be mingled with the shells now living, as well as with any which, like the bones, may have been enveloped in the original deposits, and which were too heavy to be removed with the mud, silt, or sand.

We have next to consider the superposition of rocks, their supposed equivalents in different regions, and general classifications of them. Mr. Beete Jukes has described a series of deposits in the vicinity of Sydney, New South Wales, estimated at about 2000 feet in thickness, which he refers to the geological date of the accumulations for which the name palæozoic has been employed of late. The lowest part of the series near Sydney, to which the term Wollongong sandstones is given, is commonly thick-bedded, fine-grained, often slightly calcareous, and contains many concretionary nodules, from two inches to two feet in diameter. This arenaceous deposit is estimated at from 300 to 400 feet thick, and contains the remains of *Stenopora*, *Producta*, *Spirifer*, *Pachydomus*, *Orthonota*, *Pleurotomaria* and *Bellerophon*. Above these sandstones come the strata associated with coal, the beds of which are represented as not likely to be important. The thickness of this accumulation is taken at about 200 feet. Surmounting this there are shales and sandstones, about 400 feet thick, and upon these comes the thick mass of sandstone named by Mr. Clarke the Sydney sandstone, from 700 to 800 feet thick, and composed of thick beds of white and light yellow sandstones, varying from fine-grained to coarse, containing quartz pebbles. In lithological appearance these beds were found to resemble the millstone grit and lower coal-measures of the north of England. Crowning the whole are shales at least 300 feet thick, in which are a few small fragmentary vegetable impressions and pieces of leaves. Fish are also stated to have been discovered in them. As a general fact, perfect conformability of the whole series, and a gradual transition of their divisions into each other, were observed.

Mr. Beete Jukes also notices sandstones and limestones, referred to the same palæozoic age, and igneous rocks in the south-east of Tasmania. The igneous rocks are very confusedly mingled with the two former, while they sometimes traverse and are intermingled with them, and sandstones rest undisturbed against old cliffs or ledges of trap-rock at others. Limestones near Hobartown afforded the remains of *Stenopora*, *Fenestella*, *Caryophyllæa*, *Producta*, *Spirifer* and *Pecten*. An argillaceous sandstone at Point Puer gave *Producta*, *Spirifer*, *Pterinea*, *Orthonota*, *Allorisma*, *Pachydomus* and *Pecten*. The rocks of Eagle Hawk Neck, where occurs the tessellated pavement (one of the celebrities of Tasmania), formed of a hard, fine-grained and compact grey sandstone so split up by divisional planes as to have a tessellated aspect, furnished *Fenestella*, *Producta*, *Spirifer*, *Platychisma* and *Pachydomus*. Among the sandstones of Norfolk Bay coal occurs and is worked, and in the sand-

stones *Pecopteris Australis*, a *Sphenopteris* and a *Zeugophyllites* were found. In a fine compact quartz rock of Spring Vale, on the east coast of Australia, *Fenestella*, *Producta*, *Spirifer*, and a Crinoid were obtained.

Mr. Richard Brown, in a notice of the gypsiferous strata of Cape Dauphin, in the island of Cape Breton, admitting the view taken by Mr. Lyell, that these beds belong to the palæozoic series, further points out that, on the western boundary of the Sydney coal-field, and exposed along a lofty cliff, the lower part of the coal-measure accumulations is distinctly seen to repose on carboniferous limestone and associated marls, containing gypsum. Of these beds, commencing with that termed 'millstone grit,' Mr. Richard Brown gives a detailed section, their total thickness amounting to 1056 feet. This, no doubt, is a valuable addition to our knowledge respecting the mode in which sulphate of lime occurs among rock accumulations,—a subject of much geological interest. From the remains of animal and vegetable life entombed in the coal-bearing beds of this part of North America, and in the limestones supporting them, these rocks have been referred to the date of the coal-measures and carboniferous limestone of the British Islands; and—without assuming that, part for part, they are exactly equivalent, since in the area of the British Islands themselves we find that the conditions for the growth of plants, the remains of which subsequently formed palæozoic coal-beds, obtained in the north earlier than in the south,—we may fairly conclude that they were of about that date, regarding the subject generally.

Mr. Lyell, while describing the coal-field of Eastern Virginia, above noticed, points out that the only accumulations of North America which occupy a similar position with these sandstones, shales and coal beds, the lower portion of the deposit resembling granites or syenites, having been formed from the detritus of the rocks on which they rest, are the red sandstones which repose unconformably on the palæozoic series of the Appalachian system, and which were, consequently, deposited after the movement that gave the palæozoic, carboniferous, and still more ancient groups of the Alleghany mountains their present strike, dip and direction. He then proceeds to inquire if the accumulations under consideration may be either newer or older than this so-called new red sandstone, and finds a difficulty, from fossil fish and the foot-tracks of birds, without plants, being the only evidence of life presented by the red sandstone, while the organic remains of the coal district near Richmond are almost exclusively vegetable. It is remarked that most of the fossil fish hitherto discovered in this coal district are referable to a new genus of the homocercal class, while all the fish hitherto obtained from the so-called new red sandstone of Connecticut river, four or five species in number, are heterocercal. "Could we, therefore," Mr. Lyell observes, "feel sure that the beds containing the ichthyolites and the foot-prints of birds in the valley of the Connecticut were triassic, it would afford strong ground for presuming the oolitic age of the Virginian coal strata." He however considers the question whether the Connecticut sandstone be Permian or of triassic date, to be still open.

Mr. C. Bunbury observes, that the geological evidence afforded by the fossil plants found in this accumulation is, to a certain extent, ambiguous; that the most characteristic species appear to be the *Equisetum columnare*, the *Calamites*, the *Tæniopteris magnifolia*, and the *Zamites*; that the first is a well-known plant of the lower oolite of Europe, while the *Calamites arenaceus* is discovered in the Keuper on this side of the Atlantic, and that the great abundance of these conspicuous *Calamites* strikingly distinguishes the flora of the Richmond coal-field from that of the Yorkshire series, of which it otherwise reminds us by many of its forms. He at the same time remarks on the geological value, in the Virginian coal-fields, of *Pecopteris Whitbiensis*, one of the most common plants in the coal of the Yorkshire oolites. As a whole, Mr. Bunbury considers the evidence of the vegetable remains to be in favour of the Richmond coal-field belonging to the geological age of either the triassic or jurassic series, and with equal plausibility to both; an opinion in which Mr. Lyell so far coincides, as to suppose that the Virginian beds may be equivalent either to the inferior oolite or lias, observing that we have not in Europe any large development of a fossil flora in these older divisions of the oolitic series, and that such might present more of a triassic character than in the coal-strata of Yorkshire. Viewed generally, Mr. Lyell infers with Prof. W. B. Rogers, who had previously noticed the coal-field of Eastern Virginia, that it agrees in age with the lower members of the oolitic or jurassic group of Europe, and takes occasion to point out, that while we find so much resemblance in the quality of the coal, and in the mode of accumulation of the rocks and plants associated with it, to the palæozoic coal deposits, we should be cautious with respect to popular generalizations respecting a peculiar state of the globe during the more remote of the two periods.

Though no doubt the views here taken by Mr. Lyell and Mr. C. Bunbury respecting the probable age of these coal accumulations may be founded on our present knowledge of the association of certain organic remains with the mineral accumulations of Western Europe, and that we have yet much to learn regarding them, as well as how far this knowledge may be applied, without considerable modification, to any deposits which may have been effected in the area now occupied by North America, nevertheless such views are of great value and importance: they enable us to classify the knowledge we possess, and thereby to render it available in a manner that it would not otherwise be, and the very accumulation of such views may often point out their own modification, should that be necessary. The labours of our colleague, Mr. Lyell, in America have been attended with the happiest results for the progress of our science, and by making them and his opinions known through this Society, he has not a little contributed to the aid which we have been enabled to afford to the advance of geology during the past year. We cannot also but with great satisfaction see his near connection, Mr. C. Bunbury, assisting in giving these labours still further value, by his investigations into the fossil flora of the transatlantic lands traversed by Mr.

Lyell; investigations which not only do Mr. Bunbury so much credit, but which give promise of yet more extended researches in the field of fossil botany by our Foreign Secretary.

Sir Roderick Murchison, in his introductory remarks to the memoir of Captain Vicary on the geology of parts of Sind, has shown, from the observations of that officer, the probability of the nummulitic limestones of the Hala mountains being surmounted by tertiary shelly conglomerates and beds charged with the bones of quadrupeds (many of which are of the same character as those found or described by Major Cautley and Dr. Falconer), and that the western limits may be defined of the coast-line, first laid down by Dr. Falconer, along which terrestrial animals lived at a tertiary epoch, for a very considerable distance in Asia. In this respect the information afforded is highly valuable, proving the extent and magnitude of those accumulations, skirting coasts, while the mass of the lands of India was depressed beneath the sea.

In the descending order of the Sind formations Captain Vicary notices, beneath the ossiferous beds, a coarse arenaceo-calcareous rock with *Cytherea exoleta?* and *exarata*, and *Spatangi*. Under this comes a pale arenaceous limestone with *Hyponyces*, *Nummulites* and *Charoideæ*; then the mass of the nummulitic rock of the Hala range, supported by black slates of which the thickness is unknown. The continuation of these nummulitic rocks over so great a distance, one extending across from Hindostan to the great Mediterranean accumulations of the same kind, would point to the prevalence of similar general conditions over a very great distance; conditions also continuous during a long lapse of geological time, during which contemporaneous accumulations took place in many parts of Europe of so varied a character, that convenient geological divisions can be made in them, and of which those great nummulitic deposits afford little or no trace. Indeed, all attempts to divide them, with reference to the former, have hitherto failed, and at present no good lines can be drawn between beds which may be of the tertiary epoch, and others which may even represent part of the oolitic or jurassic series of the British islands and many other parts of Europe.

Although Mr. Prestwich's memoir on the probable age of the London clay and its relations to the Hampshire and Paris tertiary systems was read at the meeting of this Society immediately preceding the last anniversary, and therefore does not strictly come within the number of those included among the communications to the Society during the past year, yet as it is intimately connected with his paper on the main points of structure and the probable age of the Bagshot sands, and on their presumed equivalents in Hampshire and France, and these memoirs are printed together in our Journal of 1847, it is desirable to consider them together. It was the chief object of Mr. Prestwich, in the first of these papers, to prove that the London clay of Highgate, Sheppy, and other places in the vicinity of London was not, as had hitherto been considered, synchronous with the *calcaire grossier* of the Paris tertiary district, nor

with the clays of Barton, and the clays and sands of Bracklesham in the Hampshire tertiary district, but that it was of older date, occupying a lower position in the tertiary series.

Upon comparing the fossil remains of the calcaire grossier with those of the London clay, Mr. Prestwich finds that not quite four per cent. of the testacea discovered in the former have been observed in the latter, and that even this small number is of little chronological value; for, with few exceptions, all of these have a wide vertical range in the Eocene series of France. The general character of the testacea is stated to differ, and if the fishes, plants, foraminifera, crustaceans and zoophytes be compared, the same marked distinctions are found throughout.

In comparing the tertiary deposits of Hampshire with those in the so-called London basin, Mr. Prestwich notices sands and mottled clays as the lowest, presenting a remarkably uniform mineral character, the beds formed of red mottled clay and of siliceous light-coloured sands, varying in proportions, and non-fossiliferous. Above this deposit there is, in Hampshire, a thick and important mass of fossiliferous brown and grey clay, well-seen in Alum and White Cliff Bays, 200 feet thick at the former, 300 feet at the latter, and in the well at Southampton, therefore thickening gradually in its range northward and eastward. To this accumulation Mr. Prestwich had formerly assigned the name of "the Bognor beds." In the London district the mottled clays are covered by a similar accumulation, and the latter in both districts is described as reposing upon a peculiar water-worn and irregular surface of the former. The pebble beds and sands at the base of the London clay are pointed out, as also the calciferous and usually fossiliferous band at Hedgerly and other places around London and near Salisbury and Southampton. It is shown that, where the superposition can be traced in the London district, the pebble beds are subordinate to sands, chiefly yellow, but sometimes green and dark gray, laminated with clays, with subordinate sandy clays. These deposits constitute the bulk of the London clay, the upper beds brown, and usually sandy near the top. As regards thickness in the London district, it is 320 feet near Odiham and about 400 feet at Highgate and Hampstead. Thus from the lithological structure alone the author concludes that the Bognor beds of Hampshire and the London clay are geologically the same.

Mr. Prestwich then examines the fossil contents of the beds, and finds that, taking the 390 described species of Testacea, of which 133 occur in the London clay near London, 193 in the beds at Bracklesham Bay, and 209 at Barton Cliffs, only 35 species are common to all these localities, 8 species common to London and Bracklesham, 11 to London and Barton, and 55 to Bracklesham and Barton. Adding to these fossil remains those of the crustacea, fishes, reptiles and plants peculiar to the London district, he concludes that the London clay is not synchronous with those of Bracklesham and Barton, but, viewing its relations with the mottled clays, lower than the former, and still lower than the latter. The author would not restrict the

synchronism of the Bognor beds of Hampshire to the lower part only of the London clay.

In his second communication, Mr. Prestwich describes the sands resting upon the London clay, and commonly known as the Bagshot sands, from their exposure in the vicinity of that town. He divides these sands into lower, middle and upper Bagshot sands, respectively of the thickness of 100 to 150 feet, 40 to 60 feet, and 250 to 300 feet; the middle division containing the greater amount of clays, with one or two beds of green sands. The Bagshot sands are considered by our colleague equivalent, though comparatively poor in organic remains, to the rich fossiliferous deposits of Bracklesham in the Hampshire district, and as synchronous with the central vertical strata in White-Cliff Bay, and with the great central mass of variegated and light-coloured sands of Alum Bay, including probably the Barton clays, and as being at all events older than the freshwater or fluvio-marine series. Mr. Prestwich regards the Bagshot sands as forming an uninterrupted sequence of deposits to the London clay, and that they may be represented in the Paris tertiary district by the lower part of the *Calcaire grossier* and *Glaucanie grossière*.

Taking a general view of the tertiary accumulations in the western London and Hampshire districts, (for he considers that there are other beds developed beneath the London clay in the eastern London district,) Mr. Prestwich divides the deposits into three chief groups: the first, or lowest, argillaceous, consisting of the mottled clays and London clay, containing a few subordinate beds of sand, chiefly confined to the former, its fauna presenting forms of which a considerable proportion is restricted to it. The central group embraces the Bagshot and Bracklesham sands; and the third or upper group contains accumulations of freshwater or fluvio-marine origin. All the groups are developed in Hampshire, while in the West London district the two lowest only are discovered.

These inferences of Mr. Prestwich not being deductions from hasty examinations, but the result of careful investigations and of long-continued labour, we may regard the views he has taken as placing us in a position respecting the Parisian equivalents of our tertiary deposits in Southern England, and of these with each other, far in advance of that which we previously occupied. So much of these tertiary accumulations has been removed by denudation, which has not only cut away a large amount of these rocks, but of those also which supported them, that great difficulties may always attend our endeavours to ascertain the shores washed by the sea during the accumulation of these tertiary beds, or the range of the deeper or shallower portions of it, at successive times, during the lapse of the same geological period. However this may be, the labours of Mr. Prestwich, who in the papers before us has combined lithological descriptions so carefully with palæontological comparisons, are in the right direction. It is from such investigations that we may expect a still more extended knowledge of our tertiary deposits, up to the changes now in progress inclusive, not restricting ourselves to supposed marked groups, the names for which, however convenient

and indeed necessary, so often interpose to prevent an examination into the continued changes and modifications of geological conditions, the more abrupt local alterations of which have been marked by results to which we may frequently give a far more general importance than they really deserve.

Mr. Lyell, in his paper on the relative age and position of the so-called Nummulitic limestone of Alabama, refers to a former communication to this Society, in which he stated that the limestone containing the *Orbitolites Mantelli*, the supposed Nummulite previously mentioned, and occurring between the rivers Alabama and Tombecbee in the state of Alabama, was a member of the Eocene tertiary group, this limestone being higher in the series than that containing the gigantic remains of the *Zeuglodon* (Owen), a deposit above beds containing a great number of well-preserved eocene shells, such as *Cardita planicosta* and others. Subsequent explorings in Alabama have confirmed him in these views. After quoting the opinions of Professor E. Forbes, Mr. Lonsdale and M. d'Orbigny, previously noticed, that the so-called Nummulites are Orbitolites or Orbitoides, he describes sections, proving the correctness of the view he has taken, and while noticing the limestone of Bettis' Hill, where it is 70 feet thick, for the most part made up of Orbitoides of various sizes, with occasionally a lunulite and other small corals, and *Pecten Poulsoni*, he refers its origin, like that of our white chalk, the softer varieties of which it resembles, to the decomposition of corals.

As it would appear that Orbitoides have been mistaken for Nummulites, though, as M. d'Orbigny observes, they differ from them by the most marked characters, this communication is not only valuable as regards American geology, but also points to the use of more caution on the part of those who may not be sufficiently skilled in palæontology when they mention nummulitic rocks, a class of deposits possessing considerable interest both as regards questions relative to the age of such accumulations, and to the vertical and horizontal range of the nummulites themselves.

Mr. Dawson has presented us with a memoir on certain red sandstones and conglomerates resting unconformably upon the palæozoic carboniferous rocks of Nova Scotia, for which he retains provisionally the name of new red sandstone, this term being at least locally appropriate. In this communication he describes this deposit as it occurs skirting the shores of Cobequid Bay. It appears that calcareous matter is occasionally mingled with the red beds, as near Truro. In the vicinity of Shubenacadie this matter shows a tendency to arrangement in large concretionary balls. Trap rocks seem also associated with this red accumulation.

The detailed descriptions of Mr. Dawson afford proof that the palæozoic rocks of Nova Scotia, from beds referred to Silurian rocks to those containing coal and the remains of plants similar to those discovered in the palæozoic coal-measures of Europe, were formed and subjected to pressure, by which they were thrown out of their original positions, prior to the deposit of these red sandstones and con-

glomerates. Making due allowance for local variations and chemical differences in the associated igneous rocks, we might suppose ourselves reading descriptions of the manner in which the great red deposits of the British Islands, known as the new red sandstone, were accumulated, viewing the subject on the large scale. Whatever the geological age of these American deposits may finally be found to be, when we compare them with the detrital deposits on the east of the Atlantic, this upsetting of the palæozoic rocks, the accumulation of pebbles and sand, with such an abundance of intermixed peroxide of iron as to produce a general red tint, here and there variegated with others, and the association of igneous rocks (such as that so common in Devonshire), bear a general resemblance to the accumulation known to us as the new red sandstone. At the same time it should be borne in mind, that though this red deposit may not be older than our new red sandstone, supposing the Nova Scotia coal a true equivalent to the palæozoic coal-measures of the British Islands, we have as yet no sufficient evidence as to how far it may correspond in geological time with that during which the oolitic or jurassic series of Europe was formed. We have already seen that inferences have been drawn as to the equal geological date of a coal-bearing series of deposits in Eastern Virginia with the lower part of that series; and though physical changes may have so taken place in Western Europe, that they have been productive of mineral accumulations which we may conveniently divide, as has been done, into Permian, triassic and jurassic or oolitic deposits, it by no means follows that the like have taken place in precisely the same geological times on the area of North America. We may have marked accumulations there formed at geological times requiring other convenient divisions for classification. The red deposits of Nova Scotia are due to certain physical conditions which may have been often repeated. Thus while we give due weight to the resemblances between the new red sandstone series of Western Europe, viewing it on the large scale, and the Nova Scotia red sandstone, we should still look for further evidence respecting the latter. Should it eventually be found probable that the two are of the same date, this contemporaneous disturbance of certain districts composed of palæozoic rocks in Western Europe and North-eastern America will offer a subject of no slight interest connected with great disturbances of portions of our earth's surface at different geological times.

Two communications from the Rev. W. B. Clarke, one on the genera and distribution of plants in the Carboniferous system of New South Wales, and the other on the occurrence of Trilobites in the same country, refer to the classification of the rocks in which these organic remains occur with the palæozoic series. According to Mr. Clarke, the same genera of plants which are characteristic of the carboniferous epoch in Europe prevail in these Australian formations, and though the species are different, they are not more so than might be expected at the antipodes of Europe. Mr. Clarke considers that there is evidence of coal deposits along the flanks of the mountain range of Tasmania and Australia for a distance of 1200

miles. After adverting to the notice of Trilobites in the work of Count Strzelecki, our author mentions the discovery of many others by himself, one a *Trinucleus*, which has been named by Mr. MacLeay *T. Clarkei*. Mr. Clarke considers these older deposits of the Australian series, with Mr. Beete Jukes, as representing the Silurian and Devonian rocks, including the carboniferous series of England, the whole forming one uninterrupted and conformable series of beds.

In his paper on the Silurian rocks in the valley of the Tweed, Mr. Nicol points out that it is only recently that any organic remains have been found in this district, or indeed in any of the older palæozoic rocks of Southern Scotland. Dr. Hutton was the first, he observes, who discovered these remains. He noticed them in his 'Theory of the Earth,' as occurring at Wrae near Broughton, on the road from Edinburgh to Dumfries. Mr. Nicol, who had visited this locality some years since, again examined it last autumn, and by diligent search obtained fossils. The only other locality where he found any such remains was at Greiston slate quarry, near Traquair, whence he procured *Graptolites Sedgwickii*, these occurring in profusion, as a mere surface-covering of a single bed. In the same bed there are fragments of anthracite and elliptical carbonaceous impressions, not unlike the leaves of a plant. A seam or vein of anthracite was once known among these rocks about a mile distant, affording, Mr. Nicol observes, additional evidence of the existence of vegetable life at this time. Mr. Salter having examined the organic remains obtained by Mr. Nicol, refers them to *Asaphus tyrannus*, another *Asaphus*, like the young of *A. megistos* (of the American lower Silurian rocks), *Phacops Odini* (Eichwald) or *P. alifrons* (Salter), and other trilobites, as also to *Leptaena tenuistriata* and other shells, *Orthis calligramma* being abundant: all, Mr. Salter considers, illustrative of forms and grouping such as are detected in the Llandeilo flags of Wales. Mr. Salter adds, that the researches of Lord Selkirk near Kirkcudbright would point to the occurrence of upper Silurian rocks also in that part of the Lammermuir range, *Terebratula semisulcata* being common among the fossils found, as also *Leptaena lata* and others.

Looking at the general evidence, Mr. Nicol considers it best to retain, for the present, the old name transition, or merely class them as Silurian, without attempting any more precise definition, and remarks as not improbable that the beds whence Lord Selkirk obtained his fossils, may be connected with some in Liddesdale, also on the extreme south of these deposits, in which he found numerous fragments of plants. The Wrae limestone, he infers, would thus range with the limestone near Girvan, in which Professor Sedgwick discovered Silurian fossils, and with other limestones in Colmonel parish, found by Mr. Carrick Moore to be fossiliferous.

Though we may regard, with him, any classifications of the rocks described by Mr. Nicol, which should extend to minor divisions, as premature, the general evidence adduced is important, and of an order which may eventually lead, by continued and detailed research, without which little can be accomplished in such regions, to sub-

divisions which may be compared with accumulations affected in the same range of geological time in other portions of the British Islands. The traces of supposed vegetable remains, and the anthracite noticed, possess no slight interest; for though, from carbonaceous deposits low down in the Silurian series of Wales, we might infer the existence of vegetable life prior to these accumulations, anthracite, from what we know respecting it in other rocks and localities, is a substance affording something more approaching to a proof of this inference. No doubt the carbonaceous substance in question might be produced from animal matter, but with our present knowledge we should rather refer it to a vegetable origin, so that in these rocks of the valley of the Tweed, we seem to attain evidence pointing to the entombment of vegetable remains amid the mud, silt and gravel of this remote geological date.

