

state of the body, and essential to the production of an important element of respiration. The American Indian, with his present habits of living solely on flesh, could not with any comfort use tea as an article of food; for his tissues waste with such rapidity that, on the contrary, he has to take something to retard this waste. And it is worthy of remark, that he has discovered in tobacco smoke a means of retarding the change of matter in the tissues of his body, and thereby of making hunger more endurable. Nor can he withstand the captivation of brandy, which, acting as an element of respiration, puts a stop to the change of matter, by performing the function which properly belongs to the products of the metamorphosed tissues. The third part of Prof. Liebig's Report treats of the recondite laws of the phenomena of motion. As it is principally of a speculative character, we can pass this over. The Professor concludes his communication by two chapters: one on the theory of disease; the other on the theory of respiration. The whole life of animals consists of a conflict between chemical forces and the vital powers. In the normal state of the body of an adult, both stand in equilibrium. Every mechanical or chemical agency which disturbs the restoration of this equilibrium is a cause of disease. Disease occurs when the resistance offered by the vital force is weaker than the acting cause of disturbance. Death is that condition in which chemical or mechanical powers gain the ascendancy, and all resistance on the part of the vital force ceases. Every abnormal condition of supply or waste may be called disease. It is evident that one and the same cause of disease—that is, of disturbance—will have different effects, according to the period of life. A cause of disease, added to the cause of waste, may in old age annihilate the resistance of the vital powers, or, in other words, occasion death; while, in the adult state, it may produce only a disproportion between supply and waste; and in infancy only an abstract state of health, *i. e.* an equilibrium between supply and waste. Prof. Liebig argues, from what has preceded, that a deficiency of resistance in a living part to the cause of waste is in fact a deficiency of resistance to the action of the oxygen of the atmosphere. The professor's theory may be compared to a self-regulating steam-engine. The body, in regard to the production of heat and of force, acts just like one of those machines. With the lowering of the external temperature, the respiration becomes deeper and more frequent; oxygen is supplied in greater quantity, and of greater density; the change of matter is increased, and more food must be supplied, if the temperature of the body is to remain unchanged. It has been proved, that iron is not necessary to the colouring matter of the blood, but that it forms an essential constituent of blood globules. These globules, it is well known, take no part in nutrition. Prof. Liebig conceives, that the iron is the great means of conveying to the lungs the carbonic acid formed in the system; and he has made a calculation, that the iron contained in the body could actually convey twice as much carbonic acid as is expelled daily from the system.

Mr. SOLLY read a paper by Prof. Schönbein, 'On the Electrolyzing Power of a Simple Voltaic Circle.' The effect of various experiments made by the learned author went to establish the fact, that voltaic effects may be produced without the solution of a metal, the usual source of voltaic actions, but by nitric and various other acids.

Mr. WILLIAM BLYTH read a paper 'On the Manufacture of Sulphuric Acid.'—The ordinary process of manufacturing sulphuric acid, by introducing into a leaden chamber a mixture of sulphurous acid, red nitrous fumes, and common air, has been long practised. Like many other improvements in the arts, it seems to have been more the result of chance than the application of scientific skill; and chemists remained long in the dark as to the true nature of the changes which took place in the vitriol chamber. The first satisfactory explanation was given to the world by Clement and Desormes, in 1806. These chemists discovered the white crystalline compound which is now known to be formed when sulphurous acid, red nitrous fumes, common air, and the vapour of water, are mixed together, and exposed to a sufficiently low temperature. They also observed the remarkable property which it possesses of being decomposed when put into water, and of being resolved

