SECTIONS & VIEWS, Illustrative of GEOLOGICAL PHÆNOMENA.

By

HENRY T. de la BECHE.
F.R.S. F.G.S.

London.
Treuttel & Würtz, Treuttel, Jun.r & Richter, Soho Square,
& GARDNER, REGENT STREET.
Paris & Strasburgh.
Treuttel and Würtz.

1830.

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PREFACE.

THE following sections and views are not intended to support or oppose any particular theory: the sole object in collecting them together has been utility. Theories, no doubt, are useful to a certain extent, for they promote inquiry; and, in the present day, a few facts, at least, must be brought forward to support them. Among the facts so produced, there is always a probability of finding some that are new. The scarcity of the facts known too often gives the theorist a false security, and he hastens to conclusions upon the most meagre data, without reflecting that a small addition to his present very limited stock of knowledge may completely overset his speculations. The complacent manner in which geologists have produced their theories has been extremely amusing; for often, with knowledge (and that frequently inaccurate) not extending beyond a given province, they have described the formation of a world with all the detail and air of eye-witnesses. That much good ensues, and that the science is greatly advanced, by the collision of various theories, cannot be doubted. Each party is anxious to support opinions by facts. Thus, new countries are explored, and old districts re-examined; facts come to light that do not suit either party; new theories spring up; and, in the end, a greater insight into the real structure of the earth's surface is obtained.

There are few modern geological theories that are not founded on some facts, and well explain those facts; their advocates are, however, not content that they explain merely a few facts, but are anxious to compel us to receive such theories, as affording the best possible explanation of all geological phænomena.

Generally speaking, geologists seem to have been much more intent on making little worlds of their own, than in examining the crust of that which they inhabit. It would be much more desirable that facts should be placed in the foreground and theories in the distance, than that theories should be brought forward at the expense of facts. So that, in after times, when the speculations of the present day shall have passed away, from a greater accumulation of information, the facts may be readily seized and converted to account.

One very reprehensible mode of theory-making consists, after honest deductions from a few facts have been made, in torturing other facts to suit the end proposed, in omitting some, and in making use of any authority that may lend assistance to the object desired; while all those which militate against it are carefully put on one side or doubted. It is true that such theories, now that facts are multiplied, cannot last long; yet, should it become the fashion of the day to see through this medium, descriptions of countries so take the colour of the medium, that it becomes no easy matter to separate what is imaginary from what is real. How long have geologists seen through the theoretical medium of the divisions, primitive, transition, secondary, and tertiary? It was taken for granted that these divisions were applicable to the whole surface of the globe; descriptions were always made with reference to them; and the consequence is, that there is now much difficulty in discovering what is valuable in such descriptions, particularly when countries, distant from those where these divisions were first imagined, have been examined.

In producing theories, care has not always been taken to view the subject on all sides. Should we have had it stated that all rivers have cut their beds, if attention had been paid to levels? Among the facts adduced to support such a theory, the rivers have been made to run up hill; that is, they have been supposed to cut through land of much greater elevation towards their embouchures, than they flowed over from their sources. In the note beneath will be found some curious and conclusive evidence, by M. Boblaye, respecting the course of the Meuse*. It will be seen that the rise of a few yards would be sufficient to turn this river in the direction of the Paris Basin; now its present course is through the Ardennes, up which it must have run, according to

* "Le bassin naturel, que je désigne sous le nom de *Bassin de Paris*, n'est pas limité, du côté du nord-est, à la ligne de partage des eaux entre la Seine et la Meuse; cette ligne, formée par les coteaux à l'ouest de Verdun et de Stenay, appartient au grand plan de pente générale qui, du plateau de l'Ardennes, descend vers le centre, où convergent l'Oise, l'Aisne, la Marne, et la Seine. En effet, le plateau de l'Ardennes s'élève de 450 à 500 mètres au-dessus de la mer; les chaînons subordonnés qui lui succèdent atteignent des hauteurs toujours moindres en s'avançant vers l'intérieur; et enfin la grande dénudation de la craie offre une chute brusque vers le sud et le sud-ouest. Les vallées présentent le même phénomène dans la diminution successive de leur hauteur, suivant une direction perpendiculaire à la ligne de partage des eaux de Florenville sur la Sémois, à Vouziers sur l'Aisne; la Sémois, 225 à 235 mètres; la Chiers, 175; la Meuse, 170; l'Aisne, 100. Ainsi les vallées comme les plateaux et chaînons indiquent une pente graduelle vers le sud-ouest, et la Meuse coule perpendiculairement au système de plus grande pente, pour s'échapper vers le nord par l'étroite et profonde coupure qui lui présente l'Ardennes. Ce sillon n'a que la largeur du fleuve; ses berges, confondues avec les versans rocheux du plateau, s'élèvent rapidement à la hauteur de 400 à 500 mètres au-dessus de la mer. La coupure a près de 300 mètres de profondeur.

"Tel serait l'obstacle que, dans l'hypothèse du creusement des vallées par les eaux, la Meuse aurait surmonté pour s'échapper vers le nord, tandis que d'un autre côté, et dans la direction du plan de pente générale, de faibles coteaux, des cols surbaissés recouverts de graviers diluviens, indices d'un ancien courant, et supérieures à peine de 30 ou 40 mètres au lit actuel de la Meuse, le séparent du bassin de la Seine.

"Ces cols sont ceux qui, près de Stonne, ne s'élèvent qu'à 20 et quelques mètres au-dessus de la Meuse, à Stenay et au delà de la Barre, celui de Chêne-le-Populeux (176 mètres) qui, d'un côté, est de niveau avec la Meuse à Stenay, de l'autre, s'élève de 75 mètres au-dessus de l'Aisne, en sorte que jeter avec une pente énorme la Meuse dans la Seine par l'Aisne et l'Oise, serait loin d'être une entreprise gigantesque."—Boblaye, Ann. des Sci. Nat. tom. xvii. p. 37.

the theory, several hundred yards in order to cut its present channel. That rivers have cut channels, and deep ones too, under certain circumstances, cannot be doubted; but this does not satisfy the theorist, and therefore all rivers are made to cut their channels. What is said of river theories is applicable to many others.

Professor Sedgwick made an excellent remark on geological theories, when he observed that "generalizations would be excellent things if we could be persuaded to part with them as easily as we formed them. They might then be used like the shifting hypotheses in certain operations of exact science, by help of which we may gradually approximate nearer and nearer to the truth*."

It would be well if the geologist would, before he begins to generalize, place himself before a globe or map of the world, and honestly ask himself how much is really known of the structure of the surface of that world. The answer might be, that if the whole, known with exactitude, were placed on the Desert of Great Sahara, the area representing that desert would not be covered. Even of the countries which have been considered the best explored, Great Britain, France, and Germany, how much remains to be examined! Yet in the face of this confessedly limited information, we are told how the whole surface of the world has been formed. Why not content ourselves, for the present, with an honest deduction from the facts before us?—The advance so made is, no doubt, slow, but it is certain, and the step gained is firm.

The work of pioneers is certainly laborious, and little suits minds which desire to advance rapidly and grasp all at once; but, as a large accumulation

* Address to the Annual Meeting of the Geological Society of London, 1830.—Phil. Mag. and Annals of Philosophy, April 1830.

of facts must precede any just conclusions respecting the general laws which have governed the formation of the world, we of the present day must, I am afraid, be compelled to perform the office of geological pioneers, however laborious and comparatively inglorious that office may be.

There does appear to be some faint hope, at last, that the old divisions of primitive, transition, secondary, and tertiary may be abandoned. At all events, the supposed general and marked division between the tertiary and secondary classes would seem to be in danger. For if the observations of Professor Sedgwick, Mr. Murchison, and Dr. Boué, on certain rocks of the Alps, be combined with those of Dr. Fitton on Maestricht, it would appear that the one supposed class passes into the other supposed class.

I may, doubtless, be accused of having indulged in theoretical speculations in the explanations of the following Plates. I have endeavoured to guard myself against this pleasure,—for pleasure it is,—but perhaps have not been always very successful. Should the reader consider that the conclusions cannot be honestly deduced from the facts before him, he has only to reject them, and the facts will, it is hoped, remain uninjured.

One of the principal objects in the following work is to induce geologists to present us with sections more conformable to nature than is usually done. Sections and views are, or ought to be, miniature representations of nature; and to them we look, perhaps, more than to memoirs, for a right understanding of an author's labours. From a want of attention to this subject, it sometimes happens that the sections and accompanying memoirs are not in strict accordance, particularly after the sections are reduced to their proper proportions. This want of accordance I have had more than one occasion to regret in the following work, as it has compelled me to omit much that appeared valuable. Among the sections here presented, there are doubtless many that are only approximations to the truth. But as approximations they may be valuable, and add to our stock of knowledge.

The advance of geological science has lately been so rapid, that it requires some exertion to keep pace with it. Hasty conclusions can no longer command attention,—there are too many observers in the field to permit errors to remain long uncontradicted,—and it is very desirable for the progress of science, that no deference for a name should cause them to remain uncontradicted. It surely can be no offence to state, that the progress of science has led to new views, and that the consequences that can be deduced from the knowledge of a hundred facts may be very different from those deducible from five. It is also possible that the facts first known may be the exceptions to a rule, and not the rule itself, and generalizations from these first-known facts, though useful at the time, may be highly mischievous, and impede the progress of the science if retained when it has made some advance.

For any inaccuracy in the lithographic plates which illustrate this work, I alone am responsible. As specimens of art they are valueless; but it is hoped, that for all the general purposes of geological illustration, they may be found as useful as costly engravings. It is, moreover, hoped that the reader will look with indulgence on first attempts, which have been made in the desire to render the book more accessible to geologists, should it be found to merit their attention.

EXPLANATION

OF

THE PLATES.

PLATE I.

THIS Plate is intended to illustrate the value of proportion when we compare the development of a given series of rocks in one country and in another. The observer at one glance perceives the thickness of the different beds, and immediately judges of their relative importance. Names frequently mislead. Thus, in enumerating the various rocks of which the oolitic group is composed, the cornbrash appears as important as the Oxford clay or lias; but, by inspecting Fig. 1., it will be observed that it was impossible to represent it in the scale adopted; and by reference to Fig. 2. it will be seen that a thick line, not given because it would have appeared to divide the oolite rocks into two masses, would represent the relative thickness of the rock.

By comparing Fig. 1. & 2. we observe that the green sand is well developed in Wilts and Somerset, and of little importance in Yorkshire, the Speeton clay being probably its representative. We further find that an important series, containing a great abundance of vegetable remains with beds of coal, has been deposited above and beneath the beds considered by Mr. Phillips (Illustrations of the Geology of Yorkshire) as equivalent to the great or Bath oolite in Yorkshire; while in Wilts and Somerset we see no traces of such deposits,—showing that certain effects were produced by certain causes in

Yorkshire, the operation of which did not extend into Wilts and Somerset. The lias will be seen nearly three times as thick in Yorkshire as it is in Wilts and Somerset.