In a report on the fossil remains of Mollusca from the palæozoic formations of the United States, contained in the collection of Mr. Lyell, Mr. Sharpe compares the older fossiliferous accumulations of North America with those of Europe. He endeavours "to ascertain what species are common to the American and European formations; how far such species have had the same duration in the two continents, and how far similar forms of animals have existed in both at what may be supposed to have been the same periods, thus collecting data illustrative of the history of the earlier marine animals." Another object was to apply this knowledge to the classification of the American formations, and to see how closely they may be compared with those of Europe. The comparisons of the American and European fossils were made with specimens themselves, and Mr. Sharpe refers to the constant assistance he has derived from Mr. Morris in this labour. The number of American specimens compared was about 200, and the bulk of the collection was from New York, with many specimens from Canada and Pennsylvania. There was also a good collection from the blue limestone of Ohio.

After noticing the divisions among the palæozoic deposits of North America adopted in that country, Mr. Sharpe observes that, however convenient these may be for local purposes, there is a necessity for larger grouping when we compare the American with the European accumulations of this date; and he also considers that the supposition of older fossiliferous beds occurring in the American than in the European series is not borne out; on the contrary, that the oldest fossiliferous beds of the United States were not accumulated anterior to the Tremadoc or *Lingula*-bearing beds of North Wales. Mr. Sharpe also adverts to the inconvenience arising from the too minute classification which has been made in these palæozoic beds of North America, a multiplication of species having ensued under the view that each division only contained certain of them, so that consequently a great number of synonyms have become necessary in his tables.

Mr. Sharpe then enters into a detailed account of his examination of the American specimens, commencing with those discovered in the lowest rocks, and finally divides the whole series of deposits

whence they are obtained into three great groups, considered as distinguishable as well by their lithological structure as by their zoological character. The lowest is a vast arenaceous accumulation, with occasional beds of limestone, and includes the lowest fossiliferous rocks in the ascending series up to the Medina sandstone. The molluscs discovered in this division are stated to present a great accordance with those in the Lower Silurian rocks of Europe, in this view including the Clinton beds.

The next group is calcareous, with some associated sandstones and shales, and commencing with the Niagara shale ends with the upper Pentamerus limestone, according to Mr. Conrad, or according to the views of Mr. Hall, with the corniferous limestone. This group is considered equivalent to the Upper Silurian series of Europe. The third, or upper group, consisting chiefly of shales and argillaceous sandstones, reaches upwards to the top of the Chemung beds, and is referred to the geological date of the Devonian or Carboniferous systems of Europe, or rather to an enormous development of the former.

In the lowest group about 30 per cent. of the species of molluscs agree with those known in the Lower Silurian rocks of Europe; in the second, or middle group, 40 per cent. of the species are the same with those detected in the Upper Silurian rocks on the eastern side of the Atlantic; and, in the highest group, 20 per cent. of species agree with those found in the Devonian or carboniferous series of Europe. To these numerical calculations of species Mr. Sharpe attaches, however, little importance, believing the sources of error in such calculations to be alike numerous and varied, and that collections must be far more extended, and comparisons made with greater care before they can be regarded as valuable.

No one is more aware than Mr. Sharpe of the difficulties attending even the larger grouping of fossiliferous accumulations, far distant from each other, or of the necessity of viewing the limits of the divisions above noticed as somewhat hypothetical. Indeed, when we consider the probable physical conditions under which the mineral matter was accumulated in which the older organic remains noticed on both sides the present Atlantic are discovered, the necessity of great caution on this head becomes apparent. We must, of course, dismiss from our minds the present geographical distribution of sea and land, extending from and including Europe and North America. The many rises and depressions of land which the study of geology teaches us has since happened within the areas in Europe and North America now above the sea, show how needful this must be. Moreover great disturbances of the earth's crust, producing crumplings, flexures, and fractures, round and against which subsequent accumulations were effected, have taken place since the deposit of these older rocks. Whatever the form of the ancient lands whence the mineral materials of the older palæozoic rocks were derived, we have a given general distance on the surface of the globe always interposed between the deposits. When we regard any extended line of coast along the shores of our present continents, and, therefore, conditions in the seas adjoining most favourable, generally, for continued similar

deposits, we see so many causes for change and modification arising from physical conditions, that we could scarcely expect uniformity of result, even upon extended coasts ranging along the same parallels of latitude, or what might amount to the same thing, as regards temperature, if an internal heat of the globe may have been so felt at these geological times as to have given a certain temperature to the ocean, higher generally than at present. Always, under the latter hypothesis, duly considering the modifications in the position of such waters from the differences in specific gravity arising from differences of temperature. We have to look also to bays, headlands, shoals, deep waters, and all the modifications now observable, including tidal action in some places greater than at others,—estuaries and bodies of fresh water flowing over the heavier waters of the sea, until their power to do so ceased, and any detrital matter they may have held in mechanical suspension was deposited far outside the localities where the sea-bottoms may have been coated by mineral substances brought directly over them by river action. We have also to look to a fair proximity to land for the deposits generally, if we are to have any regard to the kind of marine mineral accumulations now observable, or which are at all probable. When we consider the thousands of feet of thickness which have to be given to these older deposits, we have to weigh the modifying influences exerted upon the life, existing upon the sea-bottoms of the time, in consequence of the filling-up of the deeper waters, unless we infer that the sea-bottoms were depressed as the mineral matter and the remains of animals were, bed upon bed, deposited upon them. Neither should we neglect, when great distances are under consideration, the chances of unequal depressions or elevations of the sea-bottoms and dry land during the lapse of the geological time when any large amount of accumulations in the sea may have been effected.

Independently of these physical considerations, we must not forget the time required for the dispersion of the species themselves, if specific centres are in any way to be regarded, even as a convenient hypothesis, and the chances that the germs of these species, floating away from the parent stock, only here and there, and over very uneven areas, found the physical conditions suited to them. Then also we have to take into account the views of the naturalist examining specimens obtained from the rocks which, or the remaining visible parts of which, represent to us the mud, silts, sand and gravel of these ancient times. He may be, as many palæontologists have been, inclined to attach a higher value to certain differences and resemblances of general forms, or of parts of forms, than another, and hence species may be so greatly multiplied in the cabinet, that our books may represent them to have been limited to a geological time, corresponding only with a given mineral accumulation, while the study of a greater number of specimens among the rocks themselves may not warrant these conclusions.

We have also to regard another point of no small importance, which is that our classifications of rocks in one part of the earth's surface, even taking an area equal to that occupied by Europe, is

necessarily founded on the physical or zoological changes or modifications which have been effected upon it, and it were well, often, if these classifications took so wide a range and were not extended from minor portions of that area. The study of a limited district is frequently sufficient to place us on our guard against a too partial regard for subdivisions; the modification of physical conditions, and with them, allowing for a great adjusting power, of contemporaneous life, pressing upon our attention. True it, no doubt, is that, as regards temperature only, molluscs and other marine creatures may find the needful limits within which they can sustain life very extensively in the sea, the waters adjusting themselves to the specific gravities due to their relative heat. So long therefore as finding proper food, they can battle against changes of pressure from differences of depth, modifications of sea-bottom, of light passing through the waters, and of distances from shores, many species might contend through these difficulties and thus spread themselves contemporaneously over considerable areas. At the same time, this power of adjustment would enable them to live through changes of a similar physical character brought about within a limited area. This now seems a well-established opinion among palæontologists, who regard the species most widely spread at a given period as those which existed through the greatest length of geological time.

On this head Mr. Sharpe remarks that the comparison of the palæozoic fossils of Europe and of the United States bears out the view that those species which rise through the greatest thickness of formations have also the widest geographical range. "We find in New York," he observes, "European species, which are confined here to a single bed, as well as those which are common to several formations, and usually the species seem to have the same vertical range in both countries." Of this Mr. Sharpe enumerates some examples, stating that they could readily be multiplied, and he points out the importance of endeavouring to ascertain in different countries the first appearance of each species, seeing whether it is found in one at an earlier geological period than in another, and thus to learn the region of which it was originally native. Respecting this he also mentions facts which he considers may tend to show that *Spirifer Urii* appeared earliest upon the area now occupied by North America, as also *Terebratulula reticularis*, and *Orthis resupinata*. On the other hand he remarks that, when observations are more multiplied, and we discover certain species to have first appeared upon the European area, *Leptaena depressa* may perhaps be found among them. Mr. Sharpe remarks that if, without regarding species, we look only to general forms, we shall find some groups of shells common in the United States long before they lived in the European area.

Viewing all the causes of modification and change in physical conditions at equal dates and during the lapse of a certain amount of geological time, and the power of marine life to adjust itself to certain of these changes and modifications, as well contemporaneously as during such lapse of time, by no means neglecting the great changes in animal life so evident when we look at its remains en-

tomed in the general mass of geological accumulations ; on the contrary, always bearing it fully in mind, we are convinced, with Mr. Sharpe, of the necessity of comparing the older accumulations of North America and of Europe in great masses, and even to regard the groups pointed out rather as affording us the convenient means of comparison than as positively representing, to their boundaries, the divisions which the study of European geology may at present make it desirable to adopt.

While Mr. Sharpe's paper refers to the comparison of deposits so wide apart as North America and Europe, now separated by an ocean, a portion of which may or may not have existed between them in that olden geological time, a communication from Prof. Sedgwick, made to the Society at its last meeting, on the organic remains found in the Skiddaw slate, with some remarks on the classification of the older rocks of Cumberland and Westmoreland, brings us to a consideration of the divisions and subdivisions which can be effected in the accumulations of this early date, as they are found in the British Islands. Professor Sedgwick divides the Cumbrian and Westmoreland rocks into eight groups, above the granite, namely,—1, the Skiddaw slates, commonly dark-coloured, the lower part altered by the granite ; 2, a great group composed of a mass of trappean rocks, indefinitely alternating with quartzose, and more or less chloritic roofing-slates, generally of a green colour, the igneous matters, whether erupted or recomposed, being contemporaneous with the ordinary sedimentary accumulations with which they are associated ; 3, a series of deposits, chiefly dark-coloured flagstones and slates, more or less calcareous, the lowest beds passing into a limestone (Coniston limestone) ; 4, coarse and hard, light-coloured sandstones ; 5, thin beds of sandstone, like the last, associated with large masses of roofing-slate and sandstone, in some places a thin band of impure concretionary limestone is found in the lowest part ; 6, a complicated deposit of sandstones, flagstones, &c., in the upper part of which are some greenish and reddish flagstones, appearing, Professor Sedgwick thinks, to occupy the same place as the tilestones of the Silurian system in Wales and the adjoining parts of England. The seventh group is the old red sandstone, resting unconformably upon the above, and upon this comes the eighth group, formed of the carboniferous limestone, resting conformably upon the old red sandstone, or overlapping its boundaries, and then resting unconformably upon the older groups.

All these groups Professor Sedgwick points out are true physical groups, the results of certain changes or modifications of the physical conditions under which they were accumulated. And here the Professor insists upon physical groups being "the foundation of all geology, and out of all comparison the most remarkable monuments of the past physical history of our globe, so far as it is made out in any separate physical region." "Organic remains," he continues, "are, in the first instance, but accessories to the information conveyed by good sections. But when the successive groups of organic remains are once established in coordination with actual sections,

they then tell us of successive conditions of organic life which were (as we know by experience, and might perhaps have conjecturally anticipated) of far wider geographical distribution than the local physical movements which produced our great physical groups of deposits. Hence," he adds, "it follows, that in comparing remote deposits, organic remains become no longer the secondary, but the primary terms of comparison."

After pointing out that the lower part of the group No. 3, the Coniston limestone, contains fossils considered as those characteristic of the Lower Silurian rocks, and that the higher groups, up to the base of the old red sandstone, are equivalent to the Upper Silurian series, he refers the group No. 2, that replete with various trappean rocks, contemporaneous with the common sedimentary accumulations of the time, to the Snowdonian series of Wales, an opinion of his as old as 1831-32. The Skiddaw slates occurring beneath these beds had, until lately, yielded no organic remains, though from some traces of carbon long since found by him in them, Professor Sedgwick had inferred that such traces had been derived from some obscure form of vegetable life, such as a fucoid. Referring to his notebooks of 1822, the Professor, his engagements preventing an examination of the localities personally, despatched Mr. John Ruthven, of Kendal, to the Skiddaw slate-district, and the result was the discovery of graptolites and other forms considered organic, and referred to fucoids. These fossils have been described by Mr. M'Coy, as previously mentioned, and with the exception of one species referred to *Graptolites sagittarius*, are considered by him to be new, namely one species of graptolite and four species of fucoids. The remains discovered in these slates Professor Sedgwick regards as those of the earliest organic life, nearly marking its descending limit,—no new opinion of his, he adds, as he has often stated his conviction that traces of life disappeared with descending sections, independently of their obliteration by metamorphic action or mineral change. He infers that the base of the Cumberland series is more perfect and symmetrical than that of Wales, and that the Lingula beds of Merionethshire are higher, in the geological series, than the Skiddaw slates. He then points to the great Cambrian and Cambrian group of the slate and trappean rocks as the most remarkable physical group in the British Islands; and, after detailing his views on the subject, includes it in his lower division of the palæozoic rocks, by whatever name it may be thought desirable to designate it. That there are accumulations of older geological date in the British Islands than the equivalents of the Llandeilo flags of South Wales, there is now good evidence; indeed, the continuation of the Llandeilo flags rests upon older rocks in the St. David's district of Pembrokeshire; and when the labours of the Geological Survey upon the older palæozoic rocks in other parts of Wales, with adjoining portions of England, and in Ireland, become sufficiently completed for publication, other evidences will be adduced of anterior accumulations of great thickness. For the present it may be sufficient to observe that there is every probability of the physical causes which produced the

great mixture of contemporaneous igneous and common detrital products in Cumberland and Wales having extended also to Ireland, and that there was at this time a great upburst of igneous matter, fluid molten rock rising through fissures and cracks amid the older accumulations, while ashes and lapilli were vomited forth from volcanic vents, partly perhaps in the sea, and partly into the atmosphere, where they were borne about in mechanical suspension, as ashes now frequently are for distances of many hundred miles, until finally they fell upon sea or dry land as the case might be.

When we read the descriptions of volcanic eruptions, such as that of Tomboro, in Sumbawa, given by Sir Stamford Raffles, the explosions during which were heard so loud at Macasar, 217 nautical miles from Tomboro, that, considering there was an engagement with pirates somewhere in the neighbourhood, a cruiser, with troops, was despatched to look after them, these explosions also reported to have been distinctly heard at Ternate, 720 nautical miles distant,—miles around the volcano darkened by the ashes thrown into the atmosphere and falling in all directions,—we need not refer to larger volcanic eruptions, long continued, than now occur, for the origin of the mixed matter forming these great accumulations. When we hear of a darkness from the ashes thrown into the atmosphere, continued many hours, and so great that it was equal to the darkest night, that the seas around the island were covered with pumice and ashes, that the waters were greatly agitated by earthquake waves, and that the ashes which fell so far off as Bima broke in the Resident's house in several places, we see causes and their effects well-suited in our own days to produce deposits similar to those which seem to have required physical agencies of a like kind over the area now occupied by the British Islands at this old geological epoch.

We have to look back to a time, after a thick accumulation of matter now forming the Skiddaw slates, the lower dark slates of North Wales, with their capping of variegated beds, and of sandstones and conglomerates, and the continuation of these beds, variously modified, into Ireland, when volcanic forces burst out furiously, scattering ashes around, so that falling into waters, they formed the parts, or the whole of beds, or were interstratified with common detrital accumulations, according to circumstances. That there were times of repose, during even the accumulations of the ash beds, is evidenced by the occurrence of organic remains in them, just as we find these remains entombed amid the deposits of ordinary mud or silt. They occur in a manner whence we infer the existence of life upon the ashes as upon any ordinary bottom, and as many a mollusc and other marine creature must live at the present day in seas adjoining volcanic districts and islands. This volcanic condition of the area, productive of such marked results, in the end ceased, at least over part of it, and was succeeded by a geological time when the volcanic products became covered for a long period by ordinary mud, sands and gravel, mingled at times with calcareous matter, here and there, perhaps, some igneous action continuing, and producing its effects. So much of the accumulations of this geological time have

been removed by denuding action, or remain concealed beneath the sea and more modern deposits, that it may be difficult to assign any marked interval of subsequent repose over more than minor portions of the general area of the British Islands, especially as we have had igneous action exerted in it at various geological times, up to that of the tertiary deposits inclusive. Great protrusions of granite have even happened at more than one time since. However this may be, we appear to have nothing so marked for the distribution and accumulation of volcanic ashes, and possibly also of pumice and lapilli, ground down by breakers to fine sediment on the coasts, as at this period. Though ashes were also abundantly scattered and arranged into beds in the area now occupied by Cornwall and Devon, and possibly also by a continuation of the same beds beneath the eastern covering of more modern rocks, when the deposits termed Devonian were formed, their accumulation does not appear to have been on so great a scale. It does not follow that more molten rocks may not have been ejected, for viewing the variations in volcanic action, it by no means follows that the amount of ashes and lapilli, driven off by the force of vapour and gases, bears a proportion to the molten matter heaved up and ejected.

It may here be convenient to mention a notice by Mr. Logan of the discovery of coal in Junk-Ceylon, one of the islands on the coast of the Malay peninsula, where it was stated to occur in a bed three feet thick ; as also another notice by Mr. Bellot on the coal of Labuan, and on that of the east coast of Borneo. We shall have occasion to refer to the Labuan coals in the sequel, and it will here only be necessary to observe, that the geological age of both the Malay and Borneo coals is still uncertain.

Regarding the movements which mineral masses may have sustained subsequently to their accumulation, we have first to notice a communication by Mr. Smith, of Jordan Hill, on recent depressions of the land. He subdivides the "human period into the present, or that in which geological events are subjected to our own observation ; the historical, or that in which they have been observed and recorded ; and the antiquarian, in which, although we cannot assign a date to them, we can prove from human remains or works of art that they must have taken place since the earth was inhabited by man."

Mr. Smith first notices the movements of the temple of Serapis at Puzzuoli, which have often engaged the attention of observers, and in our own country that of Mr. Lyell, Professor Forbes (of Edinburgh) and Mr. Babbage, and which though so far local as to be referable to the causes and consequences of volcanic action in the vicinity of Naples, still possess considerable interest from the changes in the relative level of sea and land, which they prove may take place during the lapse of a very short time, considered geologically. The memoir of Mr. Babbage on the temple of Serapis, though read before this Society so far back as 1834, will be fresh in its recollection, since it was only published in the last volume of our Journal. In a note to that communication, dated during the past year, Mr. Babbage, referring to his views respecting the effects which may be produced

on the great scale by the application of heat to rock accumulations under given conditions, observes, that "the joint action of certain existing and admitted causes must necessarily produce on the earth's surface a continued but usually slow change in the relative levels of the land and the water. Large tracts of its surface must be slowly subsiding through ages, whilst other portions must be rising irregularly at various rates; some, though perhaps few, may remain stationary." It is important that such views should be borne in mind, whatever other causes of change may also present themselves to us, when we consider the movements which geological evidence so clearly proves have taken place since the accumulation of the earliest sedimentary deposits with which we are acquainted; these movements sometimes raising masses of rocks above the sea, at others depressing them, forcing the dry land into all kinds of varied positions relatively to the sea, modifying the life for the time existing in the atmosphere or the waters, and often so entirely cutting off that in the one or the other, as the case may be, that, after a long lapse of geological time, the organic remains subsequently entombed over the same area differ completely from those intermingled with the sedimentary accumulations of a previous time.

From observations made at Puzzuoli in 1819 and in 1845, Mr. Smith concludes that there had been a depression of the temple of Serapis at the rate of about an inch yearly. In arriving at this conclusion, Mr. Smith makes every allowance for the small tidal action felt near Naples, and for the different altitudes at which the surface of the sea might stand from the pressure of different winds upon it, the latter a very material point when we estimate small changes of level. It appears to him probable that this depression may have been going on for many years, even since the last paroxysmal elevation in 1538, one which followed a gradual movement of elevation, itself subsequent to the stationary time when molluscs bored the columns, then necessarily so far depressed beneath the sea. Mr. Smith afterwards notices the relative changes of level of sea and land shown by submarine forests, so well exposed on the coasts of Brittany, Normandy and the Channel Islands, and alludes to evidence indicative of a depression of land in the islands of Malta and Gozo, wheel tracks, not connected with existing roads, passing beneath the level of the sea.

Another communication was made to the Society respecting the temple of Serapis by Colonel Macintosh, who visited it in May and June, 1847. From his observations he concludes that the land has been still further depressed since visited by Mr. Smith, of Jordan Hill. Colonel Macintosh also calls attention to the evidence of the sinking of the land on the Naples side of Puzzuoli; the Hospice of the Capuchins having so changed its level relatively to that of the sea, that the refectory, kitchens, &c., on the lower floor have been abandoned; and an aged monk who showed the Colonel over the premises pointed out a spot where there had formerly been a vineyard, and where he had for many years eaten grapes, this spot now covered by three feet of water and traversed by boats.

Captain James has also presented us with an account of one of those accumulations of wood and peat known as submarine forests, so frequent in certain localities around the British Islands, and observable on the shores of Western Europe from Spain to the Baltic, and which, often occurring partly beneath the present level of the sea and partly above it, mark a depression of the land, since the vegetation was the same as we now find it near the same coasts. The case noticed by Captain James was observed at Portsmouth during the progress of some works there. The peat, with the trees standing as they grew, rests on clay, considered as London clay, and extends even to 29 feet beneath high-water level. The 'forest' inclines northward, or towards the inner part of the harbour. Among the peaty matter *Lacuna Montaguei* was found, as also the *Zostera marina*, on which that mollusc feeds, indicating, Captain James observes, the presence of very shallow salt water. Indeed, these may have become mingled with the peat when the land first began to descend beneath the sea-level. Over the peat there is blue clay four feet thick, similar to the present estuary mud, and containing the shells now commonly found in the harbour. Above the clay there is shingle, which may have been forced over the mud by the sea during heavy gales; and the author calls attention to the effect which would be now produced if from any cause the narrow neck of land connecting the Block House with the main-land should be carried away, the mud of Haslar Creek being then liable to be covered by shingle in a similar manner. Above the shingle there is clay, a continuation of the bed of the present estuary, and upon this a mass of rubbish of various kinds rising above the sea-level.

We have seen that Mr. Lyell points to a depression of land to produce the vegetable and mineral accumulations of the Eastern Virginia coal-field, referred to the geological date of either the oolites or upper part of the new red sandstone series of Europe. We have next to notice the changes in the relative level of sea and land, supposed by Mr. Prestwich to have taken place during the formation of the tertiary rocks in the London and Hampshire districts. He refers to the view taken by him in 1846 as to the gradual subsidence of the seabottom during the production of the Bognor beds in the Isle of Wight, and considers that this depression extended over the western portion of the London district. He further supposes that the increasing depth caused by the subsidence was neutralized by detrital accumulations, so that the general conditions for the existence of a certain animal life remaining the same, this life was continued during the deposits. He infers that proceeding more eastwards deeper water prevailed.