into nitric oxide and sulphuric acid. This fact they applied to explain the important part performed by the nitric oxide, in enabling the sulphurous acid to be still farther oxydized at the expense of the oxygen in the common air. The formation of the crystalline compound in the leaden chamber, its decomposition by the weak acid at the bottom of the chamber, and the evolution of nitric oxide to be again changed into red nitrous fumes by the oxygen of the common air,—is the favourite theory of chemists at the present time, and seems to be now generally admitted. M. Adolph Rose, of Berlin, has recently published a paper on the 'Combination of Hydrated Sulphuric Acid with Nitric Oxide.' The object of the paper is to show that the impurity in the sulphuric acid of this country, which has hitherto been considered to be nitric acid, is not nitric acid, but a combination of sulphuric acid and nitric oxide. He also shows, that this compound of sulphuric acid and nitric oxide is identical with the white crystalline formed in the vitriol chamber. There are some facts mentioned in this important paper which deserve attention; and it is more particularly the object of these remarks to bring them under the notice of those members of the Association who may be interested in the manufacture of this important acid. It is well known, that, in the making of sulphuric acid, when the acid in the chamber reaches the specific gravity of 1.450, it is impossible to go beyond this point without increasing the proportion of nitre; and even with an increased proportion of nitre, the product of acid is less than it ought to be. The reason is, that sulphuric acid, of the specific gravity of 1.450, acts very slowly in decomposing the white compound; and acid of the specific gravity of 1.500 will not act upon it at all, but, on the contrary, it has a tendency to dissolve and retain it.—Mr. Blyth demonstrated these facts by experiments.—M. Adolph Rose states, that when sulphuric acid, containing the compound, is concentrated by distillation, at one part of the process pure acid comes over; and when the acid in the retort has reached the specific gravity of 1.84, it will be found, if examined, to contain nitric oxide. It follows from this, that, when sulphuric acid is raised in the chamber above the specific gravity of 1.500, it will be found, after being rectified, more or less contaminated with the nitrous compound. He made a number of trials, to ascertain the effect of the nitrous compound upon indigo. Some of the compound was dissolved, by the aid of heat, in sulphuric acid of specific gravity 1.600. To this solution he added some drops of a strong solution of indigo in pure rectified sulphuric acid. The blue colour of the indigo was immediately destroyed. M. Adolph Rose also states, that, if rectified sulphuric acid, which is contaminated either with nitric acid or nitric oxide, be diluted with twice its bulk of water, and concentrated by distillation till it reaches the specific gravity of 1.84, the concentrated acid will be found to have been freed from both of these compounds. It follows, from this experiment, that, in order to obtain sulphuric acid sufficiently pure to be used in the preparation of sulphate of indigo, it would only be necessary to draw the acid from the chamber at a low specific gravity, not higher perhaps than 1.300 or 1.350. Rectified sulphuric acid, prepared from acid drawn from the chambers at the above strength, if found to be perfectly free from all nitrogenous compounds, will be a great acquisition to the woollen dyer in the preparation of his sulphate of indigo; and when we consider the large quantities of acid used for this purpose, it will be admitted to be a subject of great importance.

SECTION C.—GEOLOGY AND PHYSICAL GEOGRAPHY.

President—Mr. R. I. MURCHISON.
Vice-Presidents—Sir H. T. DE LA BECHE, Rev. W. BUCKLAND, Rev. A. SEDGWICK, Mr. R. GRIFFITH.
Secretaries—Mr. H. E. STRICKLAND, G. LLOYD, M.D., Messrs. E. W. BINNEY, R. HUTTON.
Committee—Prof. Owen, Mr. J. Phillips, The Earl of Enniskillen, M. Erman, Count A. Von Keyserling, Dr. Dieffenbach, Mr. Schoolcraft, (U.S.) Mr. I. F. Bateman, Dr. Black, Messrs. G. W. Ormerod, J. Taylor, W. C. Williamson, W. Gray, jun., Rev. T. Egerton, Messrs. J. Hawkshaw, J. Bryce, H. C. Campbell, E. Hall, M. Dawes, Rev. D. Williams, Mr. L. B. Ibbetson, Marquis of Northampton, Rev. W. Whewell, Mr. W. F. Ainsworth.

