LXV. Inquiry how far the theory of M. Elie de Beaumont concerning the parallelism of lines of elevation of the same geological Æra, is agreeable to the phænomena as exhibited in Great Britain

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defects unamended. It is not worth while to alter the names till we can construct them so as to indicate the constitution of the salt in reference to *water* as well as to soda. Now here we find our present system of nomenclature at fault. Such combinations as we have to name were never contemplated, and are not provided for. The function of water in the constitution of the salts has been hitherto almost entirely overlooked. I am now prepared to show that its interference is not confined to the phosphates; that it discharges an equally important function in other classes of salts. It modifies the constitution, likewise, of many metallic peroxides,—of the peroxides of tin, for instance,—and supplies the explanation of many cases of apparent isomerism.

It is certainly one great advantage of chemical formulæ that they may be made to compensate to a certain extent for the increasing deficiencies of the nomenclature. From new light thrown upon the constitution of some familiar salt, its name ceases to indicate its received constitution, or even belies it. In such cases, where it may be inexpedient to change the name, it may be qualified when used by subjoining in parentheses the correct formula of the salt. I confess that I underrated the advantages of chemical notation till its use was forced upon me in the study of the phosphates. But now I am satisfied that to neglect it would be voluntarily to forgo a most valuable aid in the conception and exhibition of chemical relations. I remain, Dear Sir,

With much respect, yours truly,

Glasgow, April 9, 1834.

THOMAS GRAHAM.

LXV. *Inquiry how far the Theory of M. Elie de Beaumont concerning the Parallelism of Lines of Elevation of the same Geological Æra, is agreeable to the Phenomena as exhibited in Great Britain.* By the Rev. W. D. CONYBEARE, M.A., F.R.S. V.P.G.S. Instit. Reg. Soc. Paris.

[Concluded from vol. i. p. 126.]

Supplement **E**LEVATIONS during the interval between to III.—the close of the æra of the carboniferous formations and the commencement of that of the new red sandstone and dolomite, which may be shortly called the Antedolomitic æra.

If we examine our principal coal-fields, *e.g.* (proceeding from S. to N.) the Bristol coal-basin, that of the Forest of Dean, that of South Wales, the coal-fields of Shropshire and Flintshire on the eastern edge of the transition chains of

North Wales, those of Central England at Dudley, in the N.E. of Warwickshire and at Ashby, those on both sides of the great Penine chain on the east in Derbyshire, Yorkshire, Durham, and Northumberland, and on the west in Lancashire, and again mantling round the Cumbrian group to Whitehaven, we shall find the subjacent old red sandstone and carboniferous limestone, and all the coal-measures, more or less elevated, generally very considerably so, and the stratification of this whole series generally conformable; whereas the lower strata of the new red sandstone and the intervening dolomitic limestone will be found comparatively almost horizontal, and little disturbed, and altogether unconformable to the carboniferous series; so that it should appear that the principal æra in which the disturbing forces which have produced these phænomena acted, was at the very close of the carboniferous period, and [anterior to that of the dolomitic formation, although it may, indeed, be said that this may with equal propriety be assigned as the concluding æra of a succession of elevations acting with a general uniformity of direction during the whole period of the deposition of the carboniferous rocks rather than one single violent elevation; and certainly the phænomena of the exact conformity of the whole coal series has scarcely hitherto been so minutely examined as to authorize our pronouncing very positively which of these hypotheses seems best to explain them, although, from the general conformity which I have noticed, I should certainly incline to adopt that of a single period of elevation. The continental coal-basins of the Meuse, and many of those of Northern Germany, appear to have been elevated at exactly the same period. The lines of these elevations are, however, assuredly not parallel, for those in the south portion of our island generally range east and west, and those in the north range north and south, forming tangents to the curve which, as I have already noticed, expresses the general line of the elevation of our strata of whatever age. But to proceed regularly with the detail.