Mr. Prestwich concludes that a sea first extended uninterruptedly over the London, Hampshire, and Paris tertiary areas; that at a period coeval with the change of conditions in the mineral structure and zoological character of the lower part of the London and Bognor clays, a separation took place between the Paris and Hampshire areas, leaving the latter still connected with the London district; that after the deposit of the London clay the communication between the French

and English tertiaries was restored, and that this connection was probably in part prolonged until the completion of the Isle of Wight series, the London district assuming a more isolated form, and emerging sooner from the sea.

With respect to the movements which the land may have sustained at this period, it should not be forgotten that the tertiary deposits which may have been affected by them were once more extensive than we now find them in mass, traces of their former existence not only remaining between the London and Hampshire districts, but also far to the westward. Indeed the extensive denudations which have been effected westward since the great bend of beds took place which can be traced across the Weald of Sussex into Somersetshire, and of which the great bulge of the Wealden rocks exposed in the former is but a part, leave it very doubtful how far in that direction these tertiary beds may have once been formed. This great anticlinal bend runs parallel with that of the Isle of Wight, and both probably belong to the same exertion of force, one showing a repetition of east and west anticlinal lines of a different geological date from those which have affected the coal-measures, carboniferous limestone and old red sandstone of the Mendip Hills in Somersetshire, the east and west anticlinal and synclinal lines in which are shown to have been produced anterior to the deposit of the new red sandstone and oolites, since these accumulations rest unconformably upon the denuded edges of the beds which have been thus disturbed.

In his 'Notes on the Geology of the Coasts of Australia,' wherein he adds to the information and descriptions of others, his own observations, made while attached as naturalist to the surveying voyage of H.M.S. Fly, Mr. Beete Jukes speculates on the past geological history of that remarkable land. Without claiming novelty for the view, he points out the absence, as far as is yet known, of rocks accumulated in geological time intermediate between the palæozoic and tertiary periods, as also the occurrence of marsupial animals, shells such as the *Trigonia*, and plants like the *Zamia*, existing Australian forms, in the oolitic series of Europe. "If," he observes, "at the close of the palæozoic period Australia had been elevated above the sea, so as to have been dry land during the oolitic æra, and never since had been wholly submerged, marsupial animals and certain plants may have inhabited the dry land, and *Trigonia* and other forms of marine life have resided in the surrounding littoral zones of sea up to the present day, however the species may have died out." The effects of submergence of the old land and its denudation are also pointed out. Mr. Beete Jukes supposes that during the tertiary time four groups of islands would be formed, one running along the present high land of the eastern coast, to which others, due to volcanic action at the time, might be added. A second island would coincide with the range of high ground in South Australia, a third with the hilly country of Western Australia, and a fourth with the part of the north coast ranging between Buccaneers' Archipelago and the Gulf of Carpentaria. He considers that in these islands, or groups of islands, certain animals and plants might die out and be replaced by others

during the lapse of time, peculiarities arising in the fauna and flora of each, so that finally, when the deposits in the surrounding tertiary seas were elevated above the water and became dry land, these islands constituted centres of terrestrial life, laying the foundation for the peculiarities now observable in different parts of Australia, though in equal latitudes and possessing similar climates.

However imperfect, from the present state of our knowledge, every attempt to take a general view of the geological structure of Australia must necessarily be, this grouping together of observations by Mr. Beete Jukes is highly valuable, especially as, from his personal inspection of several parts of the coast, he could the more readily seize resemblances and differences in rock masses which those accustomed to geological researches in the field know so well how to appreciate. It is by this gathering together of existing information, however imperfect it may be, that we possess a kind of base on which to work, and so long as we treat this as an hypothesis, which may take any direction, to be even totally changed, should the gradual development of facts require it, no impediment to the progress of our knowledge is presented, but on the contrary much assistance to it is afforded.

With regard to the changes and modifications mineral masses may have suffered since they were accumulated, and after any movements they may have sustained, we have to consider deposits formed in water and now elevated into the atmosphere, and others formed in comparatively shallow seas, depressed to various depths, and even covered by masses of mineral matter subsequently spread over them, as also some accumulations of mineral substances, such as many volcanic products, deserts of blown sand, and others, formed in the air and afterwards depressed beneath the waters.

We have first to notice changes produced in the coal deposits of Eastern Virginia, and pointed out by Mr. Lyell. After describing the character of the coal itself, the difference of its layers, and the beautiful manner in which its vegetable structure, examined by Dr. Hooker, is partially preserved, he shows that this coal in its chemical composition resembles that of the old palæozoic rocks of Europe and of North America. Analyses of specimens taken from three different localities (Clover Hill, Blackheath, and Deep-run) give carbon from 76·49 to 82·90 per cent. ; hydrogen from 4·08 to 5·23 ; oxygen and nitrogen, taken together, from 5·97 to 8·41 ; and ashes, or foreign matter, from 6·36 to 9·87. Thus we see that the changes from woody fibre to the coal, commonly termed bituminous, have been as great, as regards the loss of oxygen and hydrogen, combined with the requisite proportion of carbon, as those in the more ancient deposits, so that the conditions for such changes have been similar in both cases. Although we now know that changes, even amounting to those required for the production of anthracite, are to be observed in the vegetable matter in still more modern rocks, yet the quality of the coal in the Eastern Virginia coal-field is one of value theoretically, and important practically, as it forms an additional instance to those already known of excellent workable coal being found otherwise than in the palæozoic deposits.

Independently of the more ordinary modification of the vegetable substances constituting coal, Mr. Lyell points out another due to the intrusion of matter in igneous fusion amid the coal-measures. At the southern extremity of the coal-field of Clover Hill, a dyke of greenstone is seen cutting through the coal and associated beds, altering the coal into a kind of coke. At another point the coal was found to be also affected, being more or less deprived of its bituminous qualities. Mr. Lyell traced the igneous rock to within 120 feet of the coal in this instance, though he did not observe it in contact; but he remarks that it may have more nearly approached the coal than he observed. There are also other instances of the same kind, reminding us of the effects produced upon coal in other countries, as in Scotland, where rocks in igneous fusion have filled up fractures, charring or coking the edges of coal-beds in immediate contact, and depriving them of oxygen and hydrogen, combined with carbon, so that a bituminous bed of coal shades off gradually into anthracite as it approaches the intrusive and igneous rock.

The most remarkable example of the so-called natural coke was observed by Mr. Lyell at Edge Hill, a locality five or six miles north of the James river, where a large quantity is extracted from an eight-foot bed. The rocks passed through, above the eight-foot bed, were 110 feet thick, and among them was a conformable bed of basalt 16 feet thick. The shale beneath the igneous rock was white for 11 feet, and then 25 feet of dark shale succeeded, below which came the bed of coke resting on white shale, and lower down coal-measures with two beds of inferior coal, each about 4 or 5 feet thick. The shale interposed between the basalt and natural coke-bed exhibits so many marks of rupture and friction, including slickensides among the latter, that Mr. Lyell attributes the change from coal to coke not so much to the heat of the intrusive basalt, as to its mechanical effect in breaking up the beds and rendering them permeable to water, or the gases of decomposing coal. He also points out, that where coke or altered coal reposes on that which retains its usual character, (as it is known to do in this coal-field, even the same bed having been found thus partially changed, the upper part altered and graduating into the lower,) the intrusive and molten rock, here as elsewhere, made its way among the beds, taking the form of a conformable deposit, altering the upper coal as far as its influence extended.

These facts constitute good additional examples of the alteration of common coal by the intrusion of mineral matter in a molten state, and the Eastern Virginia coal-field seems to have been much broken up in some places, and molten rock forced among it. No doubt, as Mr. Lyell states, the fractured condition of the mass would readily permit the escape of the gases, which deprived the coal of its larger proportion of oxygen and hydrogen. The white condition of the shales beneath, or otherwise in contact with the igneous rocks, would also, if their dark colour elsewhere were due to carbon, be accounted for in the same way. The coke-bed may, from its analysis (carbon 86·54; hydrogen 4·23; oxygen and nitrogen 4·53; ash 4·70), be considered in the chemical condition of an anthracite; many anthra-

cites showing a much more considerable decomposition of the original vegetable matter, the carbon occurring in greater proportion to the oxygen and hydrogen.

Adverting to the scarcity of organic remains in the Bagshot sands, Mr. Prestwich supposes that this scarcity or absence of them arises, not so much from original causes unfavourable to the existence of testacea and other animals, or to the entombment of the remains of life, as to the subsequent operation of chemical agencies. He observes that where conditions for preservation were favourable, as in the central and upper divisions of these sands, traces of a fauna are far from restricted, and among other instances points out, that at Chobham Place, where a slight quantity of clay and peroxide of iron has consolidated the usually incoherent green sands, there is a semi-solid mass full of the casts and impressions of shells.

Mr. Prestwich, after remarking that in certain beds only the impressions and casts (and that rarely) at present exist, and that in this case there are favourable mineral conditions which do not generally prevail, proceeds to show that the hydrated peroxide of iron occurs commonly in the upper and middle Bagshot sands. He infers, that if a carbonate of iron were disseminated through the mass of these beds, and segregated in different places, it would, by decomposition, gradually evolve its carbonic acid, which being taken up by water percolating through the mass, would thus render this water capable of dissolving the carbonate of lime which might come in its way, thus acting upon the shells when it reached them in the pervious beds. It could scarcely but happen, where there may be sufficient free carbonic acid, no matter how derived, in waters percolating through rocks, that shells might be readily removed from beds, so raised into the atmosphere, that the waters containing the bicarbonate of lime in solution can readily drain off as springs, and the matter of the shells be thus removed to lakes and seas, perhaps to be again employed by molluscs for their harder parts.

The preservation of the matter of the shells themselves, in clays or other substances, usually called impervious, always however to be regarded as a comparative term, is well known to geologists, as also their absence in sandstones and other rocks. Even in some lime-stones, the carbonate of lime constituting the fossils is not that of the original shell, but a crystalline body replacing the actual shell, and therefore entering a cavity produced by the solution and disappearance of the original body. Every cast of a shell we find is an example of the solution and disappearance of the original. And not only do we find organic remains thus acted upon, but occasionally the carbonate of lime of rocks, in part formed of that substance, has disappeared partially or wholly. This may frequently be observed in some districts composed of the older rocks, and the original mixed rock, partly a mechanical accumulation of mud and silt, and partly a chemical product, from the admixture of carbonate of lime, presents only a sandy or silty appearance for many feet, where it has been exposed to atmospheric influences.

The manner in which the harder portions of animal remains have

been removed and replaced by various mineral substances forms a subject of much interest, but upon which it would be out of place here to enter. It will be sufficient to observe, that the matter of a shell or of any other organic remain being removed, and the particles of matter surrounding the organic remain having been sufficiently consolidated to preserve its form or cast, the hollows are in the condition of any other cavity, whether produced by dislocations, cracks, or in any other way, so that the solutions of any substances entering them, it depends upon a variety of conditions what those substances may happen to be, or how far any of them may be retained to fill up the cavity. The siliceous fossil shells, so to speak, of the greensand of the Blackdown Hills, are familiar examples of the substitution of silica for the carbonate of lime of the original remains, and similar examples are common elsewhere. Sulphuret of copper was found to have replaced some shells adjoining a copper lode near Nether Stowey, Somersetshire, and sulphuret of lead may be seen occasionally filling up the cavities of shells in the lias of Glamorganshire. In a trial for coal near Cairo, bitumen was found filling up the cavities left by shells in the nummulitic limestone of that vicinity. All such changes are of an order similar to that of that section of pseudomorphous crystals, where one mineral disappearing from a cavity, its form is given to another mineral of a different kind of crystallization, when the particles of the latter could freely adjust themselves. The pseudomorphous crystals of tin from St. Agnes, Cornwall, is a well-known example of this change in the body of a rock. The original crystals are those of felspar, in a granitic substance; these disappearing, peroxide of tin has percolated in solution into the cavity, and occupied it. Mineral veins, and indeed the contents of common faults, often show us one mineral cast, as it were, in a mould left by another, the mould being apparent. While thus adverting to pseudomorphous crystals, it is necessary to observe that there is another section of them, where moulds are not apparent, and where, particle by particle, one mineral seems to have been replaced by another, so that the form of the first is preserved.

In his memoir on the agate quarries of Oberstein, our Secretary, Mr. Hamilton, shows that while agates are discovered in the cells or vesicular cavities of igneous rocks, chalcedonic deposits are also found in veins traversing a red conglomerate; whether referable to the base of the palæozoic carboniferous, or to the new red sandstone series, his researches did not enable him to determine. After pointing out that the agates taken from the cells or vesicles of the igneous rocks could not, from the nature of their formation, contain organic remains, as it has been supposed the Oberstein agates did, Mr. Hamilton describes the chalcedonic veins, which evidently filled cracks formed in the conglomerate since its consolidation, not only the red cementing matter, but occasionally the pebbles themselves being traversed by the chalcedonic veins. The successive siliceous coatings of the fissures are sometimes clearly shown, with even a space left in the centre, where the mammillated surface of the chalcedony is well-exposed.

Igneous rocks underlie the red conglomerate above-mentioned, and vesicular cavities in them not only contain the siliceous deposits, but also, as is not uncommon in such rocks, zeolites, carbonate of lime, and other substances. The base of the rock is compact, somewhat porphyritic, of a dark brown or chocolate colour, and when so weathered that the contents of the numerous small cavities have been decomposed, has the appearance of a vesicular trap rock. At a distance there is a faint appearance of stratification parallel to the overlying conglomerate. Proceeding westward from the town of Oberstein, the same amygdaloidal rocks continue, in places more porphyritic, nodules of small agates and chalcedony appearing sometimes to run in lines.

These rocks are underlaid by others of a more compact character, succeeded in their turn by a highly crystalline greenstone. It is at Idal that the principal agate quarries are worked. Two varieties of trappean rock, having the appearance of a slight dip to the E.S.E., alternate with each other, one much softer than the other, and of a more amygdaloidal character. It contains numerous nodules, varying from an inch to a foot in length. Remarking that these nodules are lengthened out in the plane of the bed, Mr. Hamilton observes that this form may be due to pressure on the cavities while still in a viscous state, a point of much interest, as also indicating a movement of the mass in the direction of the lengthened cavities, such as may be observed elsewhere in rocks of this class. The other kind of igneous rock is much harder and more compact, with a total absence of all nodules. Mr. Hamilton could not observe any marked line of separation between the two kinds of trappean rock, and therefore does not consider it probable that different *coulées*, some vesicular, others without air-, gas- or vapour-cells, flowed over each other. The appearances described by Mr. Hamilton more resemble, on the great scale, those igneous products where bands of vesicles occur in a mass poured out of some volcanic vent at the same time, portions without vesicles alternating with those in which they abound, and which may be seen in fragments as small as a hand-specimen. While the rock was in a molten state portions became vesicular, and when it was poured out, the viscous stream carried the parts in elongated streaks, often alternating with each other in minor portions of the general mass.

Respecting the agate nodules themselves, they are described as varying much in character, colour and substance. The smaller cavities are generally quite filled, commonly with a compact chalcedonic mass, while those of large size are usually lined with agate layers of different colours, and are invariably hollow. The outer layer of the large cavities varies in thickness, lined either with interior mammillated surfaces or by quartz crystals.

The mineral contents of vesicles and cavities in igneous and other accumulations, these hollows having never had communication with cracks or fissures of the rocks in which they occur, furnish us with excellent examples of the manner in which silica and other substances in solution have permeated through the pores of rocks, even of many

exceedingly hard and compact. The hollows were thus necessarily filled with the solution at the time permeating through the rocks; and as no spring water is pure water, but on the contrary contains something in solution which it has taken up, in most cases, after the fall of the water as rain upon the land, we feel assured that there is no rock without a solution of some kind working its way through it, if it be above the level of the sea, and the water can percolate into the atmosphere. It will remain more stagnant if the rock be beneath the sea-level, the movement in the latter case being probably slight under ordinary conditions, though no doubt differences of temperature would produce the usual effects upon the moistened mass.

The replacement of the matter of fossil shells by other substances, as above noticed, is a filling up of cavities upon the same principle as the vesicle or hollow in an igneous rock by the siliceous matter constituting an agate. In agates we have frequently not only proof of the successive deposits of siliceous matter, but evidence also in the cavities of the interior hollows, such as are noticed by Mr. Hamilton, of the crystallization of silica in a more definite manner, the particles of silica having adjusted themselves under better conditions than in the chalcedonic bands forming the agate, so that rock-crystals are the result. The mammillated surfaces of the chalcedonic bands correspond with the mammillated surfaces of layers of many other minerals, being the grouping together of bundles of crystals radiating from a multitude of points on a previous surface of some kind, frequently not of the same mineral. The mammillated surface of malachite bands filling up cavities in mineral veins may be taken as a familiar example of this arrangement, and still better perhaps, as the crystals are better seen, such minerals as wavellite. Common crystallized carbonate of lime, filling large fissures of limestone, sometimes exhibits the succession of crystallized layers, with roughly-mammillated surfaces, in a very illustrative manner.

Mr. Hamilton remarks that the outer, or rather first-formed coatings of the large agates, these outer coatings sometimes too thin to be usefully employed, correspond in mineral structure with the whole contents of the minor cavities. This may perhaps be explained, if we consider that the siliceous solutions, the deposits from which entered both kinds of cavities, were abundant for a given time, after which they either entered less easily into the cavities, the first coatings of chalcedonic matter presenting a certain amount of obstacle to the free entrance of the solutions, or the solutions themselves contained less silica. In the well-known agate-form bodies found in the dolomitic limestones and conglomerates of Somersetshire and Gloucestershire, the evidence of changes in the kind of solutions which have entered the cavities in which these *potato-stones*, as they are commonly and locally termed, have been formed, is often very clear and interesting. Layers of chalcedonic matter, as in the agates of Oberstein, are usually first formed, after which the silica had better conditions for forming rock-crystals. The siliceous

infiltrations ceasing, carbonate of lime, iron in some form, or other minerals, the results of the percolation of different solutions into the cavities, became crystallized in the hollows still left.

While some agates show concentric bands of chalcedonic matter, entirely filling the cavity, the original sides of the vesicle or hollow evidently giving the form, however modified in parts, to the general arrangement of the layers, others, commonly termed onyxes, have a system of flat layers, parallel to each other, and considered to be also found parallel to the main bedding of the rocks in which they are discovered. In the one case the inside of the cells or cavities has been coated without much regard to gravity, while in the other the deposit more accords with a deposit having reference to it. In some agates we find that the cavity must have been filled in one way at one time and in another manner afterwards; sometimes the one kind, sometimes the other, having been the first formed. Again, some cavities in igneous rocks have been found partially filled with parallel layers of chalcedonic matter, with small pendent stalactites of the like substance depending from the upper part of a hollow still left.

The change of colour produced artificially in the agates by the workers in them at Oberstein, an art learnt from the Italians, and to which Mr. Hamilton calls attention in his communication, stating his belief (referring also to the labours of M. Noeggerath) that not a few of the onyxes which have come down from ancient times were thus treated, is of much interest mineralogically, since it shows the very different porosity of different layers in the agates, the least porous bands not being necessarily the nearest to the centre, but dispersed irregularly through the mass. To this porosity Mr. Hamilton calls attention, citing the researches of M. Noeggerath, who states that in some layers the minute hollows can be seen by means of a magnifying-glass; that while some are round others are long, and that they sometimes run into one another. These hollows Mr. Hamilton considers may form interstices between the radiating crystals. By immersion for some time in honey and water, or olive oil, so that the pores of the agate become more or less filled with a substance to be carbonized, a subsequent soaking of the stone in sulphuric acid produces a difference in the tints of the agate according to the porosity of the layers the most porous becoming black, while the least porous remain white or uncoloured. By immersion in a solution of sulphate of iron and a subsequent heating of the agate, a carnelian-red is in like manner obtained for the most porous layers, the iron being converted into a peroxide, while the least porous layers continue unchanged in colour. It would be out of place further to dwell upon the infiltration of mineral matter in solution into the isolated cavities of rocks. The mode in which the various minerals occur is highly interesting, as also their connection with the matter filling veins and fissures in adjoining parts of the same or adjacent rocks, as for example the filling of the fissures in the red conglomerate by the same kind of siliceous matter which entered into the cavities of the igneous rocks of Idal, the layers having in both cases adjusted themselves to the surfaces on which they were accumulated.

Such have been the labours of the Geological Society of London since the last Anniversary; they have neither been slight nor unimportant; they have extended from our own land to the antipodes, in one direction by North America, and in the other through India; they have embraced a variety of subjects, palæontology, and its application in identifying contemporaneous deposits having formed a prominent part of them. It is evident that we have not been idle or neglectful of that science for the cultivation and extension of which we are associated, and that, therefore, we have assisted to promote the progress of knowledge generally, and consequently the well-being of our fellow-men.

GEOLOGICAL SOCIETY OF IRELAND.

Our sister society in Dublin has, as heretofore, been active in promoting the advance of our science in Ireland. The earliest communication made to it during the year was by Sir Robert Kane, on the occurrence, in the county Clare, of carbonate of manganese as a thin earthy bed, interposed between a decomposed surface of old red sandstone and a bog, two feet deep. To all appearance this carbonate of manganese is of comparatively recent origin. Respecting mineral substances a valuable paper was read by Dr. Apjohn upon an undescribed variety of hyalite from Mexico, where it is found in large glossy, transparent, globular concretions. It is considered a hydrate of silica, containing about 2·5 of water, and was found by the optical researches of Dr. Apjohn to be formed of a confused aggregation of microscopically minute rock-crystals. This result will be appreciated by those acquainted with hyalite, a mineral exhibiting at first sight few traces of crystalline arrangement, and it at the same time proves the value of optical methods of research in the examination of minerals.

Another communication of interest respecting mineral substances was made by Professor Oldham. Among the many alterations in the structure of the various beds of the older fossiliferous rocks of the counties Wicklow and Wexford, caused by the protrusion through them of the granites, is one wherein the component parts of the beds have been so acted upon that crystals of andalusite are abundantly formed amid micaceous slates, themselves altered argillaceous slates. The crystals of this mineral, sometimes of large size, occur in multitudes, crossing each other in all directions. Among these Prof. Oldham discovered some which had themselves been again replaced by mica, the latter occupying the space once filled by the matter of the andalusite, and its cleavage planes usually running across the principal axis of the original crystal, though sometimes occurring in planes perpendicular to every surface of it. This movement of the particles of matter, taking place at different times, without the bedded or laminated structure of the original rock being lost, in consequence of actual fusion by contact with the adjacent molten mass of granite, is one of no small geological importance when the laminated crystalline rocks, forming whole regions in some parts of the world, are under consideration. Prof. Oldham points out that Mr. Weaver

had, many years since, remarked respecting the rocks of this part of Ireland, that "the character of this andalusite is altered by a more or less intimate mixture of mica."

Prof. Allman read a paper on erratic blocks of greenstone, found scattered over carboniferous slate, in the vicinity of Bandon, county Cork. As is well known, Ireland is in many districts covered by gravels and sands, occasionally mingled with blocks of large rocks, all of a comparatively recent geological date. If these be sea-borne, we should require the submergence of the land, and generally with its present physical features, to a depth of more than 1000 feet beneath the present level of its shores. The mode in which thousands of large blocks of granite are scattered over the flanks of mountains and over districts, facing great valleys, in the counties of Wicklow and Wexford, are often highly instructive. This 'drift,' as it is frequently termed, most materially influences the agricultural character of large districts in Ireland.