The next remarkable difference of development will be observed in the red sandstone group, which has attained a considerable thickness in Yorkshire, with a large accumulation of limestone (magnesian limestone); while in Somersetshire the thickness of the red or variegated marls, red sandstone, and dolomitic or magnesian conglomerate, is comparatively small. In Devonshire, the thickness of that great mass of variegated marl, red sandstone, and conglomerate, which there constitutes the red sandstone group, would appear to be much greater than in Yorkshire. The lower portion, conglomerates, are of great relative importance in Devon, and the zechstein (magnesian limestone of Yorkshire) and muschelkalk are there unknown.

In the relative thickness of the coal measures and carboniferous limestone (carboniferous group) of Yorkshire and Somersetshire there is no great difference.

Looking at the rocks of the two columns (Fig. 1. & 2.) in the mass, it will be observed that, although the cretaceous group is more developed in Wilts than in Yorkshire, the greater relative thickness of the oolite and red sandstone groups is such, that the whole height of the Yorkshire column, from the chalk to the carboniferous limestone inclusive, is nearly equal in height to the Wiltshire and Somersetshire column, from the chalk to the old red sandstone inclusive.

Fig. 1. is constructed from the observations of Mr. Phillips (Illustrations of the Geology of Yorkshire), with the exception of the red sandstone group, formed from the information of Professor Sedgwick, and from his Memoir in the Transactions of the Geological Society (new series), vol. iii. pp. 37—124.

Fig. 2. is constructed from the chalk to the lias inclusive, from the information of Mr. Lonsdale, and from the Outlines of the Geology of England and Wales, by Messrs. Conybeare and Phillips. From the red sandstone group to the old red sandstone inclusive, the column has been formed from the Memoir of Professor Buckland and Mr. Conybeare, on the South-western Coal District of England, Geol. Trans. (new series), vol. i. pp. 210—316.

PLATE II.

This Plate is intended to illustrate the value of proportion in geological sections generally. From a want of attention to this subject, the greater part of such sections are more mischievous than useful, and tend to mislead rather than to instruct the geologist.

Fig. 1. is a proportional section of the country between the Dole, the highest point of the Jura Chain, (1681 metres, 5515 English feet, above the level of the sea,) to the Mont Blanc, 4795 metres, 15,731 English feet, above the level of the sea. This section was the more easy to form, as the various heights are known with sufficient accuracy; and my visits to, and sketches made in, this part of the world, had rendered the forms of the mountains in a great measure familiar to me. This section is introduced to render the geological student acquainted with the relative value of heights and distances, and to place before him the true proportions of a high mountain range, concerning which so many circumstances connected with the eye and his own stature tend to make him form erroneous conclusions.

Scale $= \frac{1}{200{,}000}$ of nature.

Fig. 2. is a section of the English Channel, from the Isle of Portland on the north to Cap la Hogue on the south; a single line suffices: of course the thickness of the line towards both extremities represents a much greater depth than actually exists. The distance between the two coasts is about 16 leagues, the greatest depth 45 fathoms, or 270 feet: in fact, the bottom of the channel between the two points is a mere plain; and the section is here introduced, because when the sea or any great mass of water conceals the surface of land from our view, we are apt to consider the depression so covered very considerable. If true sections were made of most coasts, and continued some distance both on the side of the dry land and on that of the sea, geologists perhaps would entertain less exaggerated ideas respecting the depths of the ocean than they now do.

Fig. 3. is a section of the Lake of Geneva, from Evian on the Savoy side to Ouchi on the Swiss, constructed from my own observations in 1819, made with

a view to ascertain the temperature of the water at different depths, and inserted in the Bibliothèque Universelle for the same year. The greatest depth of this section, the most considerable which I observed in the lake, is 164 fathoms or 984 English feet; a depth in which deposits may be formed of much greater thickness than the whole of those of the supercretaceous basin of Paris. It is worthy of remark, that by far the largest portion of the Lake of Geneva is situated in the Swiss molasse and nagelfluhe.

Fig. 4. is an imaginary section, supposed proportional, introduced in order to show the mischief of adopting a scale of height differing from that of length.

Fig. 5. is a section, supposed of the same country, the scale of height being three times that of the length; the distortion has produced great differences in the dips, and has destroyed the real outline of the country, but the section still remains in some measure intelligible.

Fig. 6. is another imaginary section, supposed to be proportional.

Fig. 7. is a section of the same country, the scale of height being ten times that of the distance. The confusion that arises in this case is very apparent. The true outline of the country is entirely destroyed, towns are perched on heights, or are placed in valleys, on or in which they never would have been built, wide valleys become gorges, and shallow lakes and rivers acquire considerable depth; not only is the outline of the country distorted, but the relative positions of the strata appear altered, and erroneous impressions are produced. In Fig. 6. strata may be imagined to fine off, but in Fig. 7. the same strata appear to abut against each other in considerable thickness.

The object of Fig. 4. 5. 6. & 7. is to induce the geological student to form sections as nearly as possible approaching to the proportions exhibited in nature. Such sections as are represented by Fig. 7. are by no means so uncommon in geological memoirs as might be imagined: it is true that the strata would not be made to abut so suddenly against each other as is here represented; the lines would probably be turned up, but the section would nevertheless be a distorted section, and convey an erroneous idea of nature.

PLATE III.

Is a proportional section of the southern coast of England from near Bridport Harbour to Sidmouth, and is intended to illustrate the overlapping character of the cretaceous group in those parts of Devon and Dorset. My original section of this coast is published in the Geological Transactions (new series), vol. i.; the present is corrected and somewhat more extended, comprising Peak Hill on the west of Sidmouth. It will be observed that at Golden Cap the green sand rests on inferior oolite; at Shorne Cliff, Black Ven, Ware, Pinhay, and Charlton, on lias; and from Axmouth Point to Sidmouth, on variegated marl and red sandstone. By following the same cretaceous rocks eastwards, we observe them resting in succession upon various members of the oolitic series, which would appear to have been deposited within more contracted areas, as they were successively formed. At the epoch of the chalk and green sand, the rocks again become deposited over a greater area in this part of the world, and the cretaceous group is consequently found covering in succession many inferior strata. The whole country is more or less traversed by faults. Gravel covers all the hills, and is most frequently composed of unrolled flints and fragments of chert, which do not appear to have been transported any great distance, but to have resulted from a dissolution of the chalk and green sand in place, leaving the upper surface of the chalk or green sand, as the case may be, corroded and uneven*.

This section would seem to afford us examples of the following facts: 1. A quiet deposit of the red sandstone and variegated marls, the lias, and the inferior oolite, each within diminished areas successively; for there is no evidence of any denuding force having swept over the land before the deposit of green sand and chalk†. 2. A deposit of chalk and green sand over a more extended area. 3. A corrosion of the upper surface of the chalk or green sand, and a

* The most illustrative example of this dissolution occurs at Dunscombe Hill, between Branscombe and Sidmouth.

† The depression in the variegated or red marl at Beer would appear to be a true depression of the strata, and not an excavation.

dissolution of the softer parts, the harder forming an unrolled gravel. 4. Fracture of the country into faults: and 5. A great denudation of the country, destroying the continuity of the strata, forming valleys, and leaving isolated patches of the higher strata.

The lias strata in the vicinity of Lyme Regis have long been remarkable for the number and variety of the organic remains found entombed in them.

PLATE IV.

THIS is inserted to show that causes, similar to those which have produced certain effects in the south of England, have extended into Normandy.

Fig. 1. is a correction of part of one of my sections inserted in the Geological Transactions (new series), vol. i. It will be observed that the cretaceous group has extended over a greater area than the Kimmeridge clay, overlapping the strata as on the coasts of Dorset and Devon.

Fig. 2. is part of a section by M. de Caumont, inserted in the Atlas which accompanies his Topographie Géognostique du Département du Calvados. The section is here reduced in height, so as to render the outline of the country more conformable to nature. It will be here seen that the cretaceous rocks overlap the coral rag, so that at the escarpment near Clermont the green sand reposes on the Oxford clay; a rock particularly well characterized in Normandy, and abounding with organic remains at the cliffs known as the Vaches Noires.

In Normandy, as in the country noticed in the last Plate, the surface of the chalk and green sand has been corroded on its upper surface, and the harder parts have formed a superficial unrolled gravel, which covers the tops of the cretaceous hills to a considerable depth.

This dissolution is not confined to the chalk and green sand, but is common to the surface of the other rocks of this part of Normandy: see De Caumont's Topographie Géognostique du Département du Calvados; and the Memoir of M. de Magneville, inserted in the Mémoires de la Société Linnéenne du Calvados.

Faults are not so common on the coast of Normandy as on that of Dorset and Devon. I only observed one near Port en Bessin; but this is sufficient to show that the strata have been cracked since deposition and consolidation.

Denudation has taken place, and the continuity of strata has been destroyed.

These sections are also useful, as showing that certain members of the oolite series have been deposited much in the same manner in Normandy as in southern England. Thus we have, in the descending series, Kimmeridge clay, coral rag, and Oxford oolite, the compound great oolite, and the inferior oolite. The lias succeeds, though not included in these sections.

PLATE V.

This Plate is intended to illustrate those fractures in the strata, after their consolidation, which have been called faults.

Fig. 1. is one of the many figures which accompany Mr. Phillips's Memoir on the Group of Slate Rocks between the Rivers Lune and Wharfe, Geol. Trans. (new series), vol. iii. It will be observed that the strata have been fractured, that the edges of millstone grit and carboniferous limestone beds are brought into contact at Giggleswick Scar, and that the edges of the same limestone strata abut against grauwacke slate near Great Stainforth. By this section we also see that the grauwacke slate of this part of the country was thrown on its edges before the deposition of the carboniferous limestone, as has been already noticed by Professor Buckland and others: see Geol. Trans. (old series), vol. iv.

Fig. 2. is part of one of the many sections which accompany the Memoir of Professor Buckland and Mr. Conybeare on the South-western Coal District of England (Geol. Trans., new series, vol. i.), reduced in height. We here observe that the old red sandstone, carboniferous limestone, and coal measures were disturbed after deposition; that the red sandstone rocks, after filling up the inequalities which had been formed in the surface of the inferior strata, presented an horizontal or nearly horizontal surface, on which the oolite was deposited; and that, after the consolidation of the whole, the strata were rent, the fractures or faults traversing all the strata equally.

Fig. 3. is one of the figures illustrating Professor Sedgwick's paper "On the Geological Relations and Internal Structure of the Magnesian Limestone in the North of England," Geol. Trans. (new series), vol. iii.