1. 'On the Physical Structure of the Appalachian Chain, as exemplifying the laws which have regulated the elevation of great Mountain Chains generally,' by Professors H. D. Rogers, and W. B. Rogers.

The Appalachian Chain of North America is described by the authors as consisting of a series of very

numerous parallel ridges or anticlinal lines, forming a mountain belt generally 100 miles in breadth and nearly 1200 miles in length, stretching from the South-eastern angle of Lower Canada to Northern Alabama. 1. The strata which compose this chain are the American representatives of the Silurian, Devonian, and Carboniferous systems of Europe, united into one group of conformable deposits. The general direction of the chain being N.E. and S.W., there is a remarkable predominance of S.E. dips throughout its entire length, especially in the south-eastern or most disturbed side of the belt. Proceeding north-westwards or away from the quarter of greatest disturbance, N.W. dips begin to appear; at first few and very steep, afterwards frequent and gradually less inclined. 2. The authors consider the frequency of dips to the S.E. or towards the region of intrusive rocks, accounted for by the nature of the flexures, which are not symmetric, the strata being more inclined on the N.W. than on the S.E. of each anticlinal, amounting at length to a complete folding under and inversion, especially on the S.E. side of the chain, where the contortions are so closely packed as to present a uniform dip to the S.E. These folds gradually open out, the N.W. side or inverted portion of each flexure becomes vertical, or dips abruptly to the N.W.; proceeding further in this direction the dips gradually lessen, the anticlinals and troughs becoming rounder and flatter, and the intervals between the axes constantly increasing till they entirely subside at about 150 miles from the region of gneiss and intrusive rocks. The authors express their belief that a similar obliquity of the anticlinal axes will be found to obtain in all great mountain chains, their planes always dipping towards the region of chief disturbance. The inverted flexures are regarded by the authors as exhibiting simply a higher development of the same general conditions. The passage of inverted flexure into faults is stated to occur frequently, and invariably along the N.W. side of the anticlinal or S.E. of the synclinal axes; these dislocations, like the axes, maintain a remarkable parallelism. 3. The axes of the Appalachian chain are distributed in natural groups, the members of each group agreeing approximately in length, curvature, amount of flexure, and distance apart. Nine principal groups are described, in five of which the axes are straight, whilst the four which alternate with them are curved; in two of the curved divisions the line of strike is convex to the N.W., in the other two it is convex to the S.E. In every part of the chain the axes, whether curved or straight, maintain an approximate parallelism to those of their own division, and in the minor groups within the large divisions the parallelism is still more exact. The axes vary in length from insignificant flexures to lines frequently 100 and sometimes 150 miles in length, and they deviate very little from a rectilinear course, or, as the case may be, from a uniform rate of curvature. Some of the longer curved axes exhibit a difference of strike at their extremities of 50 in a distance of 90 miles, and the rectilinear axes of different divisions vary in their line of direction as much as 60°. As all the flexures were undoubtedly formed at one period, the authors consider these facts at variance with M. Beaumont's hypothesis, that dislocations of the same geological age are parallel to one and the same meridian. 4. The general declension in level of the Appalachian strata towards the N.W., or away from the quarter of greatest local disturbance, is considered important by the authors in its bearing upon the subject of the elevation of broad continental tracts. The authors next proceed to notice memoirs, describing what they consider similar phenomena in Europe.