The communication of Prof. Allman was followed by another from Mr. Mallet, in which the latter endeavours to show that the transport of boulders or erratic blocks may be accounted for by the slow, or occasionally rapid movement of semi-fluid masses of mud, sand, gravel and blocks, forming the bed of the sea, (and either of sufficient depth and mass alone, or resting upon a base of rock or other materials of very moderate slope,) combined with the sorting and transporting power of the tidal streams upon the finer materials of the whole mass. Mr. Mallet considers that the mass of a loose sea-bottom may be constantly sliding outwards, forming a kind of *mud glacier*, as he terms it, the whole reduced to nearly one-third of its weight in air by immersion in water, and moving gradually over slopes of three or four degrees, and even less. In this manner he observes we may account for the grooving, furrowing and scratching so commonly remarked among these accumulations of gravels and blocks, pebbles and great fragments of rock being held firmly in the under part of the moving mass, and grating against the bottom. These scratches, now so commonly found on the surface of rocks in the northern parts of the earth, and which may be equally so in the southern, allowing for the difference of area there occupied by land, have been long pointed out by Dr. Buckland and others in the British islands, and have of late been frequently, as is well known, adduced as evidences of the former existence of glaciers upon the districts where such scratches are found. Mr. Mallet points to this view, and observes that the explanation he proposes will apply equally to the facts seen. Whatever hypothesis we may adopt in order to approach the truth in this matter, we must certainly bear in mind the scratches often so common among the pebbles themselves, as well as those upon the rocks beneath the gravel and blocks, as if there had sometimes been a grating of the harder parts of the mass upon each other, after its general deposit. This accumulation is often in distinct layers, its parts sometimes arranged in the manner observable upon beaches, while at the same time it is obvious that any rolling about of the pebbles by breaker action would speedily obliterate the scratches both on the

pebbles and the rocks beneath. While this is true in some districts, and is more particularly worthy of attention over great flats, or floors of subjacent rock, sloping in various directions at exceedingly small angles, as is to be seen over the great central plain of Ireland, at other times we find huge blocks of rock perched about upon mountain summits, with scratches beneath and adjacent to them, as if we saw the very instruments which made them. These blocks, however, occur in situations which appear to show that they have been brought across deep valleys, as if ice-borne, and when the relative level of sea and land was very different from that which it now is, though we have only to look to comparatively recent geological times for their transport.

A memoir was communicated by Prof. Oldham, bearing upon the later geological changes which have been effected upon the area occupied by the British islands, as also upon the climate of the time. He announced the discovery of the undoubted remains of the reindeer (*Cervus tarandus*), in peat, marl and clay, near Kiltiernan, in the county of Dublin, in company with numerous antlers of the Irish elk (*Megaceros*). The evidence on this head is valuable, more particularly when added to the inference of Prof. Owen, in his Report on British Fossil Mammalia, that these animals once existed in our islands, and to the statement of Dr. Mantell respecting the remains of reindeer found in the Isle of Wight. Two other Irish specimens, in bad preservation, had previously been under the notice of Mr. Ball of Dublin. The value of this undoubted occurrence of the reindeer in Ireland will be at once apparent to those who remember the views taken by Prof. Edward Forbes, and published in the Memoirs of the Geological Survey, respecting the comparatively recent separation of the British islands, by elevation of the mass and subsequent sea action, from the main continent, thus cutting off the animals and plants which emanated thence from the remains of the parent stock. And this discovery is of the more value, when we connect it with the inferences to be drawn from the mixture of the reindeer bones with those of the *Megaceros*.

Mr. Mallet stated in another memoir, that having been struck with the unusual appearance of stalagtites and stalagmites discovered in the Cave of Dunmore, county Kilkenny, he found upon examination that they contained phosphoric acid, probably in combination with lime. He referred to the researches of M. Dumas respecting the extreme solubility of phosphate of lime in water charged with carbonic acid, so that bones or ivory-shavings immersed for a few hours in Seltzer water are softened and have many of their phosphates removed, pointing out that the phosphates in this case must have been derived from the dolomitic and limestone beds surmounting and including the Cave of Dunmore. The late labours of chemists have shown us that the phosphates, so important for the growth of cereals, are far more diffused through rocks than was at one time supposed, and this discovery of phosphoric acid even in the stalagtites and stalagmites of a limestone cave, is another proof of this diffusion.

In another communication to the Geological Society of Ireland,

Mr. Mallet brought under its notice some views as to the circumstances under which the quartz rocks and slates of Wicklow have been arranged, with some remarks upon a peculiarity of lamination in the finer-grained and micaceous slates. His object was to show that the component deposits were all due to the sorting and transporting power of water in motion, the cleaner-washed sand and pebbles having formed the base of the present quartz rocks. He referred to the different conditions under which deposits were now being effected in the upper lake of Glendalough, in the county of Wicklow, as a good illustration of the sorting and arrangement of deposits at different depths. Regarding the ridges and furrows resulting from the friction of water upon loose sands, Mr. Mallet points to their occurrence in the lake beneath shallow waters, and while remarking upon the supposed accumulation of certain Silurian deposits in deep water, directs attention to the ripple-marks found so frequently among them, observing that these must either be confined to shallow waters, or to situations where streams of water moving with sufficient rapidity can produce them.

That the quartz rocks of the counties of Dublin, Wicklow and Wexford are but clean sands or quartz pebbles agglutinated by silica, which while in solution, probably often by the aid of an alkali, not unfrequently dissolved the outer edges of the siliceous sands and pebbles, appears very probable, indeed is now well understood, and the quartz rocks in the district above-mentioned afford good illustrations of this view. Respecting the 'ripple-marks,' as they have been commonly termed,—a bad name, inasmuch as they may readily be produced at any depths where a current of water can move with sufficient velocity,—we would direct the attention of observers to a study of those really made by the to-and-fro motion of waves in shallow water, or where tides drain off extensive flats, and to those really due to a constant friction of water in a given direction, in order duly to appreciate their differences in form. Such a study readily leads to a knowledge of the different arrangements of the grains of sand or silt, according to the forces acting upon them; a knowledge very material when the ridged and furrowed surfaces of various beds (and we find them among our oldest accumulations) are brought under our notice.

Considering it a duty on the part of the Geological Survey to aid the progress of the Geological Society of Ireland, Mr. Du Noyer read papers on the sections observed on the Dublin and Drogheda Railway, and Prof. Edward Forbes made a communication respecting the probable geological age and British equivalents of the Silurian rocks of the hills commonly known from one in particular,—the Chair of Kildare. Having with Prof. Oldham examined, during the last autumn, the succession of rocks there seen, and ascertained that they constituted a thick series of older accumulations, in which volcanic ashes or detrital matter derived from igneous rocks, as well as molten masses of the latter, were mingled with common sands and mud, forming its lower part, I have little doubt of the true relative position of the limestone, in which the organic remains are chiefly found. Indeed, the whole group of these hills seems little else than an old

island of palæozoic rocks of the date to which allusion has been previously made, on the shores of which conglomerates and other rocks of the old red sandstone were accumulated. These again were covered up by the beds of the great carboniferous limestone, one of the most marked accumulations of the British series, especially for the evidence it affords of general similar conditions having existed over a large area at the same period, the modifications of these conditions being very gradual, though at the same time very marked, in different parts of that area.

It is probable that, like the Mendip Hills at a subsequent geological period, this island-land became covered up, as it was depressed beneath the sea, by the accumulations of the old red sandstone and the carboniferous limestone;—these accumulations again to be in a great measure removed by those extensive denudations which we have abundant evidence to show took place over this region.

Reposing on the part of the series in which the igneous rocks occur, and beneath a thick accumulation, chiefly arenaceous, the beds of limestone are found in which the fossils noticed by Prof. E. Forbes were discovered. Many of the fossils from the Chair of Kildare had previously been obtained by members of the Geological Society of Ireland, and are to be found in the collections of Mr. Griffith, where they have been described by Mr. M'Coy. Availing himself of all the sources of information presented, Prof. E. Forbes, taking zoological evidence for his guide, considers that these limestones of the Chair of Kildare are not only referable to the Lower Silurian series, but members of the lowest part of it, and equivalent to the Bala limestones and their associated beds in North Wales. A comparison of the fossils from the Chair of Kildare with those obtained from the limestone of Courtown, county Wexford, leads Prof. E. Forbes to regard it as highly probable that the limestones are equivalents, and that both are representatives in Ireland of the Bala limestones, a point of much importance as regards the accumulations during the same time in the British area.

GEOLOGICAL SOCIETIES OF CORNWALL, MANCHESTER, AND THE WEST RIDING OF YORKSHIRE.

Societies formed for the purpose of advancing our science are not confined even in this country to London and Dublin. For thirty-four years the ROYAL GEOLOGICAL SOCIETY OF CORNWALL, instituted for "the discovery of facts to enrich science and the application of science to improve art," has endeavoured to promote the knowledge of Geology in the great mining districts of Cornwall. To induce agents and others connected with mines to join the Society in its pursuits, practical miners have been admitted during the past year to nearly all the privileges of the other members, at one-fourth of the annual contribution of the latter. The seventh volume of the Transactions of this Society is now in progress, and among the papers made public through these Transactions, many are well known to us as possessing great value, and as having aided the progress of Geology

generally. The fifth volume is almost exclusively occupied by an elaborate account of the mineral veins of Cornwall, by Mr. Henwood; and other valuable notices of Cornish and Devonian lodes are scattered through the other volumes. Sir Charles Lemon, the zealous President of this Society, finding that there was a hesitation on the part of many practical men to communicate their observations in writing to the Geological Society of Cornwall, (and those who are acquainted with the Cornish miner know full well the value of his observations,) has during the last year, and at his own cost, engaged the services of Mr. Rundell, the secretary of that highly useful body the Polytechnic Society of Cornwall, to obtain information from the miners and communicate it to the Society. The experiment has been attended with success, and the result has been some interesting details, read before the Society, respecting certain peculiar circumstances in Gwinear Consols and Wheal Seaton mines. It is to be hoped that the experiment thus tried and found to be successful may be followed up by the friends of the progress of knowledge in Cornwall, and of the practical Cornish miner.

Though read in 1846, it is desirable, being now only published, to notice the communication to this Society by Mr. Pattison, on the geology of the Tintagel district, one of considerable interest, from containing the junction of the carboniferous series of Northern Cornwall and Central Devon with the range of rocks which come up westward from the Petherwin district, wherein so many interesting organic remains have been detected, and not a few by Mr. Pattison himself. In a carefully considered paper the author details the order of succession of the rocks, the admixture of igneous products with them, and the organic remains detected, remarking respecting the latter, on the absence of Trilobites and the rarity of Cephalopods which distinguish the Tintagel beds from those found near Petherwin, and the entire absence of the remains of fish, such as are found in South Cornwall.

We find Mr. Peach occupying himself as actively as ever with organic remains entombed in the Cornish rocks, accumulations which not many years since were supposed to be entirely non-fossiliferous. His communication to the Cornish Society was this year on the fossil geology of Lantivet and Lantioc Bays, near Fowey. It will be in your recollection, that last year, being then in Cornwall, Sir Roderick Murchison read a paper before the Geological Society of Cornwall respecting the probability of the occurrence of Silurian rocks in that part of England. His opinion was chiefly founded on the researches of Mr. Peach, who had obtained many organic forms, usually considered referable to that geological period. Mr. Peach in this communication enters into further detail on the subject, expressing his satisfaction that his views had been confirmed. The subject is one of much interest, particularly when we regard the physical structure of the part of Cornwall noticed, and trace the run of its beds. It is more particularly so when we examine the district generally with reference to its connection and relative position as regards the Plymouth limestone and the run of the rocks towards Torbay and

Totness; in fact, into districts the organic remains of which have engaged so much attention under the name of Devonian fossils.

There has also been a paper by Mr. Richard Couch, entitled 'Remarks on the Present State of Geology in Cornwall,' in which, while taking a general view of the actual knowledge respecting the geological structure of that county, he remarks, speaking of the general range of rocks, that after passing the Looe river westward, the Devonian fossils become more rare, that the organic remains assume more of a Silurian character, and that the peninsula formed by the Looe and Fowey rivers is composed of rocks partaking of the characters of the Devonian and Silurian series. Further westward, Mr. Couch observes, the characters of the fossils change: "there are many things to remind us of the old red sandstone, and yet sufficient to recall the idea of their being the deposits of the Upper Silurian rocks." It can be only by a careful study of all the great bends of the sedimentary rocks of Cornwall, with a constant attention to the minor flexures, and by an endeavour to trace out either overlaps or the fining off of beds, amid the contortions, that the true history of these deposits will appear.

Sir Charles Lemon, in a notice on the stump of an old tree, found in Heligan, pointed out many peculiar circumstances attending its mode of occurrence. He infers that the phenomena may be accounted for by an extensive change in the face of the country, due to local causes, since the time of the great drift, and after the growth of existing species of trees. There was also a notice by Mr. Edmonds on the rapid diminution of the sand-banks of Mount's Bay. Details are given of the loss of land sustained, and the removal of sand has been so considerable, that not only a meadow has been carried away, which seventy years since lay outside the sea-wall at the entrance to Newlyn, as well as ground occupied formerly by cottages and gardens near Penzance, but numerous rocks between high- and low-water mark, forty years since buried beneath four or five feet of sand, are now uncovered. The author attributes this loss to the quantity of sand removed as ballast for the shipping at Penzance, and employed as manure.

During the past year also, Mr. Percival Norton Johnson read a paper to the Society upon the electric action affecting metalliferous deposits. He has availed himself of every opportunity in endeavouring to establish, by observation and experiment, the effects of various rocks acting as positive and negative poles for the deposit of metalliferous substances. He infers that the existence of such deposits depends not only on the difference of the rocks, but also that the electric action must be kept up by the moisture percolating through the joints or cleavage of the rock in which they are found. From his experience he concludes that a bunch of ore or metalliferous deposit is never seen without proving its origin to have been the percolation of water through the joints or cleavage of the adjacent rock, with a difference of character in the contiguous rocks. The researches of Mr. Wre Fox and others on the electric condition of mineral veins, and on the manner in which the ores of the metals have been ac-

accumulated in them, are well-known to this Society, not only as having a scientific but a practical bearing. All investigations of this kind, therefore, which can be carried out by competent persons in the mining districts of Devon and Cornwall, will necessarily be important, and it is to be hoped that the Transactions of the Geological Society of Cornwall may be enriched by many communications on this subject.

Mr. Henwood sent a note on the detrital gold deposits of Brazil, in which the author points out the differences between the characters of the 'diluvial and alluvial' gold of that country, comparing the former with the stream tin of Cornwall. Respecting the last a communication was made by Mr. Pearce.

The MANCHESTER GEOLOGICAL SOCIETY has existed for ten years. One of the chief purposes of its foundation was "to inquire into the statistics and machinery of mining, and to collect books, maps, models, sections and mining records, to be registered and preserved in a public depositary for the use of posterity, and to direct them where their researches may be most successfully and securely carried on." This object of the Manchester Geological Society has not been attained; and though every encouragement has been given to papers connected with the district, the proceedings of the Society have tended more to advance a general knowledge of geology as a science, than to elucidate the geological features of the district. The museum of the Society has rapidly augmented, and it is stated that the visitors to it have increased in 1846 and 1847, as compared with 1845, at the rate of 60 and 80 per cent. respectively. The communications made to this Society during the year ending the 28th October, 1847, were—'On some Main Lines of Fault traversing Cheshire,' by Mr. Ormerod; 'On Modern Geology and its Fallacies,' by Dr. Sleight; 'Observations on the Primæval Condition of Matter composing the Crust of the Globe,' by Mr. Jobert; 'An Eclectic View of the Coal Formation,' by Dr. Black; 'An Account of the Coal-fields of Derbyshire and Yorkshire,' by Mr. Elias Hall; and 'On the Coal of the River Coti, east coast of Borneo,' by Mr. Bellot.

The GEOLOGICAL SOCIETY OF THE WEST RIDING OF YORKSHIRE still continues; and a paper on a new Safety Lamp, by the secretary, Mr. Thorp, has lately been read before it. It has published several communications, among the rest one by Mr. Thorp on the Yorkshire coal-field, and another by Professor John Phillips, on the 'Microscopic Texture of Rocks.'

PALÆONTOGRAPHICAL SOCIETY.

To the list of Societies instituted in this country for the cultivation and diffusion of geological knowledge, we have to add the PALÆONTOGRAPHICAL SOCIETY, formed during the past year, upon the principle of the Ray, the Hakluyt and other societies of that class, the members of which receive publications for their annual subscriptions in greater or less amount according to the total number of members, and consequently according to the amount of the

general fund collected. Though these societies have become popular of late, perhaps there is as yet no instance in which a society of a similar kind has numbered so many members in so short a time, showing that no little general interest is entertained for the palæontological works to be published by it. Though only founded on the 23rd of March, 1847, four hundred members had been enrolled in June of the same year, and the Palæontographical Society now numbers six hundred and one subscriptions to it. In consequence of this support two works will be distributed this year to the members, one a Monograph, by Mr. Searles Wood, of the Univalves in the Tertiary Deposit named the Crag, illustrated by about 550 figures, and another by Professor Bell, on the Reptilia of the London Clay, also properly illustrated. It is but justice to our colleague Mr. Bowerbank to state, that the formation of the Palæontographical Society is due to him, and that to his continued zeal and untiring activity it is indebted for its present prosperous condition.

GEOLOGICAL SURVEY OF THE UNITED KINGDOM.

Being charged by Her Majesty's Government with the general direction of this branch of the public service, I should feel some hesitation in alluding to the aid which, by its progress, the Geological Survey was affording to the advance of our science in this country, if it were not abundantly evident that the members of this Society cheerfully co-operate with the Survey, and consider that by this branch of the public service objects are accomplished which could not be otherwise attained; so that the purposes for which we are here associated are promoted by the labours of the Survey. The progress of the Survey has during the past year been considerable, and maps will soon be published completing South Wales, and extending into North Wales. The map of Herefordshire will be finished, and a large part of that of Shropshire published. Somersetshire will be completed, with adjoining portions of Dorsetshire and Wiltshire. The knowledge necessary for the maps of North Wales and of Derbyshire is considerably advanced, and these will follow the above-mentioned.

With respect to the Irish branch of the Survey, a map of the county of Wicklow, with numerous sections, including those, with proper plans, of the more interesting mines, will speedily be published. The sections extend to the counties of Carlow and Kilkenny, and illustrate the mode of occurrence of some of the coal-fields in the latter county. It is hoped that geologists will be satisfied with the manner in which sections on a true scale,—that is, the scale for height and distance the same,—illustrate the mode in which granite has upborne masses of the older deposits among which it has been protruded, altering the latter, and sometimes entangling or enveloping huge fragments of them. The publication of the maps of Carlow and Wexford will follow that of Wicklow.

MUSEUM OF PRACTICAL GEOLOGY, LONDON.

This establishment, which, but for the reasons before assigned for the Survey, I should have had some hesitation in naming, has also, by the fostering care of Government on the one side, and by the kind co-operation and support of the public on the other, considerably advanced during the past year. Thanks to the donations so frequently and liberally bestowed, its collections became so greatly increased that the Government is now erecting the considerable building which the members of this Society may have observed extending from Piccadilly to Jermyn Street, where these collections, illustrating both the science and applications of geology, can be made properly accessible to the public. There is much satisfaction in adding, that even to the limited portion of the museum which can now be exhibited, the number of persons admitted during the past year far exceeded that of the year previous, the admissions being daily and as a matter of course gratuitous. Among the various subjects investigated at the Museum of Practical Geology during 1847 for the public or the Government, perhaps one for the Admiralty may be specially mentioned to this Society, inasmuch as it relates to the British coals best suited to our Steam Navy. A first report on this subject, one so important in many respects, will be presented to Parliament in a few days.

It may be right to notice that a second volume of the Memoirs of the Geological Survey of Great Britain and of the Museum of Practical Geology in London will be speedily published, and that it was even once hoped to have placed a copy of it on your table this day.

BRITISH WORKS ON GEOLOGY.

Our last Anniversary closely followed upon the publication of a sixth edition of Mr. Lyell's 'Principles of Geology,' so extensive and long-continued has been the public demand for this work, now, though including the needful additions which the progress of our science demands, comprised within a single volume. Our present Anniversary closely succeeds to the publication of a sixth edition of Dr. Mantell's 'Wonders of Geology,' a work which its author has contrived in a great measure to rewrite during the intervals of arduous professional engagements, and also, amid the same avocations, to accomplish the publication, during the past year, of his work on the Isle of Wight. To this we would refer for a very valuable account of the geology of that island, founded as well upon long-continued personal observation, as upon the labours of his predecessors and contemporaries. When a general work on geology attains a sixth edition, it is manifest that the public have marked their view of its merits; at the same time it cannot but be gratifying to the Fellows of this Society to see that the desire to acquire a knowledge of the science they cultivate is now no longer restricted to a few, but has become so extended, as to require the publication of repeated editions of works written to convey the information desired.

During the past year also we have to record the appearance of a new work by Prof. Ansted, entitled 'The Ancient World,' in which the author chiefly occupies himself with views founded on the organic remains discovered in rocks of different ages; these views communicated in a simple form, and more especially intended for the use of the general reader.

To our colleague, the Professor of Chemistry at Oxford, Dr. Daubeny, we are indebted for a second edition of his 'Description of Active and Extinct Volcanos, of Earthquakes and of Thermal Springs,' published a few weeks since. When we consider how important a correct knowledge of volcanic action now is, even when we study the detrital deposits of the oldest accumulations, facts observed giving rise to the inference that even in such early geological times, ashes and lapilli were showered into the atmosphere and falling into the water became mingled with mud or other deposits effected round the dry land and in the seas of the period, this work, wherein the whole subject is brought up to the knowledge of the day, by one so competent, cannot fail to be most acceptable to geologists. The work is so much altered that there is scarcely a chapter which remains as in the former edition. A new classification of felspathic rocks is given, founded upon the analytical researches of Abich, Gmelin, Rose and others. There is a sketch of the Lago di Lugano, with a new theory of dolomitization. We have descriptions of the thermal waters of San Filippo, of the Lagunes of Volterra, and of the Alban Hills, near Rome. The observations on Rocca Monfina are new, and chiefly from his own investigations, as also those on Mount Vultur and the Lago di Ansanto. Additions are made to the notice of Vesuvius, the result of two visits to that volcano, subsequently to the publication of the first edition. His former theory respecting the Dead Sea is much modified, and a far more complete account of the volcanos of the American continent is given. Two entirely new chapters are dedicated to a sketch of the phenomena of earthquakes, compiled from various sources, and the like number to an account of those of thermal springs, to an extended tabular view of their physical and chemical phenomena, and to statements, chiefly his own, considered to afford proofs of their volcanic origin. A much fuller account of the chemical theory of volcanos, as suggested by Davy and developed by himself, is given than is elsewhere to be found, and additional information in support of that view is brought forward. New proofs of the truth of the chemical theory are considered to be derived from Grove's researches respecting the repulsive force of heat annulling strong chemical attraction, from his own observations on the gases of volcanos and of thermal springs, from Pilla's notices of flames issuing from craters, and from the gradually increasing proportion of *bases* found in volcanic as compared with granitic rocks. Respecting the great heat which in the opinion of many of us produced the condition of the matter composing the earth that enabled it to take the form it now possesses, and which, diminishing by radiation into the surrounding planetary place, finally left a solid crust to be abraded

by waters when they could form and act upon the hard rocks, partially reducing them, with the assistance of atmospheric influences, to sedimentary accumulations, these entombing the remains of life, when such was called into existence, Dr. Daubeny willingly admits that the researches of Mr. Grove show that, given sufficient heat, the constituents of our globe might have been mutually diffused, "and though thus intermixed, would have continued in a state of perfect chemical indifference one to the other." "Now," he adds, "if under these circumstances we suppose the temperature to have sunk down to that point at which the elective attraction of certain of the elements for each other prevailed over the repulsive force of heat, we have a right to infer the occurrence of those very phenomena and the formation of those very products, which the one theory (the chemical) assumes to be going on at the present day, wherever volcanos exist. There is therefore," he continues, "no antecedent absurdity in imagining that volcanic action may consist in a process of oxygenation, caused, in part at least, by the presence of these substances, and all that seems necessary is to ascertain how far the known phenomena accord with such an hypothesis." We would refer to the chapter on the chemical theory of volcanos for an able exposition of that theory, one which Dr. Daubeny continues to advocate as affording the better explanation of the facts observed.