Fig. 4. is a section of part of a fault many miles long, near Weymouth, described by Professor Buckland and myself in a paper lately read before the Geological Society. It will be observed that the edges of Portland stone strata are brought into contact with those of the chalk. I have introduced this as a contrast to Fig. 3., where it is easy to understand that the sinking of the strata on the right hand of one of the faults, or the uprise of the strata on the left of the same fault, could produce the curved upturned appearance of the magnesian limestone. In this figure, however, if we suppose the cretaceous rocks of the Ridgeway Hill to have subsided, they ought, if contact had always been preserved, to have turned down the edges of the Portland strata: if we imagine the Portland stone to have been forced up, contact being always preserved with the rocks on the other side of the fault, the strata of Portland stone would still have been forced down. The contrary position of the strata exists; and for this we may perhaps account by supposing that at the time of the fracture, contact was not always preserved between the two sides of the fault, but that one side (that of the Portland stone) was thrown away from the other, and by coming violently in contact, the edges of its strata were turned up while settling.

Fig. 5. & 6. are reductions of parts of the coast section inserted in Mr. Phillips's Illustrations of the Geology of Yorkshire; the space omitted from want of room is small, therefore they may be considered one continuous section. These are inserted to show that curvature, as well as fracture, have taken place in the oolitic series of that part of England. They also exhibit a section of the sandstone and shale containing such an abundance of vegetable remains.

One thing will be observed throughout these sections, viz. that though the faults traverse rocks of various ages, they are all uncovered by any strata which might determine the relative epoch of the fractures. I would by no means be supposed to deny that covered faults exist; it would but be reasonable to conclude that they must have been formed at the various disruptions of strata which have taken place: still it is very remarkable, that even on coasts, ravines, and other great natural sections, there should be great difficulty in finding a covered fault, and scarcely any difficulty in discovering those which are uncovered. I have ventured to suggest elsewhere*, that these uncovered faults, so common in various parts of Europe, may have been connected with denudation, also common, by supposing that a dislocation of a large portion of the earth's surface would throw a mass of waters into violent agitation.

PLATE VI.

THE sections in this Plate, for which I am indebted to the kindness of Colonel Page, illustrate the faults in the coal measures of Coal Pit Heath, on the north of Bristol, and may be said to explain themselves.

Not only are the lines of fracture or fault seen in all directions in the figures before us, but the same thing is observed on the surface; they preserve no parallelism; one is represented curved, and others meet the great fault at various angles. The great fault has produced a difference in the level of the strata equal to 600 feet.

PLATE VII.

FOR the section here given I am indebted to the kindness of Mr. Buddle. It exhibits the faults observed in the Jarrow Colliery, Durham. The fractures and disturbance of the various strata are apparent to the eye, and require no explanation.

Mr. Buddle informs me that a soft substance, formed, apparently, by the forcible grinding of the edges of the strata against each other, often occupies a space between the sides of the fault, as it approaches the surface; but that lower down, the sides of the fault are most commonly in contact; the clay slate frequently presenting a polished surface†, while the edges of the sandstone are much fractured. Near the surface, or when the fissure is wide, the fault frequently contains a brecciated conglomerate, formed of pieces of the neighbouring rocks. All these faults are uncovered, except on the low grounds, where rolled gravel, derived from the rocks of the Cumberland mountains, rests upon them.

* Geological Notes; and Phil. Mag. and Annals of Philosophy, March, 1830.

† The polished sides of the faults in chalk near Weymouth have been noticed by Professor Buckland and myself in a Memoir lately read before the Geological Society.

Mr. Buddle compares the dislocations of the coal measures of the North of England to fractured ice on the surface of a lake, reunited by subsequent frost. The planes of stratification are in all directions; and the same dislocation, which is an upcast fault in one place, becomes a downcast fault in another, from the crossing of two planes. The edges of these planes are angular.

PLATE VIII.

Fig. 1. is a reduction of Dr. Lusser's section of the Alps from the St. Gothard to the Righi, inserted in the Denkschriften der allgemeinen Schweizerischen Gesellschaft für die gesammten Naturwissenschaften, vol. i. pl. 7. Dr. Lusser's sections are accompanied by a detailed account of the superposition, mineral character, and organic contents of the various rocks. To this memoir I must refer for that detail which local opportunities and attentive examination can alone afford. When we regard the structure of the Alps, which has been commented on by different observers, to the east and west of this section, the detail with which this section is accompanied becomes highly interesting.

At the first glance it will be perceived that the mountains have been produced by elevation of the strata. Since the observations of De Saussure on the Vallorsine conglomerate, geologists, as has already been noticed by M. Elie de Beaumont*, have very generally agreed that beds which occur vertically or very highly inclined have not been formed as we now see them, but have been raised into their present position by forces acting upon them after their formation. M. Von Buch has observed on the marked differences which exist between the mountains of Europe. M. Boué has remarked, as is also stated by M. Elie de Beaumont†, upon more than one movement that has taken place on the Alps. M. Elie de Beaumont's labours respecting the elevations of mountains at different epochs, and his views of the connection of such elevations with the formation of certain rocks, are inserted in the Annales des Sciences Naturelles, 1829 & 1830. To this memoir I must refer for a right understanding of M. Elie de Beaumont's views, and for an account of those authors who had previously touched on the subject.

* Recherches sur quelques-unes des Revolutions de la Surface du Globe.—Annales des Sciences Naturelles. Septembre 1829.

† Annales des Sciences Naturelles. Novembre 1829, vol. xviii. p. 302.

By inspecting Fig. 1. it will be seen that the limestones rest unconformably on the strata of gneiss, which would seem to have been slightly elevated before the deposition of the former. There are parts of the same line of Alps where the gneiss, mica slate, or protogine is covered conformably by the limestone series; but these appearances, as has already been remarked by Professor Necker, are deceptive; the limestones, as a mass, resting unconformably upon the inferior rocks, also taken as a mass.

The contortions of the limestone series are very remarkable; and being on the large scale, according to our ideas, impress us with a higher idea of the great force that must have been required to twist mountains in this manner, than the mass of these mountains, considered with reference to the mass of the globe, at all warrants. The limestone series contains ammonites and belemnites in the lower part, but the larger and superior portion contains an abundance of nummulites; there is no real marked separation between the rocks containing the one or the other, they pass into each other, and the belemnites are stated, by those who have had abundant opportunities for examination, not to cease before the nummulites begin. The organic contents of the various alpine rocks have lately acquired considerable interest, from the differences of opinion which have arisen respecting even the classes of rocks to which certain deposits should be referred. I must confess I cannot see how these differences can be arranged, without supposing that the division of rocks into tertiary and secondary is imaginary, and that local facts have been too much generalized. One curious part of the section before us consists in the thrown-over appearance of the Righi conglomerates. The reader should consult Professor Studer's remarks on these portions of the Alps, (Annales des Sciences Naturelles for 1827,) where some curious observations respecting the connection of the limestones and conglomerates will be found.

Fig. 2. contains sections of the Italian side of the Alps, taken from M. Von Buch's map of the country from the Lake of Orta to the Lake of Lugano. The limestone rocks would appear to have been changed by some cause, and that cause would seem to be in some way connected with the presence of pyroxenic porphyry, or other igneous rocks in the vicinity, which have probably been intruded among the limestone after its deposition. At Monte Beuscer the dolomite is in contact with the granite, and a mass of pyroxenic porphyry has

pierced the granite at Brincio. At Monte Schieri the dolomite is in contact with both pyroxenic porphyry and granite. The small section between Lugano and Morcote is one on which M. Von Buch strongly insists for the truth of his theory respecting the conversion of the limestone into dolomite by the causes which have introduced the pyroxenic porphyry of Melide. Be the opinion of geologists what it may respecting this theory, the facts exposed in this section are curious and deserving attention. The gray stratified rock becomes crystalline, the traces of stratification are gradually lost, and a large mass of pyroxenic porphyry occurs on the side of the apparently altered rock, but separated from it, according to the section before us, by small portions of mica slate and red quartziferous porphyry.

Fig. 3. is a section from Bellaggio on the Lake of Como to the Monte San Primo, and shows the manner in which the transported blocks of granite, gneiss, mica slate, &c. of the high Alps have been scattered at all heights over this country. Further detail respecting this section will be found under the head of the Lake of Como.

PLATE IX.

The sections in this Plate are taken from those which accompany M. Von Buch's Memoir on the Tyrol, inserted in the Ann. de Chem. et de Phys. vol. xxiii. and are intended to show the great dislocations and disturbances to which this portion of the Alps has been subjected, and that such disturbances may probably be referred to the causes which have introduced the igneous rocks among the previously existing strata. Supposing these sections only an approximation to the truth, still the disturbances must have been very considerable.

Fig. 1. is a section from Sasso Vernale, through the celebrated Val di Fassa over the Rosengarten and Schlern to Colman, and is intended by M. Von Buch to show the irruption of the pyroxenic porphyry through the red quartziferous porphyry and limestone, and the probable conversion of the latter into dolomite at the same time.

Fig. 2. shows a great fault; Fig. 3. a mass of pyroxenic porphyry in contact with limestone and dolomite; and Fig. 4. a portion of dolomite included in the black porphyry.

PLATE X.

The sections in this Plate are all taken from Dr. MacCulloch's work on the Western Islands of Scotland, and are intended to illustrate the intrusion of trap among other rocks.

Fig. 1. illustrates, in a beautiful manner, the various appearances that the same mass of trap may present, viewed at different points; on one side, the trap may be imagined interstratified with the beds among which it is in reality intruded, while on the other, the trap may be seen to cut through these same beds. This section, so often quoted, presents a clearer view of the connection of laterally injected trap, with a mass which has cut through the strata, than any yet given to the public.

Fig. 2. " This is a slight sketch from a distant point, of the general appearance of the cliffs to the north of Ru na braddan; the proportions being, in most parts, very little altered from that which they bear in nature. Among them are found many minuter interesting circumstances, which are invisible from the point whence the original drawing was made, and are consequently omitted. This figure will serve to convey an idea of the nature of the scale on which these appearances take place, and of the magnitude of the disturbances; the cliffs here varying from 300 to 500 feet in height, and the extent forced into the sketch being equivalent to a mile and a half."

" Near the left side of the sketch, there is seen an insulated mass of trap lying on the strata. If this should be examined in the interior country, it would evidently appear to be one of those portions which have been called basaltic caps. There can be no doubt that it has here been once connected with the mass on the right hand; and from similar waste may be explained the appearances so common in countries where these rocks occur."—MacCulloch's Western Islands of Scotland, vol. iii. pp. 18, 19.