The carboniferous limestone first shows itself on the southern coast along the skirts of Torbay, Devonshire: it is here greatly elevated and contorted, and we may refer to the intrusive masses of greenstone as the probable cause of the disturbance. The lowest beds of the Exeter conglomerate, usually classed with the new red sandstone, also partake in this disturbance, which might seem to refer it to a more recent period than that of which we are now treating; but yet it does not appear altogether improbable that these may be the very lowest deposits of this great series, and possess a comparative antiquity

greater than that of the Pontefract sandstone and dolomitic limestone, which are usually undisturbed; a supposition which would enable us to refer these disturbances to the æra we are now considering. It seems probable, but by no means certain, that the elevation of the transition chains in North Devon and on the adjoining borders of Somerset, such as the Brendon and Quantock Hills, may be of this æra. The carboniferous limestone of Cannington park, on the north of the Quantocks, appears to conform to the elevation of that chain, which may incline us to adopt this age.

Entering on the Bristol coal-field we find its southern bordering chain, the Mendips, composed of carboniferous lime with an axis of old red sandstone highly elevated, the disturbances equally affecting the incumbent coal-measures, but leaving the dolomitic conglomerate undisturbed and nearly horizontal, so that the age is here distinctly marked. This line of elevation ranges nearly E. and W. a little inclining to W.S.W. and E.N.E.: it is prolonged by the Isle of Steepholm in the Bristol Channel. The elevation bounding the coal-basin on the west is more complicated, being associated with parallel undulations and disturbed by faults. It is continuously prolonged in a direction somewhat tortuous, but generally bearing from S. to N. into the centre of Herefordshire; and as it is obviously of the same age with the Mendip elevation, which ranges E. and W. affecting equally the coal-measures and all the older rocks, but leaving the younger dolomitic conglomerate and new red sandstone undisturbed, it seems to afford a convincing example that disturbances of the same age do not uniformly pursue parallel lines: thus, it reaches Shackwell hill, 7 miles east of Hereford, where it inosculates with the anticlinal line which forms the western border, as the above does the eastern, of the Forest of Dean basin. This ranges southwards from Westhild by Kenchurch, where it crosses the Manno River, as it does the Uske, a little west of Ryland, throwing up the transition limestone thence to Uske. A few miles south-east of this place this line, which has hitherto ranged north and south, trends towards the west, hence forming the southern boundary of the South Welsh coal-basin. Thus it affords us an example, not simply of lines of elevation of the same age, but of the same individual line, which, after pursuing a course in one direction for 50 miles, curves round, and adopts for 100 miles a course exactly at right angles to the former. It ranges north of Caerleon by Llandaff to Cowbridge: thence ranging by Kenfig, it crosses Swansea Bay to Gower, where it throws up the old red sandstone central chain of the peninsula of Gower, thence crossing to Tenby, where we have

two parallel undulations of carboniferous limestone and old red sandstone. From Pembroke this line crosses Milford Haven, still proceeding westwards. Between the haven and the Irish Channel intrusive masses of trap rocks penetrate the strata, which are here very remarkably contorted: these may, perhaps, be considered as indicating the probable volcanic origin of these disturbances. The whole of these phenomena are fully described in Mr. De la Beche's memoir in the Geological Transactions, and most accurately represented in the accompanying plates. The age of all this line is clearly defined by the contact of the disturbed coal and undisturbed dolomitic conglomerate in Glamorganshire. To trace it more particularly: its southern extremity forms a double line of elevation, including the Nailsea coal-field; between them the southern of these anticlinal lines ranges from the Island of Flatholm in the Bristol Channel through Broadfield down to Leigh Down, where it is continued by the great fault of the carboniferous limestone crossing the Avon at St. Vincent's Rocks, nearly in the same line with which we trace an anticlinal line crossing the centre of the coal-field and throwing up its lowest grits on the north of Kingswood. The range of this southern portion of the double line is S.W. and N.E. The northern portion at first seems to have its axis beneath the Severn, being connected with a tremendous fault, which on the north of Clevedon has thrown down the coal-measures more than 1000 feet, so as to bring them into contact with the old red sandstone range at the foot of Leigh Down, causing the carboniferous limestone and old red sandstone again to crop out in one place at a superficial distance of 3 miles from this natural line. Beyond this subsided tract the anticlinal line is continued from Portishead Fort across the Avon, near Sneyd Park; thence northerly to Thornbury and Berkeley, between which places the transition limestone is elevated, apparently by the intrusive trap dykes of Tortworth: here it crosses the Severn, from hence forming the eastern boundary of the Forest of Dean coal-basin, as it has before formed the western boundary of that of Bristol. It ranges by Nuneham, throws up the transition quartz rocks of May Hill, and the transition limestone chain of hills which ranges between the river Wye.