VOYAGES OF DISCOVERY AND SURVEY.

The publication during the past year of three voyages of our countrymen has added to our knowledge of the geological structure of the earth's surface in distant places. The voyage of Sir James Ross to the Antarctic regions has proved, not only the great extent of a mass of land in the South Polar regions, but also that volcanic forces are still in full activity there. A mountain estimated to rise 12,000 feet above the sea, and named Mount Erebus, is described as throwing out jets of dense smoke to the height of 1500 and 2000 feet, the diameter of the jets being estimated at 200 to 300 feet. Even streams of lava were thought by some persons to be ejected. Not far from Mount Erebus another mountain, named Mount Terror, exhibited a form leading to the inference that it was an extinct volcano, and crater-like hillocks were observable on its sides.

An icy barrier for the most part prevented access to the land, but wherever a landing was effected igneous rocks alone were found, and all the fragments or pebbles obtained from icebergs, and by soundings, were of the same character, granitic rocks being discovered among them.

It is not a little interesting to consider the different conditions under which rocks would be placed in a region like that of Victoria Land, and in those parts of the world where snow never falls and frost is not felt, as also in those exposed alternately to the cold of winter and the heats of summer. On the Antarctic land no great river appears to bear detritus into the sea, and decomposition from the action of many atmospheric influences, such as aid the disintegration of rocks in tem-

perate and tropical regions, can be little felt. As far as was seen by our navigators a great mantle of snow covers all, with the exception of some bare spots, probably either too precipitous to be thus enveloped, except by sufficient accumulation around them, or still too warm, after flowing as lava currents, to permit a covering of snow.

Though we can look to little else, for the wearing away of the land, than the action of the breakers upon the portions of the coast, which may for a time be free from ice, with such aid as any marked difference of temperature during a very short period in the summer of these regions can give, by detaching pieces of rock from the cliffs, yet the volcanos may throw mineral matter into the sea, to be distributed by tidal streams or oceanic currents. There is no reason to suppose that lofty volcanos, like Mount Erebus, do not occasionally eject ashes and cinders in the manner of numerous other great volcanic vents, scattering the finer ash around, much of it borne by the winds to great distances. The form itself of the mountain points to the ejection of such substances, its conical shape being the result of their accumulation immediately around the chief vent.

By consulting the notices of soundings obtained by Sir James Ross off this land, we find a green mud frequently mentioned. For about 450 miles this green muddy bottom seems common from Victoria Land along the great icy barrier. The same kind of bottom extends beyond it, and some detached portions of the icy barrier are mentioned as aground upon it in 1560 feet of water, 60 miles from the edge of the barrier and 200 miles from the land. When we consider that the fine detritus so commonly borne down by great rivers in the temperate and tropical regions cannot be so transported here, the presence of this green mud over so considerable a submarine area may possibly be in some measure due to the ejection of fine volcanic ashes during a long period of time, these ashes mingling with such fine detritus as can be ground off the coast by the breakers, or carried outwards by icebergs.

Glaciers are mentioned as descending from a range of mountains (the Admiralty Range) varying from 7000 to 10,000 feet in height, and projecting in many places several miles into the sea. As bare rocks were seen in a few localities, such glaciers may be the means of transporting masses of rock to the sea, a portion of them to be afterwards borne by ice into more temperate climates, supposing the glaciers to have a movement outwards, however modified this movement may be by the climate of Victoria Land.

Although the great icy barrier of these desolate regions extends far out beyond the land, and beyond where it can be aground, some portions rest on the bottom. Icebergs which have so rested upon the ground seem often to be turned bottom upwards, the previously lower portions bearing to the surface mud, sand and stones, some of which may thus become transported considerable distances; more particularly should the icebergs not again capsize, since the mud, sand and stones would be borne on the higher parts of the icebergs. Sir James Ross mentions one remarkable instance of the appearance of the mud and stone-covered bottom of an iceberg, which capsized

off Victoria Land so suddenly that it was for the moment supposed to be an island not before observed.

The amount of mineral matter borne away from this region by ice during the lapse of centuries, must tend to cover the bottom of the southern ocean not only with fragments of large size, but also with the finest mud, and this over extensive areas where no other means are apparent, under existing conditions, for the distribution and accumulation of such detritus. An iceberg was noticed in latitude 66° S. nearly covered by mud and stones. One large block of volcanic rock was estimated to weigh many tons. We may expect that not only angular but rounded blocks would sometimes be thus transported, for the beaches upon which the surf breaks in summer would be frozen in winter, and worn masses might occasionally be caught up in the ice, removing away from the shore, and be carried within the power of some iceberg to pick them up, and by capsizing bring them to the surface and transport them. Occasionally also we may anticipate that a part of the barrier itself, previously attached to, and partly covering a beach, formed before the ice adhered to that part of the land, may from local causes break away and be carried northwards. In all cases the mineral matter borne away by the icebergs would cover all inequalities in the bottom of the ocean which it may fall upon, and thus the resulting accumulation may be a mixture of large and small fragments, angular and rounded (some perhaps scratched), mingled with mud and sand, the whole arranged in the most irregular manner, large masses of rock strewn over and scattered through clay.

With respect to the turning up of blocks of large size by the capsizing of the icebergs off these southern lands, Captain Wilkes, of the United States' Exploring Expedition, which descended into the Antarctic regions in 1840, considers that he landed upon an up-turned iceberg, part of the icy barrier, weathered by storms, about eight miles distant from the main land, in latitude $65^{\circ} 59' 40''$ S. On this he found boulders, gravel, sand and mud or clay, the larger specimens being described as of red sandstone and basalt. There was also a kind of icy conglomerate, the matter cementing the stones being formed of hard compact ice. One piece of rock imbedded in it was estimated at about five or six feet in diameter. The same navigator also mentions many icebergs discoloured by earth. Indeed the evidence of the frequent overturn in these regions of icebergs which had been aground, bearing the mud, gravel and fragments of rock on the bottom upwards, appears complete, and is very important as regards the distribution of detritus by means of icebergs.

As not without its geological bearing we may here glance at the formation of the barrier itself. All the drawings made and information received point to its accumulation in layers, in at least that part of it projecting beyond the land into the ocean. The portion above water is generally described as from 150 or 180 to 200 or 210 feet. Captain Wilkes refers the formation of the ice in the first place to ordinary field ice, upon which layers accumulate, varying from 6 inches to 4 feet in thickness, from rain, snow and even fog, so that

the mass descending by the increasing weight, part takes the ground, and the other portions run out to sea over deeper water.

The layers are proofs of successive accumulations, and as they vary in their texture, they would point to modifications in the conditions of the deposit at different times. We may assume that similar accumulations are effected on the land, disturbed only by volcanic outbursts and the showering of ashes and lapilli from volcanic vents, for the time in a sufficient state of activity, such showers extending as well over any portions of the icy barrier within reach, as over the snows of the land. The uniform, or nearly uniform height of the barrier, when covering various depths of water, and not aground, would apparently indicate some counteracting cause, preventing such an accumulation of layers of ice, as by giving a total increased thickness should enable a greater height to rise above water in the deeper situations. It is here assumed that the thickness of the barrier is not increasing, and remains generally the same, a fact which may perhaps be thought not as yet sufficiently proved. Nevertheless, when we consider that the sea-water beneath the icy barrier is not exposed to that great depression of temperature, to which when directly in contact with the atmosphere, it is subject, and that beneath the lower part of the barrier, deep as that lower part is, it would be only water of greater specific gravity than that above, which could there find its way, the experiments of Sir James Ross lead us to suppose that after a certain depth the ice would cease, the temperature being too high for its continuance. Upon this hypothesis the general thickness of the barrier would be the same as long as there was a sufficient depth of water to secure the needful temperature, the accumulation of snow and ice above being met by the melting of the ice beneath.

We should expect the rise and fall of the tide to act upon the barrier, tending to break off portions at its outer edge, where, if the lower part plunge into water of sufficiently high temperature, a melting beneath would assist in detaching fragments. The needful support by the proper amount of submersion being thus to a certain extent withdrawn, the masses would strive to rend themselves off and adjust themselves in the water relatively to the floatation line now become proper to them. It is evident by the upsetting of the icebergs, so often observed, that their centres of gravity become changed, so that the masses take a new floating position relatively to them. In regions where the cold of the atmosphere is so great that little general change is produced upon the upper part of the icebergs compared with that which is experienced beneath by plunging into water above the freezing point, we should expect such changes in position frequently to happen, any load of mud or stones of the remaining portion beneath being comparatively of little importance.

Great tabular masses varying in size, some even several cubic miles in volume, float away from the parent barrier, the tidal streams and ocean currents sweeping them onwards. And it should be borne in mind that the solid barrier presents a submarine cliff of ice, by the side of which a large volume of water would readily pass without the

interruptions usually produced by land. According to the seasons so must the icebergs float, little altered in general form, to different distances from the barriers, many of them capsized with their load of mud, sand, gravel and blocks uppermost. A large tabular mass of ice about three-quarters of a mile in circumference was seen floating, 130 feet above the water, in about latitude $58^{\circ} 36'$ S. As the icebergs passed into regions where the decay, in the atmosphere, of the higher portions of them became more considerable than of those beneath, they would cease to upset, and would carry their loads of mud and stones uppermost or below, according as they may have been upset more than once by remaining a sufficient time within the needful conditions.

Whenever opportunities occurred, Sir James Ross was indefatigable in trying for soundings and the temperature of the sea at different depths. The results are highly valuable. He was enabled to ascertain that a belt of sea of uniform temperature, from its surface to the greatest depths, extends round the southern regions in a mean latitude of about $56^{\circ} 26'$. Though this may be the mean, it was found to vary in position from $58^{\circ} 36'$ in longitude $104^{\circ} 40'$ W. to $54^{\circ} 41'$ in longitude $55^{\circ} 12'$ W., being a difference $3^{\circ} 55'$ of latitude. Such variations are to be expected from local causes, and even in the same locality from modifications due to great changes of seasons. Sir James Ross points out that this belt forms a barrier between two great thermic basins, the temperature of $39^{\circ} \cdot 5$ (that of the most dense sea-water according to the observations made during this voyage) descending on the north of it to the depth of 3600 feet in latitude 45° S., and in the tropical and equatorial regions to that of 7200 feet, the surface temperature being 78° , while in latitude 70° S. the line of uniform temperature descends to 4500 feet, the surface temperature being 30° .

When we compare the distances with the depths of uniform temperature here noticed, and assume, for the sake of easy illustration, a level plain from the equator to latitude 70° S., we find that from the surface belt of $39^{\circ} \cdot 5$, the inclination of this line of temperature would be to the equator on the one side about 1 in 1723, and to latitude 70° about 1 in 1136 on the other. Thus the slopes would be most gradual, and the depressions on the north and south so slight compared with the distances that a tolerably long section would show these two thermic basins as slight depressions, and in a section less long as scarcely distinguishable from a thick line.

With such a section before us we experience little surprise that the tendency to occupy the same relative level, from the greatest density, should be greatly modified by the atmospheric influences on the surface of the ocean.

These observations respecting a belt of uniform temperature in the ocean in the southern hemisphere would lead us to anticipate that, similar causes being in action in the northern hemisphere, similar results would be found there, though no doubt modified by the prevalence of land in the north as compared with the south. The temperature of $39^{\circ} \cdot 5$, obtained by Sir James Ross for the apparent

greatest density of water in the ocean, is not that which experiments in the cabinet would have led us to expect. Dr. Marcet found that sea-water decreased in volume until it reached 22° , when it expanded a little, and continued to do so down to a temperature of between 19° and 18° , when it expanded suddenly and became ice with a temperature of 28° . According to M. Erman, salt water of the specific gravity of 1.027 diminishes in volume down to 25° Fahr., not reaching its maximum density until congelation. The temperature of the most dense sea-water observed so constantly by Sir James Ross, is about that which numerous experiments show as that of the greatest density of fresh water. Dr. Hope and Professor Moll found the latter to be between $39^{\circ}.5$ and 40° Fahr., and Professor Hållström states it to be $39^{\circ}.394$ Fahr. The observations of Sir James Ross would show that the temperature of the ocean-waters, which may be considered to vary in specific gravity from about 1.027 to 1.028, is the same with fresh water, and the mass of evidence he adduces, supposing no instrumental errors, would prove that the temperature of $39^{\circ}.5$ is that of the most dense water of the sea, and if not corresponding with experiments in the cabinet, shows either that there is some modifying cause beneath the waters of the ocean, producing a higher temperature than should otherwise be, or that there were sources of error in the cabinet experiments not observed.

It did not escape the Commander of this voyage, that the uniform temperature of so much of the ocean might be favourable for the passage of marine animals from northern to southern regions, if the animals were such as to disregard the pressure of water under the equator and in the tropics. He observes that arctic marine creatures might pass to antarctic regions with only a difference in temperature of 5° , and a pressure of 2000 feet of water in the tropics.

In the region of Victoria Land we see a striking example of the extension of marine life, and of aquatic mammalia and birds dependent upon it, beyond terrestrial vegetable life and the animals consuming it. To this, no doubt, the equal temperature of the mass of waters beneath certain depths gives great aid, and as a whole these temperatures are less variable in the sea, and fall less low than in the atmosphere, the covering of ice protecting the waters from the intensity of cold to which they would be otherwise subject.

Live corals were taken up from the depth of 1620 and 1800 feet off Victoria Land, and from the same situations *Chitons* and other molluscs, with *Serpulæ* adhering to stones and shells, were obtained*. Looking at the temperature of the sea obtained off Victoria Land by Sir James Ross, and the probable changes effected during the winter months, due allowance being made for an ice-covering, these animals would appear exposed to very moderate changes of temperature.

* These corals were examined by Mr. Charles Stokes, who found them to consist of three species of *Leprælia*, *Retepora cellulosa*, *Hornera frondiculata* (Lamouroux), *Primnoa Rossii*, *Melitæa Australis*, and *Madrepora fissurata*. He remarks that *Primnoa lepadifera* is found in from 150 to 300 fathoms, off the coast of Norway, and Prof. Forbes is given as authority for a species of *Primnoa* in 278 fathoms off Staten Land.

The marine creatures mentioned as obtained from the depth of 6000 feet were within the range of uniform temperature ($39^{\circ}5$), and therefore would not be exposed to any change in that respect.

The existence of live corals and molluscs at these depths in the cold regions of the globe, beyond the range where life based on the consumption of terrestrial plants is found, has a geological bearing of much value, since we might infer that no part of the sea-bottom, viewing the subject as a whole, is deprived of animal life. It might as well extend to the south pole as to the latitude of the seas visited off Victoria Land, if the depths be not so considerable as to interfere with its existence by a pressure too great, or by an absence of vegetable food upon which the marine life is based.

While corals abstract carbonate of lime from the sources around, and add, after death, to the sea-bottom by the accumulation of their harder and calcareous parts, a multitude of infusoria obtain and accumulate silica in the same manner. They not only appear to swarm in the muddy bottoms off Victoria Land, but were also seen in such numbers on the pack ice itself as to stain it of a yellowish tint. Thus in these remote and desolate regions, as regards terrestrial vegetation and the animal life feeding upon it, where the ordinary decomposing and degrading effects of atmospheric influences are checked, and to a certain extent unfelt, no running waters conveying detritus or saline solutions to the sea, we find marine animal life busy in obtaining and leaving solid carbonate of lime and silica. So that the forms given to these substances mingling with the inorganic matter otherwise accumulating, here, as elsewhere in the temperate and tropical regions, records are preserved of the life now existing on the face of the globe.

Among the islands visited during this voyage, a stay was made at Kerguelen's Land, sufficiently long to permit a slight insight into its geological structure. Though, like so many of the ocean islands, it presents us with igneous products, we here find detrital matter mingled with them, with coal also and fossil wood. Mr. M'Cormick describes basalt, columnar and horizontal, amygdaloidal rocks, greenstones and porphyries, as also slates termed arenaceous, with veins of basalt and hornstone traversing the igneous rocks. We seem to have the latter so mingled with detrital matter as to show that the mass of the island may have been elevated since the accumulations were effected, volcanic ashes having assisted in forming with the ordinary detritus from greenstones, porphyries or other igneous rocks, the sedimentary deposits pointed out. However this may be, we have coal and fossil wood in a locality where now the most scanty vegetation is alone found, leading Dr. Hooker, who accompanied the expedition, to remark, that the conditions for the growth of plants must have been far more favourable than at present prior to the entombment of the vegetation forming the coal and the fossil trees (one of which, dug out at Christmas Harbour, was seven feet in circumference). The coal of the same harbour was in a horizontal bed, four feet thick, requiring no small

amount of vegetable matter to form it, and another coal bed was found in Cumberland Bay. Fossil wood is also noticed as scattered through the igneous rocks. How far some of these rocks may be consolidated ashes does not appear, but it might well happen, that not only lava-currents may have flowed over a mass of vegetation, perhaps sometimes a thick peat-bog, but also that a body of ashes may have been vomited over them from a neighbouring crater. Whether enveloped by ashes, subsequently consolidated, or by molten rock, the conditions for silicification of some of the wood remind us of those in Tasmania. The prevalence of the remains of a vegetation now no longer found is a fact of much geological interest, for we can scarcely doubt, from their mode of occurrence, that the plants entombed grew on the spot. Here, therefore, upon a small point of land, projecting through the waters of the southern ocean, far remote from continents (that of Victoria Land being probably the nearest), we have evidence of changed conditions regarding the growth of plants. The mere chance of such an investigation as could be given affords the remains of a tree seven feet in circumference, in a region where small plants only can at present grow, and we are left to infer that when such trees flourished a milder climate reigned over this land, now so desolate.

Mr. Beete Jukes has, in his account of the voyage of the 'Fly' to Torres' Straits and Australia, furnished us with much valuable information respecting that coral accumulation known as the Great Barrier Reef, which extends for about 1000 miles in length, with about 30 in mean breadth, from Breaksea Spit, off the eastern coast of Australia, in lat. $24^{\circ} 30' S.$, to Bristow Island, off the coast of New Guinea, in lat. $9^{\circ} 15' S.$ During the needful examinations by Captain Blackwood, in command of the surveying expedition, Mr. Beete Jukes lost no opportunity of studying this interesting mass of matter, due to the power of myriads of polyps to obtain from the sea and secrete carbonate of lime. He divides the accumulation into, 1st, linear reefs, forming the outer edge or actual barrier; 2nd, detached reefs, outside the main barrier; and 3rd, inner reefs between the shore and the barrier. The linear reefs vary from half a mile to 15 miles in length; the detached reefs take more or less the circular or oval form, with lagoons inside, to which Mr. Darwin has assigned the name of *atolls*, and the outlines of the inner reefs are noticed as of different shapes. On the outer side of this great mass of coral accumulations, or of matter derived from them, the sea suddenly becomes deep, while on the inside it is comparatively shallow. The edges gradually slope, or are rounded to the depth of 12 or 24 feet, after which they plunge with equal slopes suddenly into 120 to 1200 feet, as the case may be. On the weather, or more exposed side of the reef, great blocks of coral, six to nine feet across, are detached by the force of the breakers from the main mass, and the surface of the reef is described as having the appearance of a great flat of sandstone. Loose slabs lie about, with here and there an accumulation of dead coral branches, or banks of white sand, and the whole is checkered

with holes and hollows, in which living corals are growing. Coarse sand occurs inside the barrier and near the reefs, while finer matter is found more towards the main-land.

We have here upon a great scale, occupying an area which may be roughly estimated at 30,000 square miles, that variable mixture of organic, mechanical, and chemical accumulations which has been so often remarked among coral reefs and islands, and of which Mr. Darwin has given so valuable a summary, illustrated with such important original reasoning, in his work on Coral Islands. Although it would be out of place here to enter into the interesting details afforded by Mr. Beete Jukes, it is important to notice that he found corals able to sustain life when left by the tide several inches out of the sea. He observed living *Astrææ*, the tops of which were 18 inches above water, and he believes that an exposure to the sun and air for two or three hours will not kill many coral polyps, the cells retaining moisture so long as they are in a position of growth.

When we consider the accumulations of the great barrier reef as a mass of matter obtained by animal life for its uses, having formed the hard parts needful to it, (including the shells of molluscs, the spines and coatings of echinoderms and the like,) before it became sand, and furnished the materials for chalky and calcareous mud, or crystallized out in fitting situations and under the proper conditions, we are forcibly struck with the means by which the same matter has probably passed from the solid form, (often perhaps from the fossil remains of pre-existing life,) into solution, whence it was abstracted by the coral polyps, molluscs and other creatures for their wants, again to be accumulated in a solid form, partly in that given to it by animal life, partly as sand and fine mud, and partly in a crystalline state. Mr. Darwin has pointed out the mixture of organic and mechanical matter forming coral islands, the growth of the reef-making corals outwards, their abrasion in part by the breakers, and the accumulation of an outside talus at a high angle, over which the living corals gradually extend, and cover the fragments and worn portions by masses of their calcareous secretions. The observations of Mr. Beete Jukes would confirm these general views, but at the same time he remarks on the possibility of corals, with whose habits we may still remain unacquainted, laying the foundation of reefs and islands in deeper water than is assigned to the existence of the known reef-constructing corals which flourish from near the surface of the sea to the depth of twenty or thirty fathoms.

In the examination of Heron Island, the coral beds, one to two feet thick, were observed by Mr. Beete Jukes to have a tendency to split into slabs, and joints were found to cross each other at right angles, parallel to the dip* and strike respectively, dividing up the coral rock into blocks of one or two feet in the side. This jointing of an accumulation, forming as it were under the eye, has no small geological bearing.

It is interesting to consider the accumulations now collecting for 1000 miles inside the outer ridge of the great barrier reef. The surf-

* The dip was from 8° to 10°.

loving corals probably extend over broken or triturated coral outwards, slowly advancing the main mass. While great depths bound the outer edge the inside becomes filled up by a multitude of corals, which can there adjust themselves to the needful conditions; and by coral sand-banks, which Mr. Beete Jukes shows are but "the washings of broken coral swept by tides and winds towards the lee side of the reef, until that is made the shallowest." "When this is dry at low-water, the sand is piled up by the wind into a heap, with a sloping bank, till it is at last reared above high-water mark."

Amid these corals and sand-banks, numbers of molluscs, radiata, and fishes live, and at death leave a large proportion of their harder parts, adding to the general accumulation, and often doubtless in a stratiform manner. Nor are these the only classes of animal life, the remains of which aid in increasing the general mass. Turtles frequent the reefs, banks and islets, where their skeletons and bones are found scattered, and the conditions are such that these remains can scarcely but be entombed amid the calcareous sands and coral growth. Their eggs are known to be so imbedded. The bones of birds also may probably be enveloped, for immense flights of them are seen on the islets. Raine's Islet, mentioned as not more than 1000 yards long and 500 yards wide, and only 20 feet above the sea, was found covered with them.