Theory of Flexure and Elevation of Strata.—From the consideration of the preceding general facts the authors have arrived at a theory which they conceive applicable to the bending and elevation of strata generally. They state that the oblique form of all normal anticlinal and synclinal flexures "indicates that the force producing the dips was compounded of a wave-like oscillation and a tangential pressure;"—a purely vertical force exerted simultaneously or successively along parallel lines could only produce a series of symmetrical flexures, whilst tangential pressure, unaccompanied by a vertical force, would result in irregular contortions dependent on local irregularities in the amount of resistance. The alternate upward and downward movements necessary to

enable the tangential force to bend the strata into a series of flexures, are such "as would arise from a succession of *actual waves* rolling in a given direction beneath the earth's crust." The authors observe that it would be difficult to account for the formation of grand yet simple flexures, by a repetition of feeble tangential movements, or by "a merely upward pressure, unaccompanied with pulsations on the surface of a fluid; and if this force be feeble and oft repeated, it is difficult to understand how it could return always to the same lines until they became conspicuous flexures." The authors suppose the strata of the region in question to have been subjected to excessive upward tension arising from the expansion of molten matter and gaseous vapours; the tension would at length be relieved by many parallel fissures formed in succession, through which much elastic vapour would escape, and, by thus removing the pressure adjacent to the lines of fracture, produce violent pulsations on the surface of the fluid below. This oscillatory movement would communicate a series of temporary flexures to the overlying crust, which would be rendered permanent by the intrusion of molten matter into the fractured strata originating the tangential force by which the flexures received their peculiar character before described. The authors do not deem it essential to this explanation that, in the production of axes of elevation, the strata should be permanently fractured to the surface. Fissures sufficient for the escape of vast bodies of elastic vapour, might open and close again superficially; and the strata may often be supported in their new position by subterranean injections not visible on the surface.

Identity of the Undulations which produced the Axes, with the wave-like motion of the Earth in Earthquakes.

—The authors suppose all earthquakes to consist in oscillations of the earth's crust propagated with extreme rapidity; and they ascribe this movement to a sudden change of vertical pressure on the surface of an interior fluid mass, throwing it into wave-like undulations, such as would produce permanent flexures in the strata if more energetic, accompanied by the formation of dykes. The successive earthquakes of any region usually proceed from the same quarter, and this must also have been the case with the movements which gave rise to the parallelism of contiguous anticlinal lines. In illustration of the power of producing permanent lines of elevation which earthquakes have exhibited in modern times, the authors instance the Ullah Bund, an elevated mound extending 50 miles across the eastern arm of the Indus, which was the result of the great earthquake of Cutch in 1819; and another case recorded in 'Darwin's Journal of Travels in South America,' which a traveller described as a line of elevation of the strata, crossing a small rivulet, and shown in the fact that he found himself going down hill while ascending the dry deserted channel.

Date of the Appalachian Axes.—The authors describe the elevation of this chain as simultaneous with the termination of the carboniferous deposits of the United States, and as the cause which probably arrested the further progress of the coal formation. With one local exception, on the Hudson, the whole series seems to have been deposited conformably, without any emergence of the land. That the elevation did not take place later, is shown by the undisturbed condition of the overlying beds, approximately of the age of the European new red sandstone. The elevation of the chief part of the great belt of metamorphic rocks on the S.E. side of the chain is referred to the same great movement. In conclusion, the authors remark that an incomparably greater change in the physical geography of North America, and perhaps of the globe, seems to have occurred at the close of the Carboniferous epoch than at any previous or subsequent period; and they consider these changes, and the effect produced by them on the organic world, as affording some of the highest subjects of geological investigation.

Mr. MURCHISON confirmed the views given by the authors of the paper, of the great break in the series of geological deposits which occurs between the Palæozoic rocks and later deposits; the coincidence in the direction of some great chains in Europe and America, belonging to the same geological period, was very striking. He was not prepared to give any opinion upon Prof. Rogers's undulatory theory.—Sir H. T. DE LA BECHE described the general character of