Fig. 3. illustrates the connection of an overlying mass of trap, with veins or dykes which proceed from it downwards. Whether, as Dr. MacCulloch observes, the intruding material has ascended from below and overflowed the strata, or whether it has descended from the mass, the effect would be here the same.

Fig. 4. " This vein presents a remarkable instance on a large scale of the entanglement of fragments of the including rock. It is here easy to imagine, that by compressing the sides together, the parts might again be brought into contact, and restored to the state in which they were before the forcible intrusion of the vein."—MacCulloch's Western Islands of Scotland, vol. iii. p. 41.

Fig. 5. illustrates the intrusion of a claystone vein, which has raised the strata on either side, and detached portions of the rock through which it cuts. " To a certain distance from the edge, it (the vein) is filled with fragments of the including rock, extremely numerous, and generally of a small size."

Fig. 6. " represents the passage of a trap vein in a direction conformable to the lamination of the schist in Lunga. It is intended to show the peculiar form which these veins assume when they traverse yielding materials. The laminæ have been merely separated, not fractured."—MacCulloch's Western Islands of Scotland, vol. iii. p. 29.

In the explanation of this Plate I have been anxious to preserve the words of an author who has so largely contributed to our present knowledge of trap rocks; to the work whence the figures of this plate have been derived, I must refer for further illustrations of the intrusion of trap among other rocks, and of the effects that have been produced by such intrusion.

There are few phænomena of more importance to geology than the intrusion of granitic, serpentinous, and trap rocks, among the stratified rocks which have been deposited at various times on the surface of the earth; for probably to this intrusion, and to the cause which produced it, we may attribute the fracture and contortions every where so common, and the frequent elevation of strata into ranges of mountains.

PLATE XI.

The views given in this Plate are, like the sections contained in the preceding Plate, derived from Dr. MacCulloch's work on the Western Islands of Scotland.

The view of Staffa from the SW. shows the precipitous cliffs which bound this island on that side, and the superposition of the beds which compose them.

Dr. MacCulloch describes the island at its western extremity as "divided into three distinct beds of trap of different characters; the lowest consisting of that conglomerate called trap tuff, the next of the great column range, and the uppermost of an irregular mixture of small implicated and bent columns, with an amorphous basalt." These beds dip east at about 9°, and are of irregular thickness. Looking at this view we can scarcely refrain from supposing that the cliffs have resulted from the action of the sea on the coast. When we consider the hardness of the rocks composing this coast, we cannot but reflect on the length of time which it must have required to form the cliffs as we now see them. Other and better examples of hard coasts cut into cliffs, apparently by the action of the sea, could no doubt be produced, in fact they are sufficiently common; but the rocks here before us are sufficiently hard, judging from the effects we now witness, to have required a longer period of time for their destruction than would be generally allowed for that purpose. As man judges of height by his own stature, so does he judge of time by the ordinary duration of his own life. Accordingly, a few thousand revolutions of our planet round the sun appear to him a lapse of time of almost immeasurable length.

Fingal's Cave, represented in one of the tablets, is probably formed by the action of the sea. Respecting the columnar trap of Staffa, Dr. MacCulloch remarks that "the differences in the frequency of the joints are important, inasmuch as they serve to explain the formation of the great cave. They are abundant in the columns which now constitute its interior sides, and it is indeed chiefly to this place that they are limited; those columns which form the faces being either entire, or divided by rare and incomplete joints. The action of the sea has doubtless caused the excavation by undermining them; and is still further perhaps destined to increase its dimensions by a continuation of the process which originally produced it."—Western Islands, vol. ii. p. 11.

The view of the Scuir of Egg is introduced to show the erroneous impression that may be received from a view. From the sketch represented, it might be inferred that the mountain was conical; whereas it is a long ridge, for the description of which I must refer to Dr. MacCulloch's Western Islands, vol. i. pp. 519—522. Such deceptive views are common in nature, and frequently mislead those who only observe a mountain on one side, or at a distance, no uncommon circumstance in geological investigations.

PLATE XII.

The sections in this Plate are illustrative of the connection between disturbed strata and trap rocks in Pembrokeshire and Devon.

Fig. 1. is a proportional and coast section of the part of St. Bride's Bay, Pembrokeshire, comprised between Broad Haven and Mill Haven. A section of the same coast, on a larger scale, accompanies my paper on southern Pembrokeshire, inserted in Geol. Traus. (new series), vol. ii. pp. 1—20, to which I must refer for details. The coal measures are greatly contorted, a small portion of carboniferous limestone intervenes between them and the trap, and arched beds of the same limestone occur beneath the trap at Gouldtrop Road; so that the trap seems to overlap the carboniferous limestone, and probably also the coal measures, contorted beneath it. At Mill Haven the trap rises from beneath the old red sandstone, which dips from it. Judging from this section alone, it might be supposed that the superposition, in the descending order, was, 1. old red sandstone; 2. trap; 3. carboniferous limestone; and 4. coal measures. We know, from an examination of the surrounding country, that this is not the true order of superposition, but that these false appearances have been caused by the intrusion of the trap rocks. We have here an example of the errors that may arise from a hasty generalization of one section.

Fig. 2. is a proportional section, on half the scale of Fig. 1., from Trafgarn Mountain on the north, to Stackpole Head on the south. It must, I think, be evident that the trap rocks have, by their intrusion, disturbed the other and stratified rocks; and it seems but reasonable to suppose that the carboniferous limestone of Stackpole Head, Pembroke, and the other places shown in the section, was once continuous, and that its continuity has been destroyed; first, by the bending and breaking of the strata, when the trap was forced in among them; and secondly, by some denuding power which has swept over the country. The masses of trap exposed by this section are two; the most northern having raised the grauwacke strata, which dip from it; the most southern

having burst up between the coal measures and the rocks, which possess the appearance of old red sandstone passing into grauwacke. The coal measures are contorted, and probably conceal the carboniferous limestone; for, at Langum Ferry, not far distant from the line of section on the east, the coal measures and carboniferous limestone are both twisted together, and, at Johnston, contorted carboniferous limestone is interposed between contorted coal measures and the trap.

Fig 3. is a coast section, on the south side of Milford Haven, of one of the carboniferous limestone troughs, which have probably been formed by the disturbance of the mass of strata. It will be remarked, that the beds of carboniferous limestone are contorted, while those of the old red sandstone are merely thrown up at high angles on either side, as if the former had been squeezed between the latter. The portion of limestone here represented is a continuation of that which occurs at Pembroke (Fig. 2.), where it will also be observed contorted between highly inclined strata of old red sandstone, which are probably arched on the larger scale, the upper part of the arches having been removed by denudation, so that the strata seem merely tilted up without curvature*.

Fig. 4. is the well-known Eligug Stack, tenanted by a multitude of sea birds, principally by the Eligug (*Alca torda*), whence the name. This Figure shows the denudation which has removed the upper part of the carboniferous limestone strata since disturbance: to render their former continuity apparent, it would be necessary to introduce dotted lines high above the present level of the land. This Figure also illustrates the operation of causes now in action, which have formed cliffs, large holes or caverns, and separated the stack, properly so called, from the main land by removing the strata which once joined them together.

Fig. 3. & 4. are among those which accompany my paper on Southern Pembrokeshire, Geol. Trans. (new series), vol. ii.

Fig. 5. shows the connection of trap with disturbed strata of Exeter red conglomerate, carboniferous limestone, and old red sandstone, and is a coast section of Babbacombe Bay, near Tor Bay, Devon.

At Hope's Nose the carboniferous limestone is contorted, while the old red

* For the direction of the troughs, and the general superficial areas of the various rocks, consult the Geological Map of Pembrokeshire, Geol. Trans. (new series), vol. ii. Plate I.

sandstone has been merely tilted up, reminding us of Pembrokeshire, and appearing as if, at the time of the disturbance, the carboniferous limestone strata had been in a softer and more flexible state than those of the old red sandstone. The cause of the disturbance of both rocks, in Babbacombe Bay, would appear to have been the intrusion of the trap of the Black Head*, in which a stratum of carboniferous limestone seems to have been entangled.

From the Black Head to the fault between Babbacombe and Petit Tor, the carboniferous limestone has apparently been disturbed by the trap beneath it, which has bent the strata, but has not pierced through them.

The fault between Babbacombe and Petit Tor would seem to present two distinct geological epochs; one, when the limestone and shales were partially destroyed, affording some materials of the conglomerate; and another, when the trap was intruded among and disturbed all these strata.

For further detail of this district, consult my paper on the Geology of Tor and Babbacombe Bays, Geol. Trans. (new series), vol. iii.

PLATE XIII.

The sections in this Plate are copied from those which accompany Professor Sedgwick's Memoir on the Association of Trap Rocks with the Mountain Limestone Formation in High Teesdale, &c., inserted in the Transactions of the Cambridge Philosophical Society, vol. ii. pp. 139—195. Before the Memoir cited was published, the trap of High Teesdale, known by the name of the Great Whin Sill, was considered a bed regularly interstratified with the other rocks, having had a common origin with them, which was supposed aqueous. Professor Sedgwick has, however, perfectly succeeded in showing that the lateral injection of the trap in question, after the consolidation of the other rocks, has probably caused the deceptive appearance of a trap bed interstratified with the carboniferous limestone formation.

Fig. 1. is a section in which the trap appears as a bed interstratified with the rest. A fault will be observed to traverse all the strata and the included

* The Black Head has erroneously been marked Black Hill in the Plate.

trap; consequently the fracture was produced after the intrusion of the trap. This fault being uncovered, we have no means of judging of its relative age.

Fig. 2. shows the trap upheaving the strata, a portion being injected among the beds so as to appear included among them.

Fig. 3. affords a section on the right bank of the Lune near Lonton, in which the trap appears as a bed. During intrusion it has caught up a portion of the inferior stratum, which is turned up in the trap.

Fig. 4. is a section on the Lune, near the same place: the same appearances present themselves, with the exception, that in this section, as represented in the Plate, the trap does not appear as an included bed.

Fig. 5. exhibits a fault cutting through the trap as well as the other strata. The trap rests, like a bed, on the stratum beneath.

Fig. 6. shows trap covering the edges of the strata, as if it had flowed over them in the manner of a lava-current.

Fig. 7. affords an example of the probable alteration of rocks by the contact of trap. The limestone has become granular, and the slate clay indurated.

Fig. 8. presents an example both of the alteration of rocks in contact with the trap, and of strata caught up by it.

For further details, consult Professor Sedgwick's Memoir.

PLATE XIV.