The interior of the coal-basin in Glamorganshire is affected by another anticlinal line, nearly parallel to the former: this commences near Bedwas in Monmouthshire, ranges by Cefn Eglwysilon, crosses the Taafé near Newbridge, and thence ranges west to the iron-works at Duffryn Llanry, and is cut off by the æstuary of the Neath at Britton Ferry.

The strata on the north edge of the South Welsh coal-basin

rise towards the general elevation of the subjacent transition chains, which, however, appear often unconformable: indeed Mr. Murchison has informed me that even the old red sandstone near Castle Carregkennon is unconformable, being nearly vertical, while the incumbent carboniferous lime is not inclined above 35° .

The north edge of the coal-basin is affected by considerable faults ranging E. and W.: one throws up the carboniferous limestone 4 or 5 miles within its general outcrop from Penderyn to the arched strata of Bwa Maln near Pont Nedd Vechon at the head of Cwm Neath. Similar to this, but on a smaller scale, is the fault at Cribborth lime rock in the upper part of Cwm Tawe, where an interval of three quarters of a mile takes place between the two outcrops of the limestone.

The line of elevation of the Malvern Hills, also N. and S., may, I apprehend, be certainly referred to this same æra, being evidently anterior to the deposition of the new red sandstone which skirts its base horizontally. Its main mass is a protrusion of sienitic rocks, which apparently have been the agents in effecting this disturbance, which throws up at a high inclination the transition limestone covering its western slope. The transition limestone of the Abberley Hills in the prolongation of this line has apparently been elevated by the same convulsion; but I am at present unable to state in what manner the coal-fields of Pensax and Billingsley, at the north end of this line, are affected.

The coal-field of Coalbrook Dale and the subjacent transition limestone of Wenlock Edge appear in like manner to have been elevated by the protrusion of the trap rocks of the Wrekin chain, and at the same period, that is, anterior to the æra of the new red sandstone: the line of direction is N.E. and S.W.

The Flintshire coal-field and its subjacent carboniferous lime repose conformably on the exterior chains of the North Welsh transition slates, so that the same forces of elevation must have affected all the members of these exterior chains; but, as before, anteriorly to the æra of the new red sandstone, the line of direction again differs from the Wrekin chain, being N.W. and S.E.

If we pass to the central coal-fields, we find that of Dudley reposing on the transition limestone elevated by a high anticlinal line ranging N. and S., with a slight tendency to N.E. We naturally incline to refer this convulsion to the eruptions which have left the overlying mass of trap on the south. Dykes of the same rock have been found intersecting the coal in Tivdale. The elevated quartz rock at the foot of the Bromsgrove Lickey, which is in the continuation of this

line, also ranges N. and S., and presents shattered masses of transition lime and trap on its sides. Trap rocks occur here also; the surrounding new red sandstone is horizontal and undisturbed. The Warwickshire coal-field, between Coventry and Tamworth, together with a subjacent narrow tract of quartz and grauwacké on its north-eastern border, is elevated in a line of direction N.N.W. and S.S.E. Greenstone dykes intersect the subjacent grauwacké at Griff near Bedworth.

The elevation of the sienitic and schistose ranges of Charnwood Forest may next be noticed; for as the contiguous coal-measures at Grace Dieu, and the magnesian beds of the carboniferous limestone at Breedon, appear to have been affected by the same convulsion, while the surrounding new red sandstone is undisturbed, this elevation must be referred to the æra we are now considering. In this view it may be compared to the eruption of the Malvern sienite and the various trap rocks of the Wrekin chain, which we have already referred to the same age*.