The conditions for the solution and chemical deposit of carbonate of lime would often arise, and a slight to and fro motion from a ripple in sheltered situations, where carbonate of lime was being thrown down from solution, would so roll about fine grains that they became covered by concentric concretions, forming oolites. Mr. Beete Jukes found such upon Raine's Islet. Where circumstances were favourable the crystalline arrangement would be upon a larger scale, and definite forms would be presented. Our author found drusy cavities in coral rock containing crystals of carbonate of lime, as also some of sulphate of lime.

While this order of accumulation was progressing from the clean sea and outward reefs inwards, different conditions would obtain along the shore of the main land. It is well known to those who have studied coral reefs that most coral polyps cannot support life where the waters are charged with muddy matter or fine detritus. We have often had occasion to observe this fact around Jamaica. As the Australian coast is approached, notwithstanding that it is protected from the ocean breakers by the outer reefs, there is still enough abrasion by the sea to produce detritus, adding to that which may be brought down by the rivers. These are known to be of so little importance that water is scarce along the whole coast bounded by the coral barrier. Indeed if it were otherwise the barrier would be broken through, or rather would never have been formed where the muddy waters of large rivers interfered with the coral growth.

Towards the coast, therefore, there would be conditions, antagonist to the growth of the reef-making corals, which would gradually cease towards the clear water outside the reefs. Though interfering with coral life, they would necessarily have no influence on the extension

of the coral pebbles, sands and finer calcareous mud towards the shore, where all such would be sorted and deposited in the usual manner. Detritus from the land would mingle with the calcareous sediments towards the coast, and especially when any was forced out of river-mouths, where, and in other sheltered situations, those detritus-collecting plants, the mangrove-trees, appear to be, from the descriptions of Mr. Beete Jukes, very common.

Respecting the volume of this accumulation, including any detritus obtained from the shores, chiefly, it would appear, granitic, and even supposing it to repose on a sea-bottom gradually sloping to the great depths found immediately outside the great barrier reef, we have to measure it by no small amount of cubic miles. If to this we add the mass of similarly formed matter now constituting the atolls or lagoon-islands, the encircling reefs and the shore reefs of the Indian and Pacific Oceans, and now constantly increasing, the various coral and other germs settling and flourishing wherever they find the conditions suited to them, we have an immense mass of carbonate of lime transformed from a state of solution to that of a solid by the agency of animal life, adding most materially to the rocks now accumulating in the tropical regions of our globe.

When we consider that heavy breakers are favourable to, and do not impede, the growth of certain corals, indeed such situations must prevent the attacks of many coral-feeding animals which would otherwise crop down the polyps and their fragile cells; and that the germs of the surf-loving corals are floating about ready to settle wherever the sea is clear enough, and the temperature and other general conditions are suited to their growth, there seems little limit to their extension where such conditions obtain. These existing, a reef is formed, and the mechanical destruction of portions of it follow. If the power of the polyps to secrete their harder parts be as a whole greater than that of the surf to break them off,—the parts which can be broken off falling into deep water beyond the range of surf, and part ground down within its influence into sand, the general mass increases.

The reason why the great barrier reef is interrupted off the southern coast of New Guinea,—for the coral conditions, and with them the coral reefs, again obtain on its western shores,—would appear to be made apparent by the voyage of the 'Fly.' A bottom of mud, the sediment from some great river or rivers flowing into the sea out of this part of New Guinea, extends over the ground which we can scarcely doubt would be occupied by coral reefs if the waters were clear. These muddy waters, every gale of wind stirring up the bottom for a long distance out, effectually keep off the coral growth; and clays, by the accumulation of the mud where it can find sufficient repose, represent in geological time the calcareous accumulations on each side, any difference which such conditions make being impressed upon the animal life, remains of which are being entombed in the different parts of the general sea-bottom.

Mr. Beete Jukes shows that at Erroob and the Murray Islands there has probably been igneous action during at least the formation

of a part of the Eastern Australian and Torres' Straits' coral accumulations. Volcanic substances are mingled with white limestone, some of the pieces of the latter and of lava even showing that they have been rounded. In Erroob, rocks that have been in a molten state are seen to cover the sandstones and conglomerates. These volcanic vents at the northern part of the great barrier reef are supposed to form part of a great belt of volcanic operations, ranging at no great distance to the northward and eastward along the north coast of New Guinea into the Solomon Islands, New Hebrides and New Zealand.

As connected with the formation of the present reefs off Eastern Australia by slow depression of the land, thus causing the corals to raise the reefs in proportion as the general mass of land and the neighbouring shore sank down, in the manner by which Mr. Darwin accounts for the atolls and barrier reefs round many islands, our author points out a fact of much importance. There are flats of coral conglomerate, half a mile wide, frequent on the north-eastern coast of Australia, in and upon which, and upon other flats of the same coast, pumice pebbles are abundantly scattered, about ten feet above the present high-water mark. Indeed these pumice pebbles are found at the same elevation for nearly 2000 miles along the eastern coast. Hence Mr. Beete Jukes infers the coast to have been equally affected as regards elevation or depression since these pebbles were accumulated, and that it has been slightly elevated, or at least has not suffered any depression during a long period of time. He allows for the piling action of breakers, which no doubt during the heaviest gales of wind throw pebbles on shore far beyond the usual average of high water, and would readily force before them such light bodies as pumice pebbles; and during such times, no doubt, they could be easily floated over extensive flats covered by the sea. It would appear that these pumice pebbles are mingled with the coral conglomerates, and were noticed in the coral rock of Raine's Island.

The accumulation of pumice at one time more than at another would depend upon the nature of the supply, and would last no longer than the eruptions continued which produced it in some situation whence it could be drifted to the Australian coast and be ground into pebbles. That there has been elevation and depression of the land and adjacent sea-bottoms in many localities in different parts of the world, producing the effects connected with coral reefs which have been pointed out by Mr. Darwin, is exceedingly probable: indeed, respecting the elevation of coral reefs we have abundant proofs, and therefore there is little reason to doubt depression, which the accumulation of rocks of all geological ages shows to have been very common and often very extensive. Upon such points the geologist can have little doubt, but he may sometimes doubt the application of depression to every case of a barrier reef, seeing the power of extension through long-continued time of the reefs outwards into deep water. The study of reef-making corals shows us how they seek clean water and the surf, and the manner in which they avoid waters charged with mineral matter in mechanical suspension. Hence we commonly find them either attached to, or at a distance from the

shore, according to the clearness of the water, though certainly here and there they seem to struggle hard with adverse conditions in this respect. Where by their increase the surf fails them, they seem to be soon covered by other corals and Nulliporæ; the latter Mr. Darwin points out as especially creeping over them towards the surf. When we consider that many a volcanic island rises through the sea by accumulating erupted masses of ashes, cinders and molten rock, and that the permanency of its continuance above the sea-level depends upon its power to resist the cutting and levelling action of the breakers, we perceive that such an accumulation may be either cut down entirely by this action, as that of Graham Island, which came through the waters of the Mediterranean in 1831, and now remains a shoal, or be notched by it, if the mass be sufficiently hard to resist entire removal. When partly cut back, the matter removed is distributed over the talus of the general volcanic protuberance, not very materially increasing its angle of slope, since it would be piled over the talus much in the same manner as the detrital coral is accumulated in front of the coral reefs. The island reduced to a shoal would have the matter distributed over the flanks of the latter in the same manner, considering the accumulation to have been conical, though more flat than the cones formed in the air. Supposing no subsidence, and this is by no means necessary, such a volcanic mass as Graham Island might be reduced to a shoal, the depth of which, beneath the surface, would correspond with the power of the waves during heavy gales of wind to remove ash and cinders from the top and scatter them over the sides, and we have the foundation for a coral reef. From the edge of a continuous or nearly continuous notch, due allowance being made for the effects of prevailing winds and breakers round a volcanic island, keeping its main mass above the sea, there would be shallow water to the cliff or new shore, having a breadth depending upon the time the breakers have been employed in cutting it back, and upon the power of the rocks to resist this abrading force. In the case of the shoal there might be a coral reef having a round or oval form, or some modification of this form, according to circumstances, the habits of the reef-making corals causing them to work outwards, so that a kind of lagoon might be inside, especially if the old crater should permit a hollow to remain. In the case of the notched islands, the abrasion of the coast and the readiness with which detritus from it would be raised in mechanical suspension by heavy gales, would cause the reef-making corals to keep the outer edge, where the proximity of the deep sea would give them clear water. Here once established they would form a barrier, and working outwards would cover the slope with their debris, and gradually rising would protect the island coasts from the heavy action of the breakers, which would then fall upon the coral reefs. These would correspond with the old shape of the island, and therefore would probably differ little from its shores, round which they would form an outer rampart with shallow water inside, better fitted for the presence of other corals and of molluscs and marine animals loving quiet and clearer water, than could have been found over

the same shallow ground while heavy seas rolled over it. As regards both the shoals and the notched sides of conical accumulations, the outside of the barrier or atoll reefs would plunge into deep water. In making these remarks we by no means doubt the correctness of Mr. Darwin's reasoning respecting the effects of depression in the formation of coral lagoon islands and barrier reefs; on the contrary, we coincide with his views, the application of which can scarcely but be correct in so many instances. The foregoing appeared to us, however, to be conditions which might often obtain, and that therefore they were deserving of consideration, to be taken, with other conditions, for what they might be worth, it being so desirable that in questions of this kind the subject should be regarded from all points, and that the various probable causes should be considered in our pursuit of that truth which it ought to be our constant endeavour to attain.

In the account of the voyage of the *Samarang*, under the command of Sir E. Belcher, there are several scattered notices respecting the rocks observed at different places, such as the raised coralline limestone of the west side of Abayat, near Batan between Formosa and the Philippines, the basaltic character of Hoa-pin-san, the igneous rocks of Quelpart and the Korean Islands, and others. Numerous remarks upon the habits of various marine animals, which by application may have geological value, are given by Mr. Adams, who accompanied the expedition. Sir E. Belcher notices banks of mud, at the Sābānon mouth of the Balungan River, east coast of Borneo, covered by a living pavement of oysters, their hinges in the mud, and their mouths upwards.

In lat. $6^{\circ} 14'$ S. and long. $4^{\circ} 41'$ W. bottom was struck at 9690 feet; four days previously no bottom was found with a line of 18,390 feet. It is very desirable that soundings in the ocean should be multiplied. No doubt very deep soundings require calm weather and a considerable expenditure of time, as was necessary when Sir James Ross took his deep soundings in lat. $15^{\circ} 3'$ S., and long. $23^{\circ} 14'$ W., 27,600 feet of line having been run out without finding bottom; but this would be amply compensated by the knowledge which might be thus obtained of the inequalities of the ocean-floor.

Two visits were made to Labuan, now a British possession, not only important for its geographical position, but also for the coal discovered in it. From communications made to the Museum of Practical Geology, chiefly from the Admiralty, we are enabled to state that the coal observed on the north-east coast of Labuan by Mr. Brooke (the Rajah of Sarawak), Captain Bethune and Mr. Wise, in March 1845, and a specimen of which, weighing 280 lbs., was brought by Mr. Wise to this country, and presented to the Museum of Practical Geology, is now found by Lieut. Gordon and others to form part of a nine-feet bed, extending from the N.E. point in a W.S.W. direction for about four and a half miles, and dipping about 24° to the S.S.E. This coal rests upon a clay bed, and is noticed as containing a quantity of small lumps, described as resin, which were not found in the specimen above mentioned. The coal of Labuan is merely a portion of a mass of associated sandstones and shales, apparently intermingled with many

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seams and beds of coal, varying in thickness, and which form a portion of the adjacent main land of Borneo, extending to, and more inland than the town of Brunai. The most considerable bed yet noticed is up a stream named the Kiangi, tributary to the Brunai river, and not far from the town, where it occurs eleven feet thick, and in a highly inclined position. Close to it is another bed three feet thick. From the statements of Mr. Hiram Williams, who was sent by the Admiralty to examine this coal district in 1845, it has evidently been much disturbed and contorted. Its relations to other accumulations (limestones, igneous rocks and others) in this part of Borneo, is as yet not clearly determined, but subsequently to its contortion this coal-bearing deposit has been subjected to denuding action, and the edges of the beds left are covered by others containing shells similar to those in the adjacent seas. The coal beds vary much in composition, as may be seen by the following analyses, made for the Admiralty at the Laboratory of the Museum of Practical Geology.

LABUAN *.		KIANGI.	
		11 feet bed.	3 feet bed.
Carbon	64·52	70·30	54·31
Hydrogen	4·74	5·41	5·03
Nitrogen	0·80	0·67	0·98
Oxygen	20·75	20·38	25·23
Ash	7·74	3·24	14·45
Sulphur	1·45		
	<hr/>	<hr/>	<hr/>
	100·00	100·00	100·00

It should be observed that several hundred tons of the Labuan coal have been raised, and that the bed is now worked. The steamers which have used this coal, though it more approaches the character of candle or cannel coal, than the ordinary bituminous varieties, report well of it.

GEOLOGICAL SOCIETY OF FRANCE.

Although it would too far extend the limits of this Address to detail the labours of the Foreign Societies which more or less devote their attention to geology, we must not omit a brief notice of so much of the proceedings during 1847, as have already reached us, of the Geological Society of France; since, though so named, its members are not confined to one country, the Society, without any distinction as to foreign members, being open to all fitting persons, wheresoever they may have been born, or now dwell.

In a communication on the variations of the igneous rocks, M. Du-rocher points out many examples of change, such as the passage of greenstone (diorite) into diallage rock and serpentine in the Côtes-du-

* With respect to this analysis it should be stated, that the specimen was from the crop of the bed, long exposed to the sea, and therefore that it is scarcely a fair example of the component parts of the coal deeper beneath the surface, and in a more favourable situation.

Nord and the Loire Inférieure, and in other places in Brittany into syenite. He also mentions that they sometimes present the appearance of quartziferous porphyry and petrosilex, and not only pass into diallage rock, but like serpentine contain oxidulated iron, as in Scandinavia. After citing various other examples, such as the passage in Norway of granite into the syenite, in which so many rare minerals are discovered, M. Durocher remarks that the variations are not so extraordinary as they appear, these igneous rocks containing the same elements,—silica, alumina, potash, soda, lime, magnesia and oxide of iron; granite being the most rich in silica and alumina, the poorest in lime, magnesia, and oxide of iron. When a granite becomes hornblendic and passes into syenite, the proportion of lime and oxide of iron augments, while that of alumina and potash or soda diminishes. In the change of the hornblendic into augitic, diallagic and hypersthene rocks there is but little difference in the elements; the hornblendic rocks are richest in silica and alumina, the augitic in lime and oxide of iron, and the diallage and hypersthene rocks in lime, and more especially magnesia. The hornblendic rocks being those which contain most silica, often too much to be altogether combined, form as it were the transition from those in which free silica is found, such as granite, to the augitic, diallage and hypersthene rocks, where silica is altogether combined with bases.

M. Frapolli read a paper on M. Desor's notice of the erratic block phenomena of the north, as compared with those of the Alps, in which he calls attention to the immense quantity of fragments of ice armed with blocks and pebbles, which are driven about the coasts of the north by the storms of winter and spring, grinding against the cliffs and the rocks. The coasts of Scandinavia, he remarks, are well known to be encased by a thick coating of ice, which when broken up carries the blocks and pebbles with it. The masses of block- and shingle-bearing ice put into motion by the tides and winds range along the shore, polishing and scratching the rocks according to their surfaces and position; the cliffs being scratched in horizontal lines along the fiords, and in other similar situations. M. Frapolli cites a map of M. Weibye, of Kragero, upon which the latter has laid down with great precision the scratches and furrows on the rocks of the country bordering the sea in the Bradsbergsamt, and quotes the inference of M. Weibye, "that the scratches and furrows on horizontal or nearly horizontal surfaces take a direction always perpendicular to the general line of coast in open bays, and always parallel to the range of the channels in narrow fiords; that the horizontality, or the greater or less inclination of the scratches on the inclined or vertical surfaces depends on the relief of the coasts of the locality, and always corresponds with this relief, and with the action of the different winds."

From personal observations M. Frapolli considers that the scratches and furrows observable in Scandinavia may be referable to the action of ice floated about, always taking into consideration the configuration of the coast when the levels of sea and land changed. And certainly the freezing of the sea on coasts, the consequent encasing of blocks and shingles in ice, the drifting of this ice, together with the

crushing and grinding of ice-floes on the coasts, as they are to be found detailed in our voyages to the northern regions of America, are points of importance not to be neglected when we take a general view of the phænomena connected with erratic blocks. Indeed there are cases in our own land where this explanation would accord best with the facts observed.

In a notice on the Heights of the Jura between the Dôle and Reculet, M. Jules Marcou gives a detailed account of that portion of the Jura range in which its chief heights are included. He observes that the four groups of Jurassic rocks are not exposed on these heights, the upper and Oxfordian divisions being alone visible, whilst the two lower groups occur more eastward in the lower range of the department of the Ain. The lower part and the great valleys of the Dôle and the Reculet are composed of neocomian rocks, and the author infers that when the latter were deposited the mass of these mountains and of Mont-Crédoz formed an island bathed by the sea, in which the neocomian deposits were effected. M. Marcou points out, that while the Oxfordian group, surrounding the ancient Hercynian and Vosgian islands, is characterized by a considerable development of marls, containing numerous pyritous fossils, the same group of the Jura is formed of a great thickness of greyish-blue limestones, more or less compact and marly. This difference of lithological structure the author attributes to the more littoral character of the Hercynian and Vosgian deposits, and the more pelagic conditions under which the accumulations of the Jura were effected at the same date. After pointing out these changes, M. Marcou states that the palæontological character of the deposits corresponds with their lithological. Thus in the littoral regions the species are numerous, and more especially belong to the cephalopods, the gasteropods and acéphala; in the subpelagic regions the individuals have much diminished, the cephalopods are stunted, and many species which did not occur in the littoral districts appear, as also many spongy polypifers and large Terebratulæ. In the localities occupied by the deep seas, such as those of the Colombier and the Reculet, fossils are extremely rare; those found are exclusively cephalopods, and hitherto confined to two species of Ammonites and one species of Nautilus.

The upper group of the Jurassic rocks occupies the highest crests and summits, and is formed of a great mass of compact limestones, without any interstratified marls. Although the mass is not very divisible into sub-groups, that considered equivalent to the coral rag of England is stated to be distinguishable both from its position above the Oxfordian group and from its fossils. The author subsequently enters into a detail of the various dislocations and contortions which the Jura may have suffered.

M. Scheerer discusses the plutonic nature of granite and of the crystalline silicates associated with it, in a communication translated by M. Frapolli. In the first part of this memoir the author enters upon an investigation of a peculiar kind of isomorphism, an account of which it is difficult to present without the formulæ and detail employed. Referring to the composition of dichroite and aspasio-

lite, he states that while in the proportions of silica and alumina they are the same, the aspasolite contains a considerable quantity of water; both minerals also possessing, though in different proportions, magnesia and oxide of iron, the former some lime, the latter only traces of it; and he asks if the differences in other characters of these minerals may not be due to the water acting as an isomorphous base as regards the magnesia, oxide of iron, &c. After investigating the component parts of serpentine, he observes that if we infer that all the basic water of serpentine is replaced by magnesia, we should have the formula for olivine, so that we should expect these two mineral substances to have the same crystalline form, which, adds M. Scheerer, is the fact. This he considers as a proof of his new kind of isomorphism, so that olivine is to serpentine what dichroite is to aspasolite.

Taking this view, M. Scheerer calculates the proportion of oxygen in more than one hundred minerals containing water, and examined with care, and infers that by considering this water as basic water, the formulæ become more simple, and more in accordance with the composition furnished by chemical analysis, than when we consider the water in a state of hydrate. From his researches he concludes that one atom of magnesia, or of protoxide of iron, manganese, cobalt, nickel, and oxide of zinc, may be replaced in this kind of isomorphism, to which he assigns the name *polymeric*, by three atoms of water, and one atom of oxide of copper by two atoms of water*.

Reasoning upon the water contained in many of the elements of granite, in which he includes mica, iron pyrites, talc, hornblende, schorl, gadolinite, orthite and allanite, M. Scheerer opposes the theory of granite having been in a state of igneous fusion, though he does not deny that heat may have given the humid mass of granite the plasticity and softness which it cannot be denied it must have possessed, and thus he so far admits heat as having been an essential agent in the formation of granite. He considers that this pasty mass, impregnated with water and heated under great pressure, would melt at a temperature much less elevated than if, in other respects the same, it were anhydrous; remarking that from this fusion, which should not be confounded with simply igneous fusion, results would follow of a very different nature than if the mass cooled down from igneous fusion alone. The minerals which had the greatest tendency to crystallize, those of which the crystalline power was greater than the opposing action of the watery vapours, would be the first to separate. All the water, continues M. Scheerer, not appropriated by the minerals during their crystallization would be concentrated where the free silica abounded. This silica would not become solidified until late, when the temperature of the granite was considerably reduced, and when the water not chemically combined with the component minerals had escaped from the mass, a process requiring a long lapse of time. M. Scheerer then applies this hypothesis to the alteration

* In thus giving this view of M. Scheerer, it is but right to observe that it is opposed by Prof. Naumann and Dr. Rammelsberg, who consider that it requires further proof.

of rocks brought into contact with the granite, plastic with water and highly heated.

This communication was followed by one from M. Virlet d'Aoust, on normal metamorphism and the probability of the non-existence of true primitive rocks on the surface of the globe. He refers to the memoir of Scheerer as supporting the opinions he had previously advanced on metamorphic granites, and points out that it is not necessary, as is too commonly supposed, that the temperature capable of producing normal metamorphism and granitic transformations should be very high, since M. Schafhäütl has shown that, under pressure, steam above 212° Fahr. can dissolve silica, and that probably, as has been pointed out by Sir David Brewster, other gases may have considerably influenced crystallization in altered rocks. M. Virlet considers that geological discoveries, as well as the advance of inorganic chemistry, tend to show that there does not probably exist, and cannot now exist, any really primitive rocks on the surface of the earth; that is to say, any rocks which have not suffered some chemical or molecular transformation, including water chemically combined, since their original cooling. Normal metamorphism, thus extended to all the rocks commonly called primitive, is only, he observes, a corollary of the theory of central heat and of the original igneous fluidity of the earth; conditions during the consolidation of the crust having caused changes of surface heat, and the returns of great heat at various times having assisted considerably in producing normal metamorphism. M. Virlet refers to the mechanical aggregation of crystalline rocks as affording a proof of general metamorphism, and as due to conditions which the researches of Schafhäütl, Brewster, Biess and Scheerer would lead us to expect.

In an elaborate account of analyses of some of the siliciferous thermal waters of Iceland, M. Damour considers that water, acting at a temperature of more than 120° Cent., under very considerable pressure and during a long period, upon the trachytic and zeolitic rocks beneath, would dissolve many of the elements of which they are composed; among others silica, alumina, soda, potash and lime. The alumina and lime would not long continue dissolved in the siliceo-alkaline solution, while the silica, potash and soda would remain in different proportions, as is found in the thermal waters of Iceland.

M. Descloizeaux communicated the results of investigations made jointly with M. Bunsen, of Marbourg, on the two principal Geysers of Iceland. Experiments were made in the pipe of the Great Geyser, by which it was found that the temperature at the bottom was variable, being highest immediately before and lowest immediately after the great eruptions. It is inferred that the source of heat is not situated immediately beneath, but at a distance, probably considerable, and that the column of water communicates by a long and winding channel with the space where the direct action of the subterranean heat is felt. After a great eruption, during which a large body of water and steam is ejected, the lower part of the liquid mass becomes colder, and the steam arriving from where it is formed, not being able to force the water out, is condensed by that filling the

channel, the increased heat of which is transmitted to the bottom of the pipe. The water in the channel becomes boiling, and the steam, no longer condensing, acquires great power by compression, and finally drives out the water through the pipe. The same facts having been observed at the Strokur, the same explanation is offered.