Fig. 1. 2. & 3. are taken from Professor Sedgwick's Memoir on the Phænomena connected with some Trap Dykes in Yorkshire and Durham, and are illustrative of the same dyke cutting through various deposits. Respecting this dyke, Professor Sedgwick observes, "No other dyke has, I believe, been yet described, which intersects so many secondary formations, and preserves such an extraordinary uniformity of direction and inclination. The whole length, reckoning from the quarry at Gaundlass Mill, is more than fifty miles: and if any one should object to this, in which the continuity is not apparent, there will still remain from Coatham Stob a distance of about thirty-five miles, through which it is almost certain that the trap ranges without any break or interruption. Perhaps it might with more justice be objected, that the first

computation falls below the truth, in consequence of the probable extension of the dyke to the north-west through the Woodland Fells and Egglestone Burn to the banks of the Tees. Should this supposition be admitted, we shall have an uninterrupted dyke extending from High Teesdale to the confines of the eastern coast; a distance of more than sixty miles." Cambridge Phil. Trans. vol. ii. p. 31.

In Fig. 2. the dyke is seen to cut the lias; in Fig. 1. it traverses the new red sandstone; and in Fig. 3. the trap not only is observed to cut the coal measures, but also to overflow them.

Fig. 4. 5. & 6. are taken from Mr. Henslow's Memoir on Anglesea, inserted in the Transactions of the Cambridge Philosophical Society.

In Fig. 4. we may observe that the trap, after breaking through the clay slate, overflows it, and contains fragments of clay slate, which, probably, were detached from the mass of the rock at the time of the intrusion of the trap.

Fig. 5. shows an union of trap dykes in the upper part of the section, which were separate in the lower part.

Fig. 6. exhibits one trap dyke cutting the schist; while another, not far from it, is seen to terminate upwards.

Fig. 7. is from a drawing by Dr. MacCulloch, an engraving of which, and of another and more detailed sketch, have appeared in the Geol. Trans. (old series), vol. ii.

In the notice which accompanies the drawing, and inserted in the Geol. Trans., Dr. MacCulloch observes, "It will be seen that the sandstone stratum has been split into two parts in the direction of its stratification. The upper portion is then separated by a perpendicular fracture, and bent upwards, terminating abruptly. It is in this position involved, supported, and covered by the greenstone." Geol. Trans., vol. ii. p. 306.

PLATE XV.

These sections are taken from the Memoir of M. Elie de Beaumont, on the Montagnes de l'Oisans, inserted in the Mémoires de la Société d'Histoire Naturelle de Paris, tom. v.

Fig. 1. shows the granite resting upon rocks, which would appear referable to the oolitic epoch: the lower part of which M. Elie de Beaumont considers equivalent to the lias.

Fig. 2. is another example of the same phænomenon.

Fig. 3. shows the rocks of the oolitic series resting upon strata, commonly called primary.

Fig. 5. This section exhibits the superposition of the oolitic rocks above the granite. Upon the granite *a*, occurs a variety *b*, much less crystallized, and slightly decomposed. Immediately above this we find a quartzose, very hard, and nearly compact sandstone, *c*: dip about 30° towards the mountain. To this the following beds succeed:

d. A schistose sandstone, the surfaces of stratification covered by a thin coating of carbonaceous matter. This sandstone is several yards thick, and contains small veins and bunches of sulphate of barytes and galena.

e. A gray and small-grained saccharoidal limestone. It contains many veins of sulphate of barytes.

f. A nearly compact, slightly schistose and blue limestone.

g. The Drac variolite, forming a mass from 20 to 30 yards thick, resting on the beds above noticed, and accompanied by its tuff. It contains different ores of copper.

This mass of variolite is covered by different beds of argillo-calcareous black schist and gray limestone.

M. Elie de Beaumont states that "the granite rises, like a wall, a short distance behind, and cuts through the prolongation of all this system of beds. It extends without interruption to the summit of the abrupt mountain named le Puy de Peorois."

Fig. 4. shows an apparent prolongation of the same granite covering the beds of the oolitic series. Above the argillo-calcareous schist *o*, we find in succession:

n. A gray and compact limestone.

m. A very fissile, friable, and argillo-calcareous schist.

l. A gray compact limestone, containing many spathose points, and small calcareous veins.

k. A kind of granite, not well characterized.

i. A small-grained saccharoidal gray limestone, containing numerous crystals of pearl spar.

h. An argillo-calcareous rock filled with crystals of pearl spar.

g. A small-grained saccharoidal limestone, gray in the interior, red on the surface, containing small veins of carbonate of lime and sulphate of barytes.

f. Very schistose sandstone, with small carbonaceous veins. It only differs from the sandstone found commonly in the oolite system of this country in being a little harder and more ferruginous.

e. Compact quartzose sandstone passing into compact quartz with crystals of felspar, nearly without traces of stratification. It contains small veins of sulphate of barytes and quartz.

d. Large-grained and quartzose sandstone; the surfaces of stratification carbonaceous. It contains many crystals of felspar near the contact with the granite, beneath which it plunges. The surfaces of stratification are nearly parallel to that of the contact of the two rocks.

c. Granite, not well crystallized. Contains small veins and bunches of sulphate of barytes and galena.

b. Granite, analogous to the preceding, but somewhat more crystallized.

a. Fine-grained granite with white or reddish felspar and black or greenish mica. It forms the mass of the mountain.

Respecting the curious and highly interesting facts represented in this Plate, M. Elie de Beaumont remarks:

"One of the most striking circumstances attending the contact of the granite containing black mica and rose-coloured felspar, which forms the mountains in the environs of Champoleon, with the oolitic series, is, that whatever may be the position of the surfaces in contact, if the secondary rock be solid (limestone, sandstone, or variolite), this rock and the granite become metalliferous near the contact, and contain small veins or bunches of galena, blende, iron pyrites, copper pyrites, sulphate of barytes, &c., and at the same time the secondary rocks are harder and more crystalline near the contact than elsewhere, whereas the contrary happens to the granite."

The superior metalliferous qualities of the granite and killas, in districts where these rocks approach each other, has been remarked in Cornwall, perhaps arising from causes similar to those which have produced the effects noticed by M. Elie de Beaumont. For sections of the contact of Cornish killas and granite, consult Mr. Thomas's Map and Sections of the Mining District of Cornwall.

PLATE XVI.

Fig. 1. 2. & 3. are taken from the Memoir of Professor Sedgwick and Mr. Murchison, inserted in the Geological Transactions (new series), vol. iii.

Fig. 1. shows the contact of the granite and oolitic series near Brora, Scotland. Sections exhibiting the same contact at Brora had been previously given by Mr. Murchison in the Geol. Trans. (new series), vol. ii. pl. 34. The opinion of the authors is, that the granite has been elevated in mass, and has thus turned up the edges of the oolite strata.

Fig. 2. represents a curious fact observed by Professor Sedgwick and Mr. Murchison. They state that "the projecting portion of the cliff, when seen from a distance, appears of a deep red colour. A mass of granite, in rude prismatic forms, here intrudes upon the stratified rocks, and occupies the coast for three or four hundred feet. On the western side of this junction the beds are in the utmost confusion, the limestone being not only highly inclined, but also crystalline and cellular. Close to the point of contact these same beds assume a brecciated structure, and even contain many fragments of the granite itself.

" The contiguous portions of the cliff are chiefly composed of this breccia, through which the red granite protrudes with much irregularity. Some masses of the conglomerate rest upon the tilted edges of the limestone, whilst others are of a wedge shape, and appear as if they had been mechanically driven in among the shattered edges of the higher beds of limestone and sandstone. The cement of the conglomerate is generally granitic; it is, however, in some parts calcareous, and in other places it approaches to the character of sandstone;—one great block of sandstone, with the usual undulating surface, seemed to be entangled in the granite. At the eastern extremity of this disturbed portion of the cliff there is no conglomerate, and the stratified beds cannot be traced into immediate contact with the intruding granite; neither do their dip and direction appear to have been much disturbed." Geol. Trans. (new series), vol. iii. p. 132.

Fig. 3. represents the contact of granite and sandstone, considered by the authors as equivalent to the old red sandstone. It is stated, that a part of a highly inclined conglomerate, separating the mass of the sandstone from the granite, "is so perfectly granitoid, that neither by hand specimens, nor even by an examination of the sections in the cliff, is it easy to determine where the depositary mass ends, and the crystalline rock begins."

Fig. 4. & 5. are taken from the sections which accompany the Geological Map of the Rhine by MM. Oeynhausen, La Roche, and Von Decken. In Fig. 4. the height has been reduced; and in Fig. 5. the horizontal distance has been lengthened, to render the sections more conformable to nature.

The sections being still distorted, it would be hazardous to reason, from them alone, upon the intrusion of the granite among the other rocks represented. If the sections had been strictly proportional, this difficulty would have been diminished. There is here, however, no evidence of that violence exhibited in the other Figures, and the bunter sandstein may have been quietly deposited on an uneven surface of granite.

PLATE XVII.

This Plate exhibits the intrusion of granite among other rocks.

Fig. 1. 2. & 3. illustrate the intrusion of the granite and granite veins of the Vallorsine, and are derived from M. Necker's Mémoire sur la Vallée de Vallorsine, inserted in the Mémoires de la Société de Physique et d'Histoire Naturelle de Genève.

It would appear that the granite has burst up among the protogine of this part of the Alps, sending forth veins, which cut the strata, and which, when only viewed in one section (see Fig. 1.), appear like included masses in the rock which they pierce.

M. Necker states that there are two varieties of gneiss subordinate to the protogine of the Vallorsine; one fine-grained, of a violet-brown colour, containing many small plates of black mica, and formed of very thin laminæ strongly adhering to each other. It is the roche de corne of De Saussure, and the hornfels of the Germans. The other gneiss is large-grained, very felspathic, and filled with large plates of mica.

The granite frequently becomes a porphyry.

M. Necker observes that the line formed by the granite and porphyry is remarkable, as it seems to have determined the direction of stratification of the rocks in the vicinity, as may be seen by reference to Fig. 1.

Fig. 3. & 4. represent the granite traversing the gneiss in the Vallée de Vallorsine.

M. Necker observes that "inferences drawn from the phænomena observable near the granitic masses of the Vallorsine, added to a remarkable analogy in the stratification, might lead to the supposition that a central granitic mass exists beneath the chain of the Mont Blanc."

"We have stated that, in the vicinity of the granite, the stratified protogine presents a granitoidal appearance, and becomes more felspathic. Now we see among the fragments of the Aiguilles of Chamouny, detached by the action of the elements, brought down by the glaciers, and found either in the *moraines**, or in the bottom of the valley, numerous varieties of protogine with a complete granitoidal structure, and abounding in felspar. We even observe some varieties which might be considered granite, if chlorite did not replace mica. These rocks remind us of the Vallorsine granites, which become charged with green particles when they approach the protogine. The enormous blocks scattered over the valley of the Drance, between Orsières and Martigny, and detached from the Pointe d'Ornex, the most eastern of the protogine *aiguilles* of Mont Blanc, and terminating that chain and the protogine, are formed of rocks which approach true granite more than any others in this part of the Alps. It is worthy of remark, that the Pointe d'Ornex occurs precisely where the Mont Blanc chain is cut the deepest in a transverse direction."