We now proceed to the great central ridge of the northern counties: this, as is well known, presents a central line of carboniferous limestone, ranging N. and S., having lateral zones of coal-measures on the east and west, which are overlaid on the east by the regular zone of magnesian limestone, as also on the west, if we consider this system as extending round the northern edge of the transition chains of Cumberland to Whitehaven. The magnesian limestone is separated from the coal-measures by a bed of sandstone representing the *rothe todte* of Northern Germany. Now as the magnesian limestone and its subjacent *rothe todte* repose unconformably on the elevated coal-measures, it is obvious that this elevation in a great measure took place anteriorly to the deposition of these superstrata. But again, as the *rothe todte* is often inclined when the superincumbent magnesian conglomerate and limestone is horizontal, we must suppose a second æra of convulsion posterior

* The first appearance of these rocks at Mount Sorrel exhibits a low ridge of well characterized sienite bursting through the red marl. A flat tract, concealed by this red marl, separates the Mount Sorrel ridge from the Swithland slate district on the west. This slate has rather the characters of greenstone slate than grauwacké: it alternates with and passes into greenstone and greenstone porphyry. The sienite presents several insulated portions emerging through the red marl south of Leicester along the western bank of the Soar, viz. Enderby Croft hill, beneath which the Soar flows through a defile of sienitic rocks, forming a sort of spur proceeding from the hill; Stony Stanton, where undisturbed beds of the red marl may be seen close to the sienite north of the village; and Shopcot, about a mile further south. The best account of Charnwood Forest will be found in the *Annals of Philosophy* for January 1824.—[See also a notice of Prof. Sedgwick's late examination of Charnwood Forest, in our Number for January last; present vol. p. 68.—EDIT.]

to the age of the *rothe todte*, and yet anterior to that of the magnesian limestone; and still further, as we find the 90-fathom dyke of Northumberland throwing down likewise the magnesian limestone, we must here have recourse to a third period of convulsion. The main direction of elevation, and that which, as we have seen, must be referred to the æra of which we are now especially treating, ranges N. and S. Of the direction of the second, we have no sufficient information: the great fault exemplifying the third ranges east and west. But before we can fully pronounce as to the æras of the several disturbances of this great chain, this very interesting portion of our country requires a much more minute investigation. It may perhaps not be altogether useless, at a meeting like the present, to suggest some of the objects of inquiry: 1st, according to Farey, the limestone district of Derbyshire forms a vast elevated tract, bounded on three sides, the north, west and south, by a vast fault, which depresses the superincumbent shale of the millstone grit formation into contact with the whole series of the subjacent limestones successively, until at length along the western border the lowest limestones abut against these superior beds. But the existence of this fault still requires more accurate examination: we do not know how far the general inclination of the strata accords with this supposition. Should it be found, as is not improbable, to have been assumed in order to explain the position of the masses of toadstone, taking these for regular and conformable beds, will it not be much more probable that these intrusive rocks are absolutely unconformable to the disposition of the strata on the great scale, and must, therefore, afford the most fallacious evidence as to the general structure of the district?*

The fault traversing the coal-measures N. and S., nearly in the line of the baset edge of the magnesian limestone which Mr. Farey describes as the great zigzag fault, also stands in need of corroborative evidence.

Yet is there nothing in the existence of these faults at all incompatible with what we certainly know concerning other portions of this central ridge; for proceeding into Yorkshire, we certainly find where the western escarpment of the carboniferous limestone reposes on the slate beneath Ingleborough a vast fault ranging E.N.E. and W.S.W., throwing down the limestone at Giggleswick Scar, &c., on the south, to the same level as the slate; and a little further south a second parallel fault, also a downcast to the south, causing a subsidence of the coal-measures near Settle to a still lower

[* A portion of this subject has recently been investigated by Mr. Hopkins, a notice of whose results has been given in our Number for January, present vol. p. 66.—EDIT.]

level. We may state generally, that this range of faults extends almost 20 miles from Malhan Tarn to Kirby Lonsdale, where the limestone skirting the Westmoreland slate mountains on the south appears connected with the subsided portion proceeding from Giggleswick Scar*.