anticlinal and synclinal lines, and stated, that whilst contortions of the strata sometimes assumed the character of mountain chains, at other times they occupied large tracts of low ground, as in the comparatively flat country of South Wales. He then made some observations on the space occupied by masses of rock over certain areas; the older rocks of England, if flattened, would occupy a much greater space than at present; and the area of the Alps and Jura would be greatly extended if all their contortions were spread out. The phenomena described in the Appalachian chain, so far as small differences in the direction of the anticlinals were concerned, did not at all affect the brilliant theory proposed by M. Elie de Beaumont; the object of the geologist was to trace the correspondence in the direction of the great lines of elevation, and in this broad view the N.E. and S.W. direction of great part of the European rocks agreed remarkably with the direction of the Appalachian chain. He did not consider the pulsation of molten matter, as described by the authors of the paper, necessary to account for the flexures so very numerous in the strata of mountainous districts, but not confined to them, and in many instances unaccompanied by the intrusion of igneous rocks. The only force necessary for the production of such flexures and contortions was, the tangential or lateral pressure, in order to compress the strata into a smaller space. Contortions were formerly accounted for by a supposed secular diminution in the volume of the earth; the crust was compelled to accommodate itself to the diminished surface arising from the contraction of the mass. But it was to be remembered, that these contortions were not common to all the world: in Russia, the strata presented one even bend over a wide area. Our knowledge of America, and much of the rest of the world, was imperfect; and until we were much better acquainted with the distribution and character of contorted strata all over the globe, we should not be able to account very rationally for the figures they assumed.—Mr. SEDGWICK pointed out those circumstances in the structure of the Appalachian chain which accorded with previous observations in Europe; the persistency of the strike of the strata, the parallelism of the anticlinal and synclinal lines, and the diminution in the amount of disturbance as the strata recede from the district where the greatest force was applied. He did not allow that the circumstance of curvilinear elevations was opposed to the theory of M. Beaumont, who had himself described curved elevations quite as striking. Most of the instances adduced by Prof. Rogers, in illustration of his view of the average inclination of the strata being greater on the side of each flexure farthest from the centre of the disturbing forces, did not, in his opinion, confirm the view the authors had taken of the origin of those contortions. Again, Mr. Sedgwick stated, the position of the successive strata in the British chains, was not generally such as that which characterized the chain so carefully described by the authors of the paper. The effects of disturbing forces, such as the intrusion of igneous rocks, was chiefly dependent on the nature of the rocks affected. In Cumberland the porphyritic rocks, which were evidently molten when introduced, had become hard by cooling, and had been fractured and dislocated along with the rocks among which they were intruded; but from the very nature of those rocks, they could not be thrown into many undulations. In North Wales, where the conditions differed, and the igneous rocks were less abundant, the alternating beds of solid porphyry and softer rocks were thrown into a series of anticlinal and synclinal lines; whilst in the Liege country the beds, when in a very soft and plastic state, had evidently been subjected to great lateral pressure, forcing them to assume enormous contortions, but never elevating them into mountains. The authors had, he thought, rather undervalued the power of tangential forces. These were well illustrated in the effects produced upon the soft slates of North Devon, by the intrusion of masses of granite many miles across, like that forming the forest of Dartmoor, between which and other granite masses, the strata were crumpled and thrown into innumerable undulations. He believed there was very little analogy between the phenomena produced by earthquakes, and those attributed to continental elevation; the oscillations of the earth's sur-

face produced by earthquakes were like those of a cord struck when subjected to tension: from the very nature of these vibrations, they might be propagated rapidly over a great part of the globe. The impulses of elevation, as far as anything was known of them, were slow, acting over wide areas, and disrupting and contorting mountain masses. Nothing was more certain than that continental masses had risen, and were rising, in our own time: Norway, for example, with curvations so slight as to be invisible. In the Southern and Pacific Ocean, Mr. Darwin had pointed out large areas, rising and subsiding, some of them 3,000 or 4,000 miles in diameter. He stated that he was not prepared to grapple with a theory which was so imperfectly explained, and without diagrams; he only wished phenomena not to be pressed into its service, which either bore not upon it at all, or were, perhaps, opposed to it—namely, the phenomena of the British chains. He lastly endeavoured to show how, in many cases, a reversed dip might be produced after the first protrusion of a central granitic axis. Prof. Sedgwick concluded with a merited compliment to the American nation for the elaborate surveys they had published, of which the present memoir was an example; the facts of which must, in the end, serve along with similar phenomena to form the base of a legitimate theory.