In conclusion, the author observes, that geologists should study with care the general and particular stratification of the rocks composing this chain, before they state opinions respecting the relative position of the formations composing it; because we see, as for example in Savoy, considerable masses of strata so displaced, that more ancient rocks do, over very considerable spaces, cover more modern rocks with an appearance of regularity and order that is highly deceiving.—Such advice, from a geologist who has carefully traversed so many parts of the Alps, merits the greatest attention: and I can state from my own

* "Moraines" are heaps of rubbish forced forward by the advance of the glaciers.

observation, that I have more than once been deceived by sections made at the bottom of the great transverse valleys of the Alps, and that the conclusions at which I arrived, after traversing the heights on the same line of section, were very different from those which I had first formed.

Fig. 4. & 5. illustrate the granite veins of Cornwall, and are taken from those which accompany the Memoir of MM. Von Oeynhausen and Von Dechen, inserted in Phil. Mag. and Annals of Philosophy, March and April 1829.

Fig. 4. shows not only that the granite has pierced the killas, but that it has heaved one side, as appears by the quartz vein. Thus, there is here a fault, as well as an intrusion of granite. Faults are, as is well known, the fissures in which the veins of Cornwall occur. Such faults have never been better shown than in a short notice by Mr. Henwood, inserted in the Transactions of the Geological Society of Cornwall, vol. iii. p. 329—331. A flucan clay vein cuts the copper vein, and the latter is heaved, as the miners term it, about seven feet to the left.

"At the depth of fifty-three fathoms, just at the point of intersection, where the flucan vein was first discovered, the copper vein contained a large rock of quartz, apparently unconnected with any stone of a similar description." ..... "On following the flucan vein about seven feet, the copper vein was again discovered; and at the point where it came into contact with the flucan, another quartz rock, similarly situated, was found." The workmen, thinking that the two fragments belonged to one mass, dug out the piece last noticed, and took it to the other, when they found that the two pieces joined exactly; "the angular protuberances of the one answering in most respects to the fissures of the other, so as to leave no doubt in those who saw them that they had once been united." In fact, the rock had been fractured, and the flucan filled the space between the two sides of the fault.

Fig. 5. exhibits the junction of the granite and killas at Mousehole; veins may be perceived proceeding from the main body of the granite into the killas, from which portions have been detached, now observed included in the granite veins.

PLATE XVIII.

The sections in this Plate are illustrative of the intrusion of trap among other rocks.

Fig. 1. & 2. are portions of the sections, reduced in height, which accompany the Geological Map of the Rhine by MM. Von Oeynhausen, La Roche, and Von Dechen. A mass of pyroxenic porphyry appears among the coal measures of the Saarbrück coal district near Brems, and the pyroxenic porphyry of the Schaumberg comes up through the same rock near Tholey, forming a continuation of the large mass which traverses so considerable a portion of this coal district.

Fig. 3. is also taken from the same work, the height not being reduced, but the igneous rocks of the Kaiserstuhl being omitted, because they are removed some distance from the line of section, and because it might have been inferred, from the original section, that the trap of the Kairserstuhl rested upon the gneiss which formed an elevated portion of the Schwarzwald. It is by no means improbable that the igneous rocks of Mahlberg and the Kaiserstuhl are connected, but they do not both occur on this line of section.

The scale of height being very different from the scale of length, we cannot infer, from this section alone, whether the granite and porphyry, which probably are only modifications of the same thing, raised the bunter sandstein, or whether the latter was quietly deposited on the former.

Fig. 4. is taken from the Atlas which accompanies M. de Caumont's Topographie Géognostique du Département du Calvados, and shows the manner in which the coal measures of Littry have been disturbed by the porphyry.

PLATE XIX.

For this continuous section of a considerable part of the North-east of Ireland I am indebted to the observations of Professor Buckland and Mr. Conybeare. These geologists have already published a larger series of sections, upon a scale which exhibits more detail, in the Geol. Trans. (first series), vol. iii. To the Memoir which accompanies them I must refer for a general account of that country.

It will be observed in the accompanying section, that the basalt covers indifferently any rock which it may encounter; that it is sometimes columnar, sometimes not; that it sometimes appears stratified, while at others it has broken through the strata, and has caught up portions of the rock which it traversed.

At Murlock Bay, Fairhead, and Cross Hill, columnar basalt rests on the coal measures; at Knocklead and other places, on chalk. At Kenbaan large masses of chalk seem caught up by the basalt, which appears to cut off and pierce the same rock in other places. In the range of cliffs extending from Dunseverie Castle to the celebrated Giant's Causeway, the alternation of columnar with other basaltic rocks produces the appearance of stratification. The Causeway, properly so called, is a continuation of one of the columnar beds into the sea.

Dykes cut indifferently all the rocks. Thus the Carrich More Dyke, between Fairhead and Cross Hill, cuts through a basaltic rock and the coal measures. Dykes traverse the basalt and the chalk. The most celebrated dyke, not here represented, but which will be seen in the Geol. Trans. vol. iii. traverses chalk and basalt in the Isle of Raghlin. There are, in fact, three dykes, two large and one small. The chalk included between the two large dykes, and traversed in a zigzag manner by the small dyke, is converted into granular marble, as are also the portions of chalk in contact with the large dykes on either side.

There can be little doubt, from an inspection of the section represented in this Plate, that the basalt has been intruded among, and overflowed, the other rocks after their deposition, and has afterwards, in common with the other rocks, been cut by dykes, the age of which it would be difficult to determine.

PLATE XX.

Illustrates the effects of meteoric or atmospheric influence exerted on the exposed granite of the West of England. The three tablets which compose the Plate are taken from the drawings of Dr. MacCulloch, and have already been given to the public in the Geol. Trans. (old series), vol. ii. accompanied by a Memoir, in which Dr. MacCulloch shows that the present appearance of the three objects represented, is due to the decomposing effects of atmospheric influence.

"The granite of this country is known to be in general split by fissures in different directions, but most commonly tending to the perpendicular and horizontal. By those it is divided into masses of a cubical and prismatic shape. Of the exceptions to this rule, there is one, among many other instances, in Shaugh rick, near Plymouth. If we examine a rock of this kind near the surface of the soil, we shall find that the fissure is a mere mathematical plane separating the two parts, and that the angles are sharp and perfect. If we turn our attention to granites which, from their greater elevation above the present soil, appear to have been longer exposed to air and weather, we shall find, as the first step to change, a gentle rounding of the angles, such as is exhibited in the Vixen Tor. By degrees, the surfaces which were in contact become separated to a certain distance, which goes on to augment indefinitely. As the wearing continues to proceed more rapidly near the parts which are most external, and therefore most exposed, the masses which were originally prismatic acquire an irregular curvilinear boundary, and the stone assumes an appearance resembling the pieces which constitute the Cheese-wring. If the centre of gravity of the mass chances to be high and far removed from the perpendicular of its fulcrum, the stone falls from its elevation, and becomes constantly rounder by the continuance of decomposition, till it assumes one of the various spheroidal figures which the granite boulders so often exhibit. A different disposition of that centre will cause it to preserve its position for a greater length of time, or, in favourable circumstances, may produce a logging-stone." MacCulloch, Geol. Trans., vol. ii. p. 71.

The same author estimates the weight of the Logan-stone at 65.8 tons. The wanton overthrow, and subsequent restoration to its place, of this block is well known.

Looking at these drawings, and taking into consideration the comparatively little waste which the objects they represent now suffer, it would seem to require a long lapse of time to produce the effects we here witness.

PLATE XXI.

This Plate, representing the Mont Blanc as seen from the Breven, is taken from that by Birman, and is remarkable for the fidelity with which every point is delineated. It is here introduced for the purpose of showing the effects of what have been termed meteoric influences on the High Alps. The point whence the view is taken is 2545 metres, or 9350 English feet, above the level of the sea; and from it there is a commanding and long celebrated view of the valley of Chamonix* beneath, and the Mont Blanc range in front. The destructive and preservative powers of the atmosphere, above the limit of what is commonly termed perpetual snow, are well seen in the view before us. When, as in the case of the various *aiguilles*, the perpendicularity or steepness of the rocks will not permit the snow to lodge, the destruction that takes place is very considerable, and huge blocks are hurled down into the valleys beneath. But when, as in the cases of the real Mont Blanc, the Dome de Gouté, &c., the snows can lodge and become accumulated to considerable depths, the rocks below are preserved in their places, and no degradation of the mountain can take place in those parts so protected. In the highest regions the avalanches do not bring down the rocks protected by a mass of snows; at such great heights avalanches are commonly formed by a superior bed of snow sliding over the smooth and frozen surface of an inferior bed. The avalanche which overwhelmed M. du Hamel and his party was of this description.

The decomposition of the rocks in the *aiguilles* is certainly considerable†; and although their mass may not be perceptibly diminished by it, still, as it is constantly going on, we may imagine that after a great lapse of time they might be degraded, and their bold spires destroyed. Should such a state of things arise, the snows would accumulate upon them, and in the end they would, like the highest point of Mont Blanc, become protected.

* From some reason or other,—perhaps because the celebrated De Saussure used the word,—this place is commonly written Chamouni or Chamouny; but the real name is Chamonix. It is so written in all good maps of this part of the Alps.

† I can speak feelingly on this subject, for once I narrowly escaped destruction from the falling blocks, when ascending by the side of the Aiguille de Gouté.

The Mont Blanc range is divided into many other minor mountains and valleys, and some of the latter are of considerable depth; as for instance, that occupied, in its lowest part, by the well known glacier named the Mer de Glace.

The surface of a glacier is generally more or less covered with rock fragments, some blocks being of considerable magnitude; these the glacier advances slowly to the valleys below; except in cases where the glacier comes to the edge of a precipice, when, in the advance, masses of the glacier, charged with the fragments of rocks, are hurled into the ravines beneath. Glaciers shove loose rocks, trees, and in fact any substance not firmly fixed, before them. These accumulations, named *moraines*, are sometimes considerable. By these the advance or retreat of a glacier is estimated. If, in front of a glacier, there is a *moraine* beyond that which it immediately bears before it, it is clear that the glacier once advanced beyond its actual limits; whereas, if there is no such *moraine*, the glacier may be considered advancing.

Notwithstanding all this apparent great destruction of the exposed part of the mountain, it is curious to observe how little the valley is filled up by it. The river, it is true, flows on the debris of the mountains on either side, in the part observed in the view before us, therefore the depth of the debris cannot be ascertained; but towards Pont Pellisier, on the descent of the valley towards Servoz, the river's course is on the main rock, which it has cut down, but to no great depth.

The glacier waters are charged with fine particles of decomposed felspar and other matters; the heavier particles are deposited near the glaciers and in the valley, but the lighter are transported to considerable distances; for the Arve, at its junction with the Rhone near Geneva, is charged with them.

There was a time when the Arve was supposed to have cut out the valley of Chamonix; and I believe there will even now be found geologists who would attribute much to its cutting powers; but, unfortunately for this theory, the glacier waters flow over the rubbish of the mountains, and deposit in the valley much of the matter held by them in mechanical suspension: and upon the whole, it would seem more probable that the valley would be filled up by existing causes, than that it should have been formed by them.

The following are the names of places corresponding with the figures in the Plate:

1. Aiguilles Rouges.
2. Cabane de la Flegère, 7040 English feet.
3. Chalets de la Charlanoz.
4. Chalets du Planprat, 6790 feet.
5. Path from le Planprat to Chamonix.
6. Les Escaliers.
7. Northern chain of the Vallais.
8. Rocks of the Croix de Fer.
9. The Col de Balme, 7558 feet.
10. Chalets de Charamillan.
11. Village du Tour.
12. Aiguille du Tour.
13. Glacier du Tour.
14. Aiguille du Chardonnet.
15. Aiguille d'Argentière, 12,896 feet.
16. Glacier d'Argentière.
17. Aiguille Verte, 13,400 feet.
18. Aiguille de Dru, 12,454 feet.
19. Aiguille du Moine.
20. Glacier du Nant Blanc.
21. Aiguille du Bochard.
22. Le Chapeau.
23. Village of Lavanché.
24. Les Tines.
25. Village des Bois.
26. Village of Prats.
27. Source of the Arveron.
28. Glacier des Bois.
29. Rochers des Mottets.
30. The Mer de Glace.
31. House on the Montanvert, 6105 feet.

32. The Aiguilles de Léchand.
33. Aiguille de Charmoz.
34. Aiguille des Grandes Jorasses.
35. Aiguille de Greppond.
36. Aiguille de Blaitière.
37. Aiguille du Midi, 12,857 feet.
38. Glacier des Pélérins.
39. Glacier de Blaitière.
40. Glacier de Greppond.
41. Le Plan de l'Aiguille.
42. The Chalets de Blaitière.
43. Chalets named sur le Rocher.
44. Path of the Montanvert.
45. Path of la Filia.
46. Hamlet of Planaz.
47. Village of Mouilles.
48. Chamonix, 3353 feet.
49. The Arve.
50. Village of Favrans.
51. Village of les Pélérins.
52. Cascade, or Nant des Pélérins.
53. Bridge of Piralota.
54. The Mont Blanc du Tacul.
55. Aiguille without a name.
56. The Mont Blanc, 15,744 feet.
57. The Dôme du Gouté.
58. Aiguille du Gouté.
59. The Grand Rocher Rouge.
60. The Grand Plateau.
61. Rocks of the Grands et Petits Mulets.
62. Glacier des Bossons.
63. Village of les Bossons.
64. Montagne de la Côte.
65. Glacier de Tacconnaz.

66. Montagne des Feaux, or du Taconnaz.
67. Montagne de la Gria.
68. Pierre Ronde.
69. Mont Lacha.
70. Aiguille de Bionassay.
71. Mont Blanc St. Gervais.
72. Glacier de Bionassay.
73. Montagne de Tricot.
74. Aiguille de Rousselette.
75. Lake of the Breven.
76. The Pavillon de Bellevue.
77. Village of la Morlaz.

PLATE XXII.

This Plate exhibits the crater of Vesuvius as it appeared on Feb. 15, 1829. The volcano was in a minor state of activity, and showed, on a small scale, some of the effects produced during great eruptions.

During the ascent of the cone, I found it difficult to avoid the stones, which were rushing down the sides, and bounding by with great velocity, an inconvenience which I only encountered this day. They were detached from the side of the cone, not by any shock given to the sides of the mountain, but by the effects of the sun's rays, which dissolved the snow that had fallen, and the ice which had formed on the heights during the preceding night.

The large crater was of great circumference, and such nearly as it had been left by the late great eruptions, with the exception that the bottom seemed gradually filling up by an accumulation of lava, proceeding apparently from the cone or crater in the centre.

The height of the cliffs of the great crater seemed between 300 and 350 feet; that of the cone in the centre about 90 feet. After the more continued detonations there was a lull or calm, always succeeded by a violent explosion, throwing up stones to a considerable height, mixed with portions of red hot lava, which latter fell like lumps of soft paste upon the sides of the small cone.

When the smoke or vapour cleared away for a moment, the red hot liquid lava could be clearly distinguished inside the small crater. At every great explosion the sides of the little cone appeared to heave considerably: during one of these paroxysms the base of the central cone was pierced by the little lava current exhibited in the sketch. Some barometrical measurements which I made during the month of February 1829, gave me 3897 feet for the elevation of the highest part of Vesuvius above the sea. The height obtained by M. Von Humboldt, in 1822, was 3890 feet, or 608 toises.

PLATE XXIII.

The three tablets contained in this Plate afford examples of phænomena which have been supposed contemporaneous.

Fig. 1. represents the Goat Hole Cave in the cliffs near Swansea, and is taken from Professor Buckland's Reliquiæ Diluvianæ.

A. A mass of argillaceous loam, fragments of limestone, and the remains of elephants, &c. which has, according to Professor Buckland, been dug over since its original deposition, perhaps in search of fossil ivory. B. Bottom of the cave to which the sea never reaches, covered with similar materials to A. but more disturbed. In this was found part of the skeleton of a woman, apparently buried here in very ancient times. Small ivory rods were found with the skeleton, and were perhaps formed from fossil ivory. D. D. D. Rock basins produced by the friction, during storms, of large pebbles which now lie in them. C. upper termination of a chimney-shaped aperture in the face of the cliff.

The sea only enters a certain distance, and during heavy gales, into this cave. It therefore could not have deposited, under existing circumstances, the bones of the elephant, &c. found in the back part of the cavern. The skeleton of the woman proves that since her interment, probably in very ancient times, the sea has not washed that portion of the cave in which her bones were discovered. But although the sea, at its present level, has not deposited the animal remains discovered in the cavern, it is not so clear that it has not laid open the cave, or diminished it, by cutting back the cliff.

Some caverns which I observed in the cliffs of carboniferous limestone near

Pendine, in Caermarthen Bay, may throw some additional light on this subject, as they are not very far distant, on the same line of coast, from the cave represented in the figure before us. Several caverns occur in the face of the cliff; and at first sight they might be considered as formed by the sea at its present level. A little attention will, however, show that the sea, at its present level, has been brought in contact with the caverns by cutting back the cliff. The caverns have been once filled with sandy and clayey matter, which, in many instances, has not been yet washed away: this is particularly remarkable in the roof of one cave. The sea has certainly enlarged these caves; but they appear to have been caverns, and to have been filled with transported materials before the commencement of the present order of things.

Fig. 2. is a section of the osseous breccia of Nice, and has already appeared in the Geol. Trans. (new series), vol. iii. accompanying my memoir on that country. The remains of mammiferous quadrupeds found in the breccia have been mentioned by M. Cuvier in his Ossemens Fossiles. They are here mixed with marine and land shells. It would appear from this section, 1. That there existed a fissure beneath the level of the sea, one side of which was bored by some lithodomous shell (L. L. L.). 2. That the lowest part of this fissure was filled with pebbles of bluish limestone transported from a distance (C). 3. That the remainder of the fissure was filled by broken bones of terrestrial mammiferous animals, shells (terrestrial and marine), and fragments of rocks, mostly, but not solely, those of the neighbourhood (A). 4. That the land rose, or the sea fell, to their present relative position. The pebbles in the lower part of the cleft, once apparently the lowest part of a great cave, now destroyed by blasting, would seem to be of the same age as the tertiary conglomerates of the same vicinity: of which see an account in the memoir cited, Geol. Trans. vol. iii. pp. 175, 176.

Fig. 3. & 4. are taken from the memoir of M. Brongniart, entitled, Notice sur les Brèches osseuses et les Minerais de Fer pisiforme de même Position géognostique; inserted in the Annales des Sciences Naturelles, August 1828. In this memoir M. Brongniart shows that the clefts occupied by the pisiform iron ore in the Jura are most probably contemporaneous with the osseous breccias of Nice and other places, and of the same age as a considerable proportion of cavern remains. Since the publication of this paper, M. Necker has

shown that the iron ore filling the clefts in the white limestone of Carniola contains the bones of mammiferous animals, and in particular the teeth of the *Ursus spelæus*.

After noticing the rocks of the country near Kropp, M. Necker proceeds to remark that the surface of the upper beds, composed of a whitish-gray compact limestone, is broken into deep and large vertical fissures. These contain yellow ochreous clay and hydroxide of iron; sometimes compact in its tissue, but porous and cellular in its structure, the cells being filled with yellow or yellowish red clay; sometimes in tubercular nodules, the surface either smooth or else rough, with the points of quadrangular crystals. These crystalline masses are radiated in the interior, and are true brown hematites. The iron ore often occurs in pieces as round as a musket-ball, shining, and as if polished on the surface. They are generally the size of a nut or a walnut, but sometimes surpass that of the fist. The iron ore is cemented by a yellowish red clay, containing angular fragments of white limestone. M. Necker further says, "I was convinced, by visiting the upper and accessible portions of the works, that the ore which filled the clefts or fissures was altogether independent of the limestone in which they occur: the irregular sides of the fissures are covered with a coating of earthy yellow hydroxide of iron; and I have also observed true calcareous stalactites, with great masses of concretionary limestone, and veined alabaster with a radiated structure, lining the sides of the clefts, and being penetrated and mixed with fragments of hydroxide of iron; thus forming a breccia of which the fragments are ferruginous and the cement calcareous. Large veins of white calcareous spar traverse the masses of clay and iron which adhere to the sides of the fissure, but never penetrate into the limestone of the mountain." Annales des Sci. Nat. vol. xvi. pp. 95. & 96.

The author cited then proceeds to state, that fossil bones have been discovered in this mass of clay and iron ore, and particularly mentions the canine tooth of a bear, in the ferruginous clay of one of these clefts.