North of this, on the borders of Cumberland, we find at the foot of the western escarpment of the great calcareous chain of Cross Fell, a protruding ridge of greenstone rocks at Dufton Pike, &c., attended by shattered portions of carboniferous limestone and coal; and in the great calcareous chain itself we trace several faults, some very considerable, associated with the presence of the great whin sill in Upper Teesdale; and a little further north we have the great Burtreeford dyke (head of Weardale) ranging N. and S., and occasioning a subsidence of 80 fathoms to the west in the different members of the limestone series. At the head of Tynedale we have similar faults, apparently connected with the western prolongation of the great Northumberland 90-fathom dyke; but this, as we have seen, is certainly posterior to the age of the magnesian lime, and we are yet unable to pronounce how far many of those just noticed may not be equally recent, only that it certainly appears that the disturbances connected with the eruption of the trap rocks at Dufton are to be referred to our present æra, being posterior to the coal-measures, which are elevated and shattered, and anterior to the new red, which reposes against these fractured masses horizontally.

Our information is yet imperfect as to the termination of this great calcareous chain against the Cheviot group; still less are we acquainted with the structure and phænomena of the great Scotch coal-field.

IV. Elevations which appear to have affected the transition rocks anteriorly to the deposition of the carboniferous series.

An attentive examination of the phænomena of the great Scotch coal-field, and the relative position of the older rocks near their junction, would throw great light on this part of our inquiry. As to these points our present information is altogether deficient; but the general line of elevation of the southern transition chain clearly ranges E.N.E. and W.S.W. In the Cumbrian Lake district, as the lines of direction of the included transition series of formations are entirely unconf ormable to the position of the zone of carboniferous limestone which ranges round them, reposing indifferently on the younger member of that series on the S.E. and against the oldest portions of the system on the N.W., we must at once

* Mr. Phillips does not exactly explain whether the calcareous conglomerate of the new red occurring at Westhouses below Kingsdale is or is not affected by these convulsions.

refer the primary elevation of the transition rocks to a period antecedent to the formation of the carboniferous lime. The general direction of these transition lines of elevation is E.N.E. and W.S.W., and they appear to have been attended with great transverse fractures, which have often indicated the course of the actual valleys.

In the Island of Anglesea the whole of the transition chains are highly inclined and much disturbed, while the old red sandstone, mountain lime and coal repose on their edges in nearly horizontal strata. The lines of direction are here N.E. and S.W.: this is also the general line of the transition chains of North Wales. To this direction it is evident that the line of the border of carboniferous limestone on the north, proceeding from Ormes Head, is entirely unconformable. The same N.E. and S.W. direction seems to prevail also in the transition chains of South Wales, while the lines of elevation of the incumbent coal-measures range E. and W.; and in the Vale of Towy, while we find the transition rocks on the northern bank nearly vertical, the carboniferous limestone chains on the south do not deviate above 10° from being horizontal. The general range of the transition chain occupying the peninsula of Devon and Cornwall ranges also from N.E. to S.W.; but here we have scarcely any opportunity of ascertaining the relative position of those rocks as regards the carboniferous series, for the overlying mantle of new red sandstone is the only rock we observe in contact with their exterior border; unless, indeed, the limestone of Torbay, as Mr. De la Beche has stated, be carboniferous. But this district apparently has been subject to local convulsion at a much later period, from the intrusion of greenstone dykes, so as to afford no precise indications as to the general structure.

The general parallelism of these transition chains, all nearly ranging E.N.E. and W.S.W., is, as Elie de Beaumont has well urged, very favourable to his theory: he classes this as his first system, including the continental chains of the Hunsrück.

In conclusion, I would inquire whether we are to refer this general direction of the Cornubian transition chain to the eruption of the granitic masses which are constantly protruding through its axis. In this case we must refer that eruption to a period so late as to include *almost** the whole series of transition rocks which appear to be equally effected by it.