M. Dumont, in a memoir on the value of the palæontological character in geology, endeavours to ascertain the aid geology may derive from organic remains: first, as regards the relative age of superimposed beds in the same country; secondly, in comparing the dates of rocks situated in countries remote from each other; and thirdly, in order to fix the limits of formations. He concludes, after entering upon detail, that fossils are valuable in the same country in determining the relative age of rocks formed at epochs very distant from each other, while they gradually lose this value as the formation of the beds approached each other in geological time. Under the second head he infers that analogous beings have existed in different localities at different times, that the series of organisms belonging to different latitudes have commenced at distinct epochs by analogous species, and that the organized beings existing at the same time in the various geographical zones were as different formerly as they are now. With respect to the limits of formations, M. Dumont concludes that palæontological divisions cannot exactly accord with the geological divisions founded on the revolutions of the globe.

In some reflections on the nature and application of characters for determining rocks, M. Frapolli remarks that, zoological characters being only of comparative value, and mineralogical considerations constantly leading us wrong, it is to superposition of rocks, or their stratigraphical arrangement, that we must look for the sole true base of geological science, and that our principal attention should be directed to it when determining unknown formations. M. Frapolli passes in review the hypothesis of the original igneous fluidity of the earth and its consequences, as the heat radiated into space and the crust became solid, adverting to times of repose and fracture, the accumulation of sedimentary deposits and their upheaval, and especially referring to secular upheavals and their results.

M. de Verneuil read a note on the parallelism of the palæozoic rocks of North America and Europe, followed by a table of the fossil species common to the two continents, with the indications of the groups in which they are found, and a critical examination of each of the species. In this communication M. de Verneuil, describing the composition of the palæozoic rocks of New York, of which he enumerates the twenty-eight groups into which they have been divided by the New York State geologists, points to the excellent succession of beds observable in that part of North America. He also gives an account of the groups, thirty-eight in number, into which the palæozoic rocks of Ohio, Kentucky and Indiana have been divided, and then proceeds to examine into the parallelism of these North American deposits with the older fossiliferous rocks of Europe. He investigates this subject upon the principle, that if in two countries a certain number of systems, characterized by the same fossils,

are superimposed in the same order, whatever may be the thickness or number of the physical groups of which they are composed, these systems should be considered as parallel and synchronous.

The American series is so complete, its parts being conformable and passing into each other, that marked divisions cannot be established. Hence it follows that the limits corresponding with the different European systems are in some cases uncertain, but this is considered as of less consequence if the middle parts of each system can be established. The important point, M. de Verneuil adds, is to feel assured that during the palæozoic period the animal kingdom upon the area occupied by the two continents has suffered simultaneous transformations, so that identical species occupy the same geological positions.

The six lowest New York groups, from the Potsdam sandstone to the Hudson river group inclusive, are referred to the Lower Silurian rocks, the *lingula* sandstone of Potsdam being probably equivalent to the *obolus* sandstone of Russia and the lower sandstones of Scandinavia. The siliceous limestone, with the Black River and Trenton groups, are referred to the bituminous slates and the orthoceratite limestones of Sweden and Russia, while the Utica slates and the Hudson river groups, with the Graptolites at their base, are considered equivalent to the graptolite slates of Sweden, succeeding the red orthoceratite limestone, and also to those of Bain in France. Trilobites were largely developed both in Europe and America at this period, and the genus *Isotelus* represents in the latter the *Asaphus* of the former. Orthoceratites were abundant, and *Bellerophon* appeared in connection with this early life, marked also by the presence of *Orthis*, *Leptæna*, and *Terebratula*.

The New York groups, rising above those mentioned, up to the Oriskany sandstone exclusive, are referred to the Upper Silurian rocks, the Niagara limestones and shales being considered equivalent to those of Wenlock and Gothland. Trilobites were still abundant, some species being rare and limited to thin groups of rocks, such as *Phacops Hausmanni*, *Sphærexochus minus* and *Cheirurus insignis*. Orthoceratites are less abundant than in the lower series. Spirifers and Tentaculites appear, and large corals are found, such as *Favosites Gothlandica*, &c., while Graptolites cease. Of forty identical species found in the Upper Silurian rocks of America and Europe, M. de Verneuil considers that thirty-two have neither lived before nor after this period.

The New York groups, from the Oriskany sandstones to the sandstones and slates above the Chemung group, inclusive, are all referred to the Devonian series. The characters common to the Devonian fauna of Europe and America are considered to be the appearance of the ganoid fishes with great *plaques* or scales, and the genera *Gonia-tites*, *Nautilus*, *Pentremites* and *Productus*.

Above these American rocks come the limestones referred to the carboniferous limestones of Europe, and M. de Verneuil considers this division as well-characterized in both continents; and it is remarked that the Trilobites, decreasing in a parallel manner in both

countries, finally end with the small species of *Phillipsia* in the carboniferous limestones. The memoir of M. de Verneuil, of which the above is a very brief sketch, contains much detail, and terminates with remarks on the palæozoic fossils common to America and Europe, and on their distribution.

In a memoir on the mineral and chemical composition of the rocks of the Vosges, M. Achille Delesse remarks on the passage of the different igneous rocks into each other. M. Delesse observes that many minerals, even those widely spread and forming important portions of rocks, are but little known, and he points out the felspar family, though it forms fifty per cent. of the crust of the globe, as being one, the species of which are little understood. Their chemical properties are nearly identical, and their composition has reference to a common law; they all contain the same radical bases, in such proportion that the quantities of oxygen are as 1 to 3, and the different felspars are only saturations of these radical bases with silica. Hence the difficulty of determining the different felspars, though they belong to an easily distinguished natural family.

After taking a brief view of the formation of the stratified, M. Delesse proceeds to examine that of the unstratified rocks, and their igneous origin, glancing at the original fluidity of the earth, its consequences, and the metamorphism of rocks. Proceeding to the classification of the non-stratified rocks, he points out that too much importance has been assigned to their physical characters, and too little value given to their chemical composition, and that it is highly desirable researches in chemical mineralogy should accompany the geological study of the non-stratified rocks. He adds, that these researches in chemical mineralogy should be carried on with the rocks in place, inasmuch as the chemical geologist will not otherwise be enabled to observe all that is required. In this manner M. Delesse studied the non-stratified rocks of the Vosges, carefully separating the isolated minerals from the main mass and subsequently experimenting upon them, and as carefully also examining the main mass or base of the rocks. The crystals in the Belfahy porphyry were found to be a variety of labradorite. Augite is another mineral found in this porphyry, one of those termed also *Melaphyre*. Its base or paste contained water chemically combined, as in the crystals of felspar, and M. Delesse refers to the views of M. Scheerer on this subject. In chemical composition this paste contained silica in the same proportion as in the isolated crystals of labradorite, and in all the varieties less alumina, soda and potash, and more iron, manganese and magnesia, with sometimes more and sometimes less water and lime. The spilite of Fauconey, a vesicular rock, was found upon analysis to be nearly of the same composition as the base of the Belfahy porphyry.

In conclusion, M. Delesse points to the approximation which these researches on the Vosges melaphyres establishes between them and basalts. The base of the two rocks is the same, being labradorite, and they likewise contain augite and oxidulated iron in common; both also contain water. The differences consist chiefly in the greater

or less proportion of bases in the constituent labradorite. Thus soda, potash and water form a notable part of the labradorite of the melaphyres, while these bases diminish and even completely disappear as the rock approaches to greenstones, basalts and modern lavas. They are replaced by lime, which then becomes the dominant base.

Besides these communications there have been others, also presenting much interest, such as the observations of M. Martius on the mass of the Jungfrau, which M. Studer refers to gneiss, masses of limestone being included among it; the note of M. Boué, referring to a memoir of M. de Hauer on the Cephalopods of the shelly limestone of Bleiberg, Carinthia, wherein three stages of cephalopods, each characterized by its fossils, is considered to be distinguishable in the Alps; a notice by Desmoulin of fossils in flints, which he infers are the remains in the south-west of France of upper chalk, equivalent to that of Maëstricht, the softer parts of these beds having been removed by denudation; a notice by M. Viquesnel on the chalk of Turkey; a note on the mode of occurrence of the sulphur in the Soufrière of Guadeloupe by M. Ch. Deville. We have also a note by M. Boué on pseudomorphism arising from the disappearance of crystals of rock-salt in rocks; a notice and analysis of a hydrosilicate of alumina, found at Montmorillon (Vienne) by MM. Damour and Salvétat; a note on the pisolitic limestone (of the Paris district) by M. Hebert; remarks by M. Paillette in illustration of notes on the mines in the south of Spain by M. Pernollet; reflections in favour of the hypothesis of the central heat of the earth, by M. d'Omalus d'Halloy; a note by M. von Buch on some points connected with the structure of Terebratulæ, and on the range of nummulitic limestones; a description of a gigantic Orthoceratite, six English feet long, from North America, by M. de Verneuil; a notice of the occurrence of a cretaceous Terebratula in some tertiary marls near Corbières, these marls considered equivalent with others full of cretaceous fossils in the Haute Garonne and Haute Pyénées, by M. Leymerie. There are other notices and papers by M. de Collegno on the classification of certain rocks in Italy; on some peculiarities in the exterior form of the ancient moraines of the Vosges, by M. Collomb; on the genus Palæotherium, by M. Pomel; a notice of the rocks in the basin of the Adour, by M. Delbos; a notice respecting a geological map of the Subhercynian Hills, and an essay on the geological topography of that country, by M. Frapolli; a note on the mode of occurrence of the Iceland spar in Iceland, by M. Descloizeaux; and a note by M. Nérée Boubée on the relation between the nature of soils and the different antiquity of the alluvions in valleys marked by different stages or levels.

It should be observed that the Bulletin of the Geological Society of France contains the observations of those present at the different meetings upon the papers read before them, and that among them there are remarks of great value, both as respects the memoirs before the Society, and points of geological interest and importance connected with them. Indeed many a remark, as in the discussions upon papers read before us, may be considered as the foundation for

subsequent researches and discoveries. This year the members of the Geological Society of France have had presented to them the first part of a History of the Progress of Geology, from 1834 to 1845, by the Vicomte d'Archiac, a closely printed octavo volume of 679 pages, published under the auspices of the French Minister of Public Instruction, M. de Salvandy. This part contains *Cosmogonie* and *Géogénie*, the *Physique du Globe*, *Géographie physique* and *Terrain moderne*.

GEOLOGICAL NOTICES.

As it would far exceed the limits of an address of this kind to attempt an account, in any useful detail, of the various publications either directly dedicated or having reference to our science, and which have appeared during the past year, the following notices have been selected, not because others of great importance to the progress of geology may not readily be found, but because they have reference to points of considerable interest.

Palæontologists have continued to add abundantly to our knowledge of the ancient forms of life, extending from the gigantic mammals of previous geological times down to the minute infusoria which have been found forming, by their immense numbers, a large proportion of certain rocks. While at our own meetings Professor Owen has made known to us the fossil animals previously mentioned, we find other comparative anatomists and palæontologists adding to our stores of this branch of our knowledge. Thus M. von Meyer describes a new fossil genus of the Carnassiers, found in the tertiary beds of Mombach. To this genus he assigns the name of *Stephanodon*, and to the species *S. Mombachensis*. We find him establishing a new genus by the examination of the reptile found in the Grès bigarré of Bohemia, and named *Palæosaurus Sternbergi* (Fitzinger). He adds also many new species to our fossil fauna, such as two new species of *Labyrinthodon*, in the Vosges sandstone of the Swartzwald, the *Homosaurus Maximiliani* from Solenhofen, the *Rhamphorhynchus longicaudis* from the calcareous slates of Eichstadt, and the *Emys Turnauensis* from the tertiary rocks of Styria, with many other palæontological communications of interest, such as his notice of the abundance of Batrachian remains (*Triton opalinus*, *Rana Luschitzana*, and *Asphæron Reussi*, the last a new genus) in the tertiary rocks of Bohemia, as also his notice of a fossil marmot (*Arctomys marmotta*) in the drift of Mosbach, near Wiesbaden. Von Meyer considers that the *Arctomys primigenia* of Kaup is the modern marmot, and the *Spermophilus superciliosus* of the same author the *Spermophilus citillus*.

We are indebted to Dr. Jeffries Wyman, Professor of Comparative Anatomy in Harvard College, Massachusetts, for a description of the cranium of *Casteroides Ohiensis*. The geological position of this fossil has been shown by Mr. James Hall to be similar to that assigned by Mr. Lyell, in his 'Travels,' to the *Mastodon giganteus*, the bones of which, as well as of the Elephant, accompany the Casteroides. They all in fact occur in superficial deposits, often of shell

marl, and containing freshwater shells of the genera *Planorbis*, *Valvata*, *Cyclas*, and others identical with species now inhabiting the same region. Dr. Wyman, in his excellent paper, has pointed out that the *Casteroides* is a large extinct rodent, having greater analogies in its osteology to the *Castors* than to any other living genus. Its relation to the *Capybara Hydrochaerus*, the largest of living rodents, which it exceeded in size, is also alluded to, and the differences in its teeth carefully described. It is also shown to present some analogies with the genus *Fiber*, as well as with *Castor* and *Hydrochaerus*.

The discovery of the entire cranium of the *Zeuglodon* was announced in the course of last year by Mr. Tuomey, State Geologist of South Carolina, and a figure of it was published in the *American Journal of Science*, September 1847. It was discovered by Messrs. Holmes and Gibbes in the eocene beds of the Ashley river, about ten miles from Charleston. Mr. Tuomey observed that the double occipital condyle showed it to have been a mammal, while the squamous sutures have a symmetrical form, and refer it to the *Cetacea*, to which Prof. Owen first pointed out its relations. These conclusions are the more important, because they differ from those deduced by Dr. Carus from the imperfect skeleton of the *Zeuglodon*, submitted to him by Mr. Koch, and of which he has lately published a detailed description with plates. A full and complete notice of this singular fossil has just appeared in the form of a monograph on the genus *Basilosaurus* or *Zeuglodon* by Prof. L. R. Gibbes, who has shown that there are two species of the genus.

In regard to the geological position of the *Zeuglodon*, you have learnt from Mr. Lyell's paper on the so-called nummulitic limestone of Alabama, above-mentioned, that it occurs in one of the members of the Eocene group in all the places where he met with the bones. He has since informed me that the analogy of the whole group of tertiary shells, with which it is more immediately connected in the localities examined by him, leads him to infer that it belongs to that middle division of the Eocene which in Mr. Prestwich's paper is called the Bracklesham beds.

Various additions to our knowledge of fossil mammals have been made by M. Pomel, who has among other labours described a new genus of fossil pachyderms, approaching the hippopotamus, under the name *Elotherium*. To one of the communications by the same author, it may be desirable especially to call attention more in detail, inasmuch as it refers to the life upon, and physical conditions of a particular locality at a highly interesting geological period. This memoir relates to the fossil flora and fauna of the pisolitic formation, a name given to certain deposits in the Paris tertiary district, of a concretionary form, occurring between the plastic clay and the chalk, and which M. Elie de Beaumont, upon purely geological data, refers to the highest portion of the cretaceous series. M. Pomel points out that the observations of M. Desor show this formation not to be accidental, but to be clearly equivalent both geologically and palæontologically to the highest chalk of the Pays Bas.

At a few leagues from Sezanne, at Mont Aimé, and at the plateau of Faloise or of La Madelaine, the remains of fish and reptiles were discovered in this formation, without the trace of those of any mammal. The fish and reptiles differ alike from those of the tertiary rocks above and of the cretaceous rocks beneath. Among the fish was a Cycloid, a large species of the cretaceous genus *Istieus* of Agassiz, differing from any species described by him. Of Placoids, there was a species of the genus *Lamna*, and another probably of the same genus, and approaching *Lamna verticalis* of Agassiz, without being identical with it. It may belong to the genus *Otodus*. Teeth also were discovered, resembling those of the Pycnodonts, but the specimens were too imperfect to establish the presence of this family.

The most remarkable fossil was a saurian of the section of Crocodiles, and of the subgenus Gavial, to which the specific name of *isorhynchus* has been assigned. After giving a detailed account of this saurian, M. Pomel remarks, as deserving of attention, that a reptile should occur in the upper limit of the secondary rocks which should more remind us of the saurians of the Jurassic series than of those found hitherto in the European tertiary deposits. Many important parts of the skeleton show, it is observed, that it partakes of living types. At least one large species of tortoise is discovered among the reptilian remains.

With respect to the flora of the Sezanne deposit, there is an indeterminable species of moss, and the genus *Marchantia* is for the first time seen in a fossil state, in a species approximating to, but distinct from, *M. polymorpha*. A new *Asplenium* and *Aspidium* represent the ferns, and are very abundant. There is also a third species which may belong to the genus *Sphenopteris*. Leaves were found closely approaching those of *Cinnamomum* and the chestnut; a new *Corylus*, a *Caprifolium*, and leaves of *Salix*, *Populus*, &c. M. Pomel calls attention to the remains of a crustacean, of the genus *Oniscus*, as being abundantly discovered among the mosses and Marchantiæ. This he considers as confirming his opinion that the deposit resembles the travertine now forming in many parts of Central France.

During the year Mr. M'Coy has published an account of the fossil botany and zoology of the rocks associated with the coal of Australia, founded upon specimens sent to the Woodwardian Museum of Cambridge by the Rev. W. B. Clarke. Seventeen species of fossil plants, twelve of them considered as new, are described from the Mulubimba district, a portion of the Newcastle and Hawkesbury region. Of the ten genera noticed, two (*Vertebraria* and *Zeugophyllites*) are found in the coal-field of India, and one (*Gleichenites*) is considered provisionally as the same with *Pecopteris odontopteroides* of Morris. All the other genera (with the exception of *Phyllothea*, which has hitherto been only discovered in Australia) are well-known in the oolitic coal deposits of Yorkshire; one species (*Sphenopteris germana*, M'Coy) is stated to be scarcely distinguishable from *Pecopteris Murrayana* (Br.) of the Scarborough shales. Mr. M'Coy concludes that the evidence of fossil plants is in favour of these Australian coal deposits being of the age of the oolitic rocks

of Europe. It may be here observed, that upon an examination of a fine collection of fossil plants, obtained by Mr. David Williams from the Burdwan coal district of India, and transmitted to the Geological Survey, Dr. Hooker was also struck with the forms which corresponded with those observed in the oolitic coal deposits of Great Britain.

Respecting the animal remains of the rocks underlying the coal of this Australian district, Mr. M'Coy determined 83 species. These belong to 39 genera, all of which, with the exception of four, (*Tribrachyocrinus*, *Pachydomus*, *Notomya* and *Eurydesma*, forms up to the present time only known in Australia,) are abundant in the carboniferous rocks of the British Islands. Eleven of the species are considered to be identical with those in the same rocks, and nine more to be so closely allied that no difference of character can be observed, though from their imperfect state of preservation they cannot be absolutely identified. From the difference in palæozoic character, Mr. M'Coy infers, as not improbable, that there was a wide interval between the consolidation of the fossiliferous beds underlying the coal, and the deposit of these coal-measures themselves. This forms a subject of interest for further investigations, and it will be remembered that in his communication Mr. Beete Jukes considered the upper and lower series to graduate into each other, an opinion apparently participated in by the Rev. W. B. Clarke.

Considering the conditions under which the remains of insects are likely to be entombed, notices of any large accumulation of them in a fossil state possess much geological importance. In a communication by Prof. Heer to Prof. Bronn respecting the insects discovered in the tertiary deposits of Eningen and Radoboj, he states that 100 species of insects found at Eningen may be referred to 68 genera and 34 families; that 51 of these genera occur in the present Swiss fauna, 5 genera are absent in the Swiss fauna and discovered in the south of Europe, 1 is found in North America, 4 cannot be well determined, and the remaining seven appear extinct, these seven being *Glenopterus*, *Escheria*, *Protractus*, *Coprologus*, *Prologenia*, *Fusslinia*, and *Pristorhynchus*. By comparing the fossil coleoptera of Eningen with those now existing, they are found more to resemble the coleoptera of Southern Europe than of the district in which they are now found. They are considered to offer the general characters of the Mediterranean region combined with some American forms.

Sir Roderick Murchison, during his present absence on the continent, has not neglected the palæozoic rocks; and we find that, accompanied by M. de Verneuil and Count Keyserling, he traversed Bohemia for the purpose of still further examining that country, in which M. Barrande, whose labours on the trilobites of this region are so well known to us, had shown the occurrence of Silurian rocks. The Silurian rocks of Bohemia are described by our colleague as extending from N.E. to S.W. for about ten German miles, with a maximum transverse breadth of about three miles and a half. This mass is considered to be divisible into Upper and Lower Silurian rocks, and according to a section across the whole, from Ginetz on the one side to Skrey on the other, forms a great trough

in which the Upper Silurian rocks occupy the central portion. Sir Roderick Murchison, while pointing out that geologists should refer to the great divisions of Upper and Lower Silurian rocks, when comparing distant countries with each other, and not to the minor subdivisions he adopted in Great Britain, at the same time remarks, that however the minor divisions may differ from each other, similar types of organic life frequently occur in distant lands when similar mineral conditions are repeated. The lowest fossiliferous schists of Ginetz and Skrey are said to remind the geologist of the Llandeilo flags and schists of England and the alum shales of Sweden, by the development of large trilobites, and the genus *Battus*, which together with *Orthidæ* and *Cystidæ* mark these deposits. The Bohemian quartz rocks reminded Sir Roderick of the Caradoc sandstones of the British types, with their abundant *Trinuclei*. The upper division is stated strikingly to resemble the British division of the same age, in being like it eminently characterized by a multitude of chambered shells, some of the characteristic species of which are most abundant in the shale between the Ludlow and Wenlock rocks in England. The middle group of the upper division of Prague contains large *Pentameri*, one of which cannot be distinguished in external form from *P. Knightii*, and in Bohemia, as in England, it is associated with *Terebratula Wilsoni*. In the same communication (a letter to M. Leonhard), Sir Roderick stated that certain rocks of the country round Olmutz should be referred to the Devonian series, the fossils discovered in them bearing out this inference.