It would appear that there is a very considerable correspondence in the nature of the organic remains which we find in most caverns, in the osseous breccias, and in the fissures filled with iron and clay in Carniola. Professor Necker states that neither terrestrial nor marine shells have yet been seen in the fissures of Carniola. The remains of marine and terrestrial shells occur, and even corals have been discovered, in the osseous breccia of Nice and its environs, which is, as is well known, highly ferruginous. Much information is yet wanted on this subject, which probably will be afforded us in the continuation of Professor Buckland's Reliquiæ Diluvianæ. The facts at present known are well worthy of attention, more particularly the occurrence of brown hematite iron ore, of sufficient value to be profitably worked, in clefts of rock, mixed with the remains of the cavern bear, *Ursus spelæus*.

PLATE XXIV.

The supercretaceous or tertiary rocks have of late been the subject of very interesting discussion. The two great advances which have been made consist in connecting them with very recent strata on the one side, and with the secondary rocks on the other. Professor Sedgwick and Mr. Murchison, in their joint observations on certain rocks of the Bavarian and Austrian Alps, have observed upon the apparent passage of the rocks, commonly called tertiary, into the strata, usually termed secondary. Now, if this passage shall become established by careful future examination, the fact will be of the highest importance to geology, as it shows us that the distinction between tertiary and secondary rocks is imaginary; for there would appear to be no more difference in organic character between the lower parts of the class termed tertiary, and the upper parts of the class named secondary, than there is between the cretaceous rocks and the oolite, or the chalk and the muschelkalk, which are united in one class. The recent labours of Dr. Fitton on the Maestricht rocks seem to show the passage of the cretaceous into the supercretaceous rocks.

Respecting the supercretaceous or tertiary rocks, I cannot forbear quoting the excellent observations of Professor Sedgwick, contained in his Address delivered before the Geological Society at the annual meeting, 1830. Phil. Mag. and Annals of Philosophy, vol. vii. p. 300.

"Twenty years are not yet passed away since MM. Cuvier and Brongniart first published their researches on the geological structure of the Paris basin. The innumerable details exhibited in their various essays; the beautiful conclusions drawn from unexpected facts; the happy combination of mineralogical and zoological evidence; the proofs of successive revolutions, till then unheard of in the physical history of the earth—all these things together, not merely threw new light on a subject before involved in comparative darkness, but gave new powers and new means of induction to those who should in after times attempt any similar investigations."

"Mankind are, however, dazzled and astonished by great discoveries, as well as guided and instructed: and for some years after the publication of these admirable works, the naturalists of various countries, whose attention had been so loudly called to the deposits above the chalk, saw in them only a repetition of what was already described, and of which the true type was in every case to be sought among the formations of the Paris basin. Investigations conducted in this spirit sometimes ended in disappointment. But this was not the spirit recommended in the incomparable Essay of Cuvier (Discours Préliminaire); for after exhibiting the true method of geological induction, and describing the intense and almost tormenting interest with which he had followed out his own investigations, he points to the long series of deposits in the Sub-Apennine hills, and states his conviction that in them lies concealed the true secret of the last operations of the ocean."

"Since that discourse was written, much has been done; but much more still remains to be done." Phil. Mag. and Annals, vol. vii. 1830.

I have been the less anxious to exhibit sections of the supercretaceous rocks, as our present knowledge of them is expected to be condensed and illustrated in a forthcoming geological work.

Fig. 1. & 2. are proportional sections of the supercretaceous rocks of the Paris basin and of the Isle of Wight, placed side by side, for the sake of comparison. The difference in the relative thickness of the two deposits is very considerable. The plastic clay of the Isle of Wight may owe its great thickness to local circumstances; but granting this, it is still a good example of the depth which this deposit has attained in the south of England.

Fig. 1. is constructed from the celebrated work of MM. Cuvier and Brongniart on the tertiary rocks of the Paris basin, and from M. de Caumont's and my own observations on Normandy.

Fig. 2. is formed from Mr. Webster's well known remarks on the Isle of Wight.

Fig. 3. is taken from M. Elié de Beaumont's Recherches sur quelques-unes des Révolutions de la Surface du Globe. (Ann. des Sci. Nat. 1829 & 1830.)

A. A. beds of limestone, which M. Elié de Beaumont considers may be equivalent to the upper beds of the oolitic series. B. B. a marly limestone, containing ammonites and *Belemnites mucronatus,* and considered referable to the cretaceous rocks.

"On these beds, partly vertical, the elevation of which evidently dates later than the deposit of the chalk and green sand, we observe on the left of the Durance, from the entrance of the Pertuis nearly to Peyrolles, the nearly horizontal beds a, a, a, of a thick freshwater deposit, principally composed of compact gray limestone, and of a sandstone analogous to that which, near Aix, alternates with variegated marls of a freshwater formation." Recherches sur les Révolution de la Surface du Globe.

Fig. 4. is a reduction in height of part of a section accompanying the memoir by Mr. Lyell and Mr. Murchison on the freshwater formations of Aix, in Provence, and inserted in Jameson's Edinburgh Philosophical Journal, vol. xxi. (1829) p. 287-298. It exhibits the very considerable thickness of the freshwater deposit, shown in the last figure to rest upon disturbed strata of oolite and green sand. To the memoir itself I must refer for details, and for figures of some of the insects, plants, and shells contained in these strata. The authors remark, that "the great thickness of the regular beds of blue limestone and shale, the quality and appearance of the coal, the large developement of compact, gray, brown, and black argillaceous limestones and sandstones, together with the red marls and gypsum, gives to the whole series the aspect of the most ancient of our secondary rocks; and it is only by the occurrence of fluviatile and lacustrine shells, and the seed-vessels of charæ, that the geologist is undeceived, and recognizes, from the unequivocal *specific* characters of many of these remains, the comparatively recent date of the whole group."

From want of room, the beds containing the coal, which succeed to the compact limestone with shale and sand, on the right of this figure, have been omitted.

PLATE XXV.

Fig. 1. exhibits the effects of an upburst of volcanic rocks amid the freshwater limestones of central France. It is constructed from the information of

Mr. Murchison, who kindly furnished me with all the materials necessary for a more proportional section than that which accompanies his and Mr. Lyell's joint Memoir "Sur les Dépôts Lacustres Tertiaires du Cantal, et leurs Rapports avec les Roches Primordiales et Volcaniques." Annales des Sci. Nat., Oct. 1829.

To this memoir, full of very interesting detail, I must refer for the views of the authors respecting the manner in which they suppose the freshwater limestones to have been formed. The section before us seems to prove, that the volcanic explosion has broken the freshwater limestones into fragments, which have afterwards become included in the igneous rocks ejected. This is a point the authors desire to establish. The broken portions of freshwater limestone, included in volcanic rocks, cannot fail to remind the geologist of the fragments of stratified rock caught up and included in the trap rocks of the Western Islands of Scotland, described and figured by Dr. MacCulloch.

Fig. 2. is taken from Mr. Scrope's Memoir on the Geology of Central France, and is highly illustrative of the fact, that no great mass of waters has passed over these countries since the eruptions of the volcanoes here represented. Had any such mass overwhelmed the land, the craters before us must have been obliterated.

PLATE XXVI.

The sections in this Plate are intended to illustrate the different development of the chalk and green sand in northern and southern England, and in Normandy.

In a paper inserted in Geol. Trans. (new series), vol. ii. pp. 109—118, I had occasion to remark on the changes which take place in the green sand, even within the distance of a few miles, on the coasts of Devon and Dorset.

Fig. 1. is taken from a section by Dr. Fitton, inserted in the Annals of Philosophy for 1824, accompanying his Memoir on the Isle of Wight. As a mass, the upper part may be considered cretaceous, and the lower portion arenaceous and argillaceous. We have here all the divisions that have been made in this group. 1. Chalk; 2. Upper Green Sand; 3. Gault; and 4. Lower Green Sand. The organic remains contained in these various divisions are considered to

possess a marine character; that is, the greater portion of the fossils is of such a nature, as to lead to the presumption that they are the remains of animals which existed in the waters of a sea. This is, however, not the inference that can be drawn from the contents of the beds that next succeed in the descending order. The animal remains found entombed in the latter strata are inferred, from analogy, to be principally terrestrial and freshwater. It therefore may be concluded, that the Weald clay (5) and the Hastings sands (6) have not had a common origin with the cretaceous rocks above, but that they have been formed under different circumstances. For information on these various deposits, consult Dr. Fitton's paper in the Annals of Philosophy, Nov. 1824; Mr. Mantell's Illustrations of the Geology of Sussex; and Mr. Webster's and Mr. Murchison's papers in the Geological Transactions.

Fig. 2. is taken from part of Mr. Phillips's Coast Section of Yorkshire, reduced in height. The characters of the group are here cretaceous and argillaceous; the upper part chalk, the lower part gault. The arenaceous beds, if ever traced, must be very insignificant.

Fig. 3. is part of an unpublished section by Mr. Lonsdale. The divisions that can be established in the group are here the same as in Fig. 1.: chalk, upper green sand, gault, and lower green sand; the latter being very thin.

Fig. 4. is taken from one of M. de Caumont's sections, inserted in the Mémoires de la Société Linnéenne de Normandie. The chalk is represented in this part of Normandy (Cotentin) by the bacculite limestones, so called from the number of these fossils they contain. M. Desnoyers establishes these rocks as equivalent to the chalk and green sand, in his paper intitled Mémoire sur la Craie et les Terrains Tertiaires du Cotentin, inserted in the Mémoires de la Société d'Histoire Naturelle de Paris, vol. ii. pp. 176—248.

Fig. 7. has been constructed from the description of the Freville quarries, contained in the Memoir of M. Desnoyers. The bacculite limestone of the Cotentin affords us an example of the loss of the cretaceous character of the chalk, not far distant from the great mass of that formation, where this character is seen in the highest perfection.

Fig. 5. is a section of Cap la Hêve near Havre. The lowest beds of chalk here, unlike those of the South of England, contain an abundance of flint. To the chalk succeeds the green sand; so that the group in this coast is cretaceous

above and arenaceous beneath. This figure is taken from the wood-cut accompanying Mr. Phillips's notice on the Geology of Havre*.

Fig. 6. represents the chalk and green sand in the vicinity of Lyme Regis, and is one of the figures which accompany my paper on the Chalk and Green Sand of that coast, inserted in the Geol. Trans. (new series), vol. ii. To this paper I must refer for details. It will be observed, as a curious contrast, that in Yorkshire the chalk is based on clay, while at Lyme Regis it rests on a thick arenaceous deposit, a mere trace of clay being found in the lowest part.

It would be curious to trace, if possible, the causes which have produced a large deposit of clay over one part of a given area, while, in another portion of the same area, the great deposit has been arenaceous. If the object in tracing minute differences was to discover the causes that produced them, such investigations would be valuable; but as the subject is at present considered, the importance frequently attached to such small divisions more frequently retards than advances geology. What time and talent would be wasted in attempts to discover the upper green sand, the gault, and lower green sand, in the Alps, where even the divisions into chalk and green sand have not yet been established, though comparatively