I have much preferred in this essay the endeavour to

* De Beaumont has, however, considered its precise æra to have been anterior to the formation of the more recent members of the transition series, such as the transition limestones of Dudley, Malvern and Wenlock Edge.

collect the scattered evidence we possess on the subject to which it refers, and to indicate the points in which that evidence is defective, than the attempt to deduce certain conclusions from materials so avowedly imperfect; and I will therefore content myself at present with observing, that while the evidence of the parallelism of the principal transition chains appears undoubtedly favourable to M. de Beaumont's hypothesis, I am altogether unable to reconcile to that hypothesis the facts I have stated, with regard to the anticlinal lines bounding the coal-fields of South Wales, the Forest of Dean, and Bristol, where we have seen the very same lines of elevation inflected from an E. and W. to a N. and S. bearing: and I would further observe, that to me the subject appears to embrace a much wider field of consideration; we have not only to consider the results of the more violent paroxysmal convulsions which have affected the strata at different epochs, but the more general and gradual elevation which the phenomena of the post-carboniferous rocks indicate to have proceeded very gently, and to have produced very little relative disturbance in the strata so elevated.

Finally, when the theory of parallel chains with reference to the points of the compass is so extended as to embrace half the circumference of the globe, (as is done in the conclusion of M. de Beaumont's memoir*,) I would inquire, Do we not require a more exact definition of the sense in which the term parallel is here used? The parallels of latitude are, indeed, strictly parallel lines; but the meridians are great circles passing through the centre of the planet, and no two of them can possibly be parallel to one another: thus, an east and west chain in central Africa and Iceland are parallel, in every acceptance of the word; but north and south chains in the old and new continents, the Ural mountains, for instance, and the Cordilleras of the Andes, are not parallel in the same sense; the two systems of lines in no manner bear the same relations to the spheroidal form of the planet, the meridional system having constant reference to its centre, which the parallels of latitude always neglect. If, therefore, we are to receive the idea of parallel chains, not as strictly parallel to each other, but as having always similar bearings with regard to the points of the compass, must we not further demand some explanation why north and south chains are thus determined in their elevation by their relations to the centre of the planet, while the east and west chains do not follow that relation?

[* See Phil. Mag. and Annals, N.S. vol. x. p. 259, in an extract from M. de Beaumont's Essay.—EDIT.]

I would also observe, that I have never in my life seen an anticlinal line of any extent which followed a direction mathematically straight. Those which have fallen under my own observation, on the contrary, have been always more or less sinuous, although having on the whole a prevailing tendency in one direction for considerable distances; and when we speak of the general bearing of such lines, we intend, as I conceive, to express only this general and average tendency, on either side of which the partial flexures, however, often deviate 20° , or more.

LXVI. *On the alleged Greek Traditions of the Deluge.*
By the Rev. JOHN KENRICK, M.A.*

IT is a very generally received opinion that the same event, the destruction of the human race by a flood, which is recorded with so much minuteness of detail in the Book of Genesis, has been preserved in more vague traditions among all the principal nations of the earth, and especially among the Greeks. Not to mention a crowd of writers by whom this question has been treated in connexion with the evidences of Revelation, the sanction given to the opinion by Cuvier is sufficient to show that it belongs to science as well as to religion. Some of his readers may have thought his arguments less conclusive upon this subject than upon those which lay more immediately within his province, but the majority no doubt have considered his authority decisive.

I propose to arrange chronologically the testimonies of Greek authors to the existence of such traditions of a Deluge: without this we can arrive at no certain conclusion. The coincidences which we may find between Pagan fables and the narratives of Scripture in the second or third century after the Christian æra, can never warrant our inferring their existence a thousand years before it. I confine the inquiry to the Greeks, because the chronology of literature among other ancient nations is very uncertain, and modern accounts of the traditions of barbarous tribes come to us generally through channels not free from suspicion. Cuvier has given such a chronological view (*Discours sur les Révolutions du Globe*, Edit. 1826, pp. 83—87); but as his enumeration is not complete, and the inference which he draws seems the opposite to that to which his authorities point, it is the more necessary to reexamine them.

It is important to fix accurately what it is that we are to

* Communicated by the Author.