As connected with the progress of geology, we must not omit to mention a lecture of Mr. Lyell, delivered during the past year before the Royal Institution, at one of those Friday-evening meetings at which so much that is important in various branches of science is first given to the public. He referred to the volcanic district of Auvergne as one of peculiar interest, since it does not appear to have been submerged beneath the sea during a period in which its geological and geographical structure, and the animals and plants by which it has been inhabited, have undergone a great succession of changes. Mr. Lyell thus brings before us terrestrial changes, so to speak, which should be equally taken into account when we consider the mode in which, on the great scale, rock-accumulations, as well igneous as aqueous, have been effected in all geological times since land rose above sea, affording by its abrasion the detritus among which the remains of animals existing at the time became entombed. It is highly useful to regard such terrestrial changes with reference to geological times, when the regions in which they took place may have been depressed beneath the sea and became buried beneath accumulations heaped upon them by the agency of water. Mr. Lyell dwelt much upon the antiquity to be ascribed to the Puy de Tartaret, a type of one of the most modern cones of eruption in Central France. After entering upon much interesting detail, he proceeds to show that a lava-current from this crater flowed over a bone-deposit, containing osseous remains referable to the genera *Equus*, *Sus*, *Tarandus*, *Cervus*, *Canis*, *Felis*, *Martes*, *Putorius*, *Sorex*,

Talpa, *Arvicola*, *Spermophilus*, *Lagomys*, *Lepus*, and, according to Mr. Waterhouse, *Cricetus*, or hamster, and others, besides the remains of a frog, a lizard, and snake, and the bones of several birds. Prof. Owen recognized among these remains the *Equus fossilis* and *Tarandus priscus*, both extinct species, occurring in the caves of England, with the contents of which generally this assemblage of fossils of Auvergne is stated to agree very closely. Among the land shells found associated with the bones were *Cyclostoma elegans*, *Clausilia rugosa*, *Helix hortensis*, *H. nemoralis*, *H. lapicida*, and *H. obvolvata*. It was inferred that a similar fauna continued in Auvergne after the latest eruptions, the remains of many of the same group of animals having been discovered in the clefts of a lava-current at Aubier, near Clermont, as modern as that of the Tartaret; an observation of importance, since the covering of a bed by the lava-current of Tartaret would not prove the existence of the animals at the time of its flow, as it might have flowed over accumulations of an older date. Mr. Lyell remarks that in Auvergne it is possible to distinguish the relative ages of a great variety of alluviums containing the bones of terrestrial quadrupeds, partly from their position beneath lavas of different ages, and partly from their occurrence on the sides of valleys which were gradually deepened; “no flood or return of the ocean having disturbed the surface and mingled the fossils of one period with those of another, as has happened in England and most parts of Europe. The oldest fauna of land quadrupeds in Auvergne,—that found in a fossil state in freshwater strata of marl and limestone, older than the trachyte of Mont Dor,—consisted of species of *Palæotherium*, *Anoplotherium*, *Anthracotherium*, *Opossum*, &c.; analogous in great part to those of the Paris basin, with some miocene forms associated, and belonging to an upper eocene group, newer than the Parisian tertiaries, or the uppermost freshwater beds of the Isle of Wight.” “Hence,” adds Mr. Lyell, “it follows that the whole succession of revolutions in the animate and inanimate creation which have occurred in Central France since the land emerged, vast as they are in duration, as compared to the æra of more modern volcanos, is, nevertheless, considerably posterior to the marine clay on which London is built; this last being one of those tertiary deposits which rank as but the monuments of yesterday in the great calendar of geological chronology.”

To these palæontological notices it may be added, that the moluscs of the cretaceous beds near Geneva have been well-illustrated by M. Pictet, in a monograph of high character, and that the fossils of the chalk of Aix-la-Chapelle have been described by Dr. Joseph Müller. Brachiopods have engaged much attention. De Koninck has given a highly illustrated monograph of *Productus*. M. Barrande has described and figured the palæozoic brachiopods of Bohemia. D'Orbigny has commenced his account of the cretaceous brachiopods of France, and Mr. Davidson has illustrated many of our British palæozoic forms. We should also mention that the important work of Michelin on the fossil zoophytes of France is completed. Mr. Toulmin Smith has published a paper on Ventriculites, remarkable

for minute investigation. He considers these bodies to be the polydids of Bryozoa. Of the highly illustrated monograph by Prof. Heer of the insects of Ceningen, the first part, treating of the Beetles, has appeared; and M. Bosquet has published an important paper on the Entomostraca of the chalk of Maëstricht.

As regards geological interest, one of the most remarkable palæontological discoveries of the year has been that of a reptile skull by Von Dechen in a nodule of ironstone from near Lebach, in the Saarbrück palæozoic coal district. According to Goldfuss, who assigned the name *Archigosaurus Decheni* to the reptile thus found, it is a kind of crocodile-lizard, the skull not resembling that of the *Emydosauri*, which are nearest to it in geological date, but that of the true Crocodiles now existing. At the same time there are characters in the skull, which is $6\frac{1}{2}$ inches long, (Rhine measure,) showing it to partake of the lizard. Regarding the skull to have formed the same proportion to the entire reptile as in the young crocodile, this specimen would have belonged to an individual measuring 3 feet 8 inches. Mr. Lyell stated the other evening, in a lecture at the Royal Institution, on the foot-marks of a reptile in rocks of similar age in North America, that Dr. Falconer, now on his road to India, has seen the specimen and had no doubt of the skull having belonged to a reptile. Here then we appear to have an example of the existence of crocodilian animals at the comparative early time when those remarkable plants flourished, parts of which grew upon, while others were drifted into, the districts in Europe and North America, where much of them, by subsequent chemical changes, forms the palæozoic coal.

Mr. Lyell, in the lecture above-mentioned, refers to the discovery by Dr. King, in 1844, of reptile foot-tracks upon sandstones in Pennsylvania considered equivalent to part of the palæozoic coal-measures of the British islands; indeed the Greensburg sandstone is stated to occur in the very midst of the Appalachian coal-field, the main Pittsburg seam of coal being worked 100 feet above it. Mr. Lyell visited the locality in company with Dr. King, and from all the evidence before him, concludes that these foot-prints are those of a new reptile, and that the tracks are different from the *Cheirotherium* foot-prints of England and Germany. The average length of the print of the hind-foot is $5\frac{1}{2}$ inches, and of the fore-foot $4\frac{1}{2}$ inches. The fore and the hind feet follow each other in pairs very closely, there being an interval of about one inch between them. Between each pair the distance is 6 to 8 inches, and between the two parallel lines of tracks there is about the same distance.

It would be useless before those now assembled in this room to point out the value of the evidence thus brought to bear upon the existence of reptiles at the date of the palæozoic coal deposits; foot-prints and other tracks and trails of animals upon the sands, and mud of various geological times being now acknowledged as important aids in palæontological inquiries. Indeed, the muddy banks of tidal estuaries in various parts of the world, particularly if there be much difference in vertical height between spring and neap tides,

abundantly show how, if land be slowly sinking beneath any given level of the sea, or successive layers of mud and sand be accumulating, tracks of birds, reptiles and mammals may be preserved. Mr. Lyell pointed out the manner in which foot-prints of the sandpiper (*Tringa minuta*) are preserved in the red mud of the Bay of Fundy, and the drift of blown sand fills up the foot-prints of opossums and racoons on the beach near Savannah, Georgia. The tides rising high in our Bristol Channel and its continuation, the estuary of the Severn, and there being much difference between spring and neap tides, abundant opportunities are there often afforded for studying foot-prints of various kinds, mixed with estuary drift, such as different shells (terrestrial among them), terrestrial plants and sea-weeds, and other things. Many other localities around our islands also afford excellent opportunities for this study.

Professor Ehrenberg, to whom we owe so much for the discovery of the remains of infusoria in such abundance among some of our fossiliferous deposits as to form no unimportant part of them, has added further to the obligations of geologists by his examination of certain pumiceous marls of Barbadoes, brought to Europe by Sir Robert Schomburgk. In 1839 M. Ehrenberg made known some new microscopic polygastrica with siliceous shells, some living, one species fossil, so peculiar in their structure that he deemed it necessary to constitute a new order, under the name of *Polycystina*, for their reception. Up to the time of Sir Robert Schomburgk's visit to Barbadoes, only thirty-nine species of this group had been observed: in the marls before-mentioned no fewer than 282 species, belonging to seven families and forty-four genera of *Polycystina*, have been brought to light—all new. Whatever these singular organisms may eventually prove to be, this is probably the most striking instance of the sudden increase of our knowledge of any single group of fossil animals ever recorded.

The Parallel Roads of Glenroy, as they have been termed, have long and deservedly attracted the attention of geologists, and several explanations have been offered. Mr. David Milne, in his paper upon these terraces (published in 1847), considers that they should be attributed to the shore-action of lakes, formed by mounds of boulder clay and detritus across the valleys which barred the drainage. To the lowering of these barriers by river-action would be due, Mr. David Milne considers, the levels at which the successive pauses of the lakes continued sufficiently long to produce the so-called parallel roads. These are shown to be perfectly horizontal by actual measurements, and similar beach-lines are pointed out on hills in other parts of the country. Although around the prominent elevations of land which have risen through the sea, with sufficient intermediate pauses to permit a notching, or cutting back of the land by breaker-action at different times, we should expect evidence of such pauses in cliffs and raised beaches, such as we undoubtedly find, lake action as pointed out by Mr. David Milne must also be regarded. There is no difficulty in many lands, mountainous regions especially, in seeing that lakes have been drained by the cutting back

of river channels, and in volcanic districts lakes may readily be formed and subsequently drained, the barriers which caused them being cut through or removed. It will depend upon obvious conditions whether any permanent records of these levels at different times be left or preserved. Lakes and isolated so-called seas, as is well-known, are inferred to have occupied larger areas than at present from evidences of this kind.

The beautiful manner in which silica has entered the interstices of vegetable matter, even showing the succulent parts of plants which must have been in a state of partial decay, is well known. We have the finest vegetable tissues most perfectly preserved by means of silica. It will be in the recollection of the Society that Dr. Mantell pointed out to us in this room what he considered the soft parts of molluscs also preserved in silica. Yesterday only I received a communication from Mr. Charlesworth, in which he informs me that in a collection which constitutes part of the well-known museum of Miss Benett of Wiltshire, he had found several examples of *Trigonia* with their branchiæ well-preserved in silica. As silica may have, and has filled up cavities left by shells, thus giving us the most perfect representation in silica of that which was once carbonate of lime, great care is of course required, so that the mere filling up of the interior of univalve and bivalve shells, before the matter of the shells themselves disappeared, or even when these are still left, be not taken for the preserved remains of the fleshy portions of the molluscs. We should expect, in cases of real preservation, as in those of vegetables, that the original tissue would be found by slicing in the usual manner. Mr. Charlesworth, who also forwarded a lithographic plate to appear with descriptions in the next number of his *Geological Journal*, considers that in the specimens he notices the fleshy parts of the *Trigonia* are really silicified, and states that the silica has only preserved some of the soft parts, without filling the entire cavity of the shell, and so that the filaments of the branchiæ have all the appearance of an elaborate piece of dissection. Certainly the entire cavity of the shell not being filled up is very important, and as we find that the tissue of succulent vegetables has been preserved in silica, it may be fairly asked, why may not the fleshy parts of molluscs be thus also preserved?

The slags from our furnaces are often, as is well known, found crystallized in drusy cavities, their component parts having in such situations been placed under the needful conditions for adjustment according to their affinities, and for taking the definite forms due to their combinations. In a Report to the British Association on Crystalline Slags by Dr. Percy (of Birmingham) and Professor Miller (of Cambridge), published during the past year, we have the analyses and crystallographic and mineralogical descriptions of many of these bodies, some of which, in the collection of Dr. Percy, are exceedingly interesting. Six analyses of crystallized slags from iron blast furnaces gave the formula $Al^2 O^3, SiO^3 + 2(3(Ca, Mg, Mn, Fe)O, SiO^3)$, which differs from that of vesuvian in containing two equivalents of the lime series instead of one. The crystals of these

slags were square prisms, some having their angles truncated by planes, making equal angles with the adjacent faces of the prism. In hardness they varied from 5.5 to 6.

Another slag from a hot-blast furnace at Oldbury is crystallized in thin square plates, the lateral faces of which are perpendicular to each other and to the terminal faces. Analyses lead to the formula $3(3\text{CaO}, \text{SiO}^3) + 3\text{Al}^2\text{O}^3, \text{SiO}^3$, one which appears also to represent the constitution of gehlenite. It is remarked, that admitting this slag to be the same with gehlenite, its production at a high temperature in an iron furnace is interesting when compared with the mode of occurrence of the natural mineral in the Fassathal, Tyrol, a description of which by Von Buch is appended. The analyses of another slag gave a formula nearly representing that of humboldtite, as deduced from the analysis of Von Kobell; at the same time it is observed that Damour gives another formula for humboldtite, which he believes to be identical with mellilite, and this formula is precisely that given for the first series of blast-furnace slags. Another beautifully crystallized slag was found in form and constitution to resemble olivine, the magnesia of the latter being replaced by protoxide of iron. A large series of slags from various metallurgical works have still to be investigated, and it is hoped that Dr. Percy and Professor Miller may ere long still further add to our knowledge of this class of substances, so important in their bearing on the minerals found in connection with igneous rocks.

All modes by which we can artificially imitate the minerals found in nature are valuable, and more especially if any of these minerals should be what is commonly termed infusible. We have to record very important and successful experiments of this kind by M. Ebelmen, who has employed a method entirely new. He observes that two modes have hitherto been adopted to produce definite and crystallized combinations. One consists in submitting to igneous fusion either simple or compound bodies, alone or mixed with each other in certain proportions proper to form the definite combinations, whence it often happens that crystals form and become isolated in the midst of the melted mass as it cools, thus presenting a substance of a porphyritic character. The second method is by sublimation.

M. Ebelmen proceeds upon another and very simple principle. He seeks for a substance which at a high temperature acts like water, as regards the substances dissolved, either at its ordinary or at a slightly elevated temperature. As by the evaporation of water crystallized combinations may be obtained, so by employing bodies capable of volatilization at very high temperatures, yet at a given degree of heat, while in fusion, capable of dissolving the greater part of metallic oxides, it was expected that certain calculated proportions of some oxides would crystallize, when the dissolving body was evaporated, at a great heat, in open vessels. Complete success has attended this view.

In this manner he has produced many minerals. He first mentions those composed of 1 equivalent of oxide consisting of 2 atoms of metal and 3 of oxygen, with 1 equivalent of oxide consisting of 1

atom of metal and 1 of oxygen, a class of minerals for the most part very hard, and some of which are gems. By mixing together

	gr.
Alumina	6·00
Magnesia	3·00
Green oxide of chromium.....	0·10 to 0·15
Fused boracic acid	6·00

he obtained, after the mass had been fused, and the boracic acid had been volatilized, rose-coloured spinels in every respect identical with the natural ruby spinel in form, hardness and chemical composition, analysis giving for the latter the formula $Al^2 O^3 MgO$. The blue spinel sapphire (octahedral) was obtained by mingling

	gr.
Alumina	5·00
Magnesia	2·40
Oxide of cobalt	0·20
Fused boracic acid....	4·70

The crystals arising from the treatment of his compound were sufficiently large to be seen by the naked eye, while those of the rose-coloured ruby spinel required a lens; they were hard, readily scratching quartz. Analysis gave the formula $Al^2 O^3 (MgO, CoO)$, that of the natural sapphire blue spinel. By employing the proper combinations, M. Ebelmen obtained the black and colourless spinels.

Referring to the analyses of M. Awdejew and M. Damour, as showing chrysoberyl to be an aluminate of glucina, he mixed together

	gr.
Alumina, slightly ferruginous ..	6·00
Glucina	1·62
Fused boracic acid.....	5·00

The form of the crystals obtained resembled some from the Brazils; they scratched quartz and topaz, were infusible before the blowpipe, and their analysis gave the formula $Al^2 O^3, GlO$, that for chrysoberyl. To complete the investigation for this substance its optical properties were tried, and were found to accord with the natural mineral.

Many other aluminates were obtained by the same method, such as the aluminate of manganese, the aluminate of iron, the aluminate of cobalt, the aluminate of lime, and the aluminate of baryta.

Many combinations of the sesquioxide of chromium with bases may in this manner be formed, and among them M. Ebelmen obtained an artificial chromate of iron by mixing

	gr.
Green oxide of chromium ..	7·50
Alumina	1·60
Peroxide of iron	3·00
Magnesia	1·10
Boracic acid	8·00
Tartaric acid	1·50

The tartaric acid was employed for the reduction of the peroxide

of iron. The octahedral crystals obtained, though they scratched quartz, did so with difficulty. The results of analysis sufficiently accorded with the formula ($\text{Cr}^2 \text{O}^3$, $\text{Al}^2 \text{O}^3$), (FeO , MgO), which it was inferred the analyses of the natural mineral by M. Abich would give.

Experiments, not yet completed, clearly show that silicates, infusible in our furnaces, may be prepared. Emeralds were obtained in crystals by fusing together, and treating in the manner mentioned,

	1.	2.
	gr.	gr.
Pounded emerald . . .	2·27 (Ural.)	5·00
Melted boracic acid . .	1·25	2·00
Oxide of chromium		0·05

The first mixture gave a stony mass, well-melted, the upper surface of which was covered by a multitude of small regular hexagonal crystals. The second compound gave a beautiful green mass, full of cavities in which were crystals similar to those found on the surface of the first mixture. Chrysolite was also obtained crystallized.

By employing borax as a solvent, crystallized alumina was procured. A mixture was made in the proportion of 4 parts of fused borax to 1 of alumina, and to this was added 1 part of oxide of chromium, by weight, to 100 parts of alumina. Numerous transparent crystals of a beautiful ruby colour, disseminated through a vitreous mass, were the result. By dissolving the vitreous paste in which they were included the crystals were isolated, and found completely unattackable by acids. In form these crystals resembled those of *téliésia*, and in their characters are identified with the real rubies and sapphires of mineralogists.

Seeing the results of his experiments, M. Ebelmen asks if, by adopting the method he has pointed out, we may not hope to obtain gems of a sufficient size to be valuable as such. His apparatus was small, and a few grammes only of the mixtures were employed. He anticipates that by using a greater quantity of the needful substances, and effecting the evaporation of the solvent in apparatus of larger dimensions, kept for a long time at a high temperature, crystals of greater size will be formed.

M. Ebelmen points out that the results of this inquiry, which can, as yet, be only considered as in its infancy, may be useful to geologists, as showing them that minerals completely infusible in our furnaces may be crystallized by aid of a solvent, at temperatures far inferior to that of their fusion, and thus we may account for the presence in many rocks of minerals associated with others of very different fusibility. He does not pretend that boracic acid and the borates have always been the natural vehicle for the crystallization of such minerals, though at the same time he remarks on the evolution of boracic acid from the earth, brought up at high temperatures by currents of gas and steam, pointing to the Lagoni of Tuscany, whence 500,000 kilogrammes of boracic acid are annually obtained, to the crystallized boracic acid found in the crater of Vulcano, and to the lakes in many

parts of the world containing borax in solution. Boracic acid and the borates may be certainly more abundant than is commonly supposed. As a constituent of schorl the former is much intermingled with the granites of Cornwall and Devon, and is more especially common in the schorl rocks, often occupying the outer part of these granites. In estimating the relative amount of boracic acid in schorl-bearing rocks, we should recollect that the mean of six analyses of black tourmalines, by Gmelin, gives 3.49 per cent. of that acid in their composition. We have also to reflect, that other substances may play the same part relatively to certain mineral compounds which boracic acid and borax have done for the substances employed in the beautiful experiments of M. Ebelmen.

It is always cheering to witness the application of mathematics to our science, showing its connection with those of the highest order. The labours of our colleague Mr. Hopkins in this field have, during the past year, been extended to a consideration of the Internal Pressure to which Rock Masses may be subjected, and its possible influence in the production of laminated structure. Referring to the lamination, so commonly known as *cleavage*, he points to the finest and most regular as leaving "no doubt of its being the result of some kind of molecular action of the constituent particles on each other, analogous to that of crystallization, and not the direct and immediate mechanical effect of external forces acting on the mass." It is scarcely necessary to state that this is the view taken by Professor Sedgwick, and that it is one in which we have long participated. When we consider the discoveries and researches of Faraday and others respecting the properties of matter, we seem to have forces acting on the great scale amply sufficient to produce such minor effects as we have then to consider jointing and cleavage to be. Indeed, looking at the arrangements of the mineral masses, their varied composition, and the general conditions under which they are placed, it is difficult to conceive that the particles composing them should not be subjected to influences thus affecting their ultimate arrangement. When we find pebbles, even as large as the head, cut through by joints, and are unable, by the most careful examination, to detect any shifting on the two sides of the joints, the surfaces of the latter most beautifully plane, with no appearance of splitting according to minor differences of resistance, such as we might anticipate in a mechanical fracture through conglomerates, we seem to have before us the effects of some great power, which can cut through pebbles, often of the hardest substances, adjusting the component matter on the (to us) great scale, without reference to such comparatively minor bodies. While in the divisional planes, to which the term *cleavage* has been applied, we find a shifting of the particles in the finer rocks, so that organic remains in them are contorted or lengthened in given directions, this becomes less as the rocks take a coarser character. As is well known, while the cleavage, in alternating beds of sandstone and slate, may be clearly seen in the latter, it can be often only discovered in the former by fracture of the beds, and then frequently it is coarse, while the cleavage in the alternating slates may be fine. These are

effects which we should expect from the causes to which we have before alluded.

Mr. Hopkins, after referring to the distortions of organic remains in cleaved rocks, observed some years since by Professor John Phillips, and more recently by Mr. Sharpe, remarks, that "these distortions of determinate organic forms indicate corresponding distortions in those elements of the mass in which they are respectively comprised." To the memoir of Mr. Hopkins, read before the Cambridge Philosophical Society, we must refer for the mathematical reasoning employed. In conclusion he points out that the shells, after being subjected to the pressure due to the weight of the superincumbent matter (and it may be here observed that the rocks cleaved, and thence termed slates, were originally clay, or at most silt beds), would be again exposed to pressure in common with the general mass, when the latter was folded into flexures and contortions so frequently observed in the cleaved districts composed of our older rocks. He observes, that none but small pressures or tensions would be called into action in the strike of the beds by their elevation into straight anticlinal ridges; and that two of the directions of principal tension or pressure would be in a vertical plane perpendicular to the direction of the anticlinal line and strike of the beds, with which the third axis of principal tension must coincide. "The axes of greatest and least tension," he adds, "through any point will lie in a vertical plane perpendicular to the strike of the beds, and consequently the intersections of the planes of greatest tangential action with the planes of the beds will be horizontal lines. Through every point there will be two planes of maximum tangential action perpendicular to each other, and therefore, dipping one of them in the same direction as the beds, and the other in exactly the opposite direction, the strike of all these planes being the same."

Mr. Hopkins further remarks, that if we recognise the probability of the influence of internal pressure, though not as a primary cause, yet as effective in determining the *positions* of the planes of cleavage, we must suppose that these planes must coincide more or less accurately, either with planes perpendicular to the directions of maximum pressure, or with those perpendicular to the direction of minimum pressure, or with the planes of greatest tangential action. He also points out, that on the last supposition the line of strike of the lamination must coincide with that of the planes of stratification, and considers that observation corroborates this inference. With respect to the opinion that currents of electricity have produced cleavage lamination, Mr. Hopkins remarks that such views, and those founded on the distortion of organic forms, are by no means to be considered as opposed to each other, but that on the contrary they may assist each other, and be mutually useful for arriving at a correct theory.

Even this notice of some portion only of the progress made in Geology during the past year (for it would require a volume instead of an address, necessarily limited as this must be, to enter

upon its full detail) will be sufficient to show, that not only does the geologist advance by means of those labours which may be considered as more peculiarly his own, but that he also receives the aid of those cultivating various other branches of knowledge, and who find in his science objects of high interest, and not unfrequently obtain assistance for their own sciences, which otherwise would not occupy the advanced position they now hold. It may be that amid the communications made public, many may be defective, some even erroneous: in the advance of knowledge this always has been and will be: the approach to truth is often but the removal of error; but looking broadly at the state of our science, we find it occupying minds of no ordinary kind, dispersed over various parts of the world, and we cannot but anticipate that great as its advance has been within a very limited number of years, it is destined to move forward still more rapidly. Let us trust that these anticipations may be realized, and that by a continuance of the kind feeling and hearty cooperation of its members which has marked its course hitherto, this Society may ever be found taking its right place among those which seek only the advance of truth.

THE END.