'Report of Committee appointed at the Meeting of the British Association, held at Plymouth in 1841, for Registering Shocks of Earthquakes in Great Britain.'

The Report commences with a list of shocks observed at Comrie, in Perthshire, since the date of that given in, last year, to the Association by the Committee. (*Athenæum*, No. 719.) Sixty distinct shocks are recorded as having occurred on thirty-six different days, between July 23rd, 1841, and June 8th, 1842. Twelve of these are registered as having occurred on the 30th of July, 1841, being the greatest number hitherto noticed in the course of a single day. The instruments employed to indicate the shocks were those described last year (*Athenæum*, No. 719.) The new instruments provided by the Committee have not (with one exception) yet been affected, having been but a short time at their respective stations; and out of the sixty shocks above mentioned, there were but three occasions on which these instruments were moved.

1. On the 26th July, 1841, the inverted pendulum set in the steeple of Comrie parish church, was thrown about half an inch to the west, apparently indicating a horizontal movement of the ground eastward, to the same amount. An upward heave of the ground, to the extent of half an inch, was also indicated by two instruments, one of them being a horizontal bar, described in the course of the Report.—2. The next shock by which the instruments were affected occurred on the 30th July, 1841. The inverted pendulum in Mr. Macfarlane's house at Comrie, vibrated to the extent of half an inch, in a direction south and north; whilst at Tomperan (about 1½ mile east of Comrie), an instrument on the principle of the common pendulum vibrated east and west. The instruments for showing vertical movements were but slightly affected. Mr. Macfarlane describes this shock as very severe, though not so violent as that of October, 1839: estimating the former at 10, the intensity of this shock may be represented by 8. The shock was distinctly double, and the noise and vibrations accompanying it are described as very loud and violent, both as observed within houses and in the open air. Twelve shocks are said to have been felt in the course of the day; the weather was cold and inclined to stormy, at the time of this occurrence, and for a day or two before and after. The trees in the neighbourhood of Comrie are described as much agitated. The shock was felt eastward, at least as far as Newburgh, about 38 miles from Garriehrow; westward to Dalmally, about the same distance; as far north as Glenlion, 30 miles; and southward to Alloa and Stirling, 20 or 30 miles. All the shattered chimneys noticed near Duniva, were on walls, &c. running N. and S.; those on E. and W. walls being untouched. The injured buildings stood on a gravelly soil; but the distance from rocks below was unknown. There was nothing in the weather previous to the earthquake, to give any notice of its approach; indeed, after a course of some years' observation, no exact rule in this respect has been obtained; even a period of wet weather, which was formerly thought the constant forerunner of frequent and violent shocks, is not always succeeded by them; and, on the other hand, earthquakes have occurred when the sky was clear and open. The spot from which the earthquake shocks in Perthshire appear to originate, being situated about a mile to the north of Duniva, it is not difficult to understand why walls running N. and S. were affected; and those from E. to W. untouched.—3. On the 9th Sept. 1841, another pretty severe shock was felt at Comrie, about 10' before midnight. The following morning the Association's instrument in the steeple was inclined ¼ of an inch to the south; that in the Comrie House ½ an inch to the north. This disagreement in the indications may perhaps be accounted for by the occurrence of two other shocks in the course of the night, and previously to the examination of the instruments: the weather during the two preceding days was remarkably wet and close.—4. On the 8th June, of the present year, two shocks were felt at Comrie, between 1 and 2, A.M. The horizontal pendulum recently sent to Mr. Macfarlane's house, indicated an upheave of the ground to the extent of a quarter of an inch. From a review of all the details, it seems probable that the particular spot from which the earthquakes emanate, is situated about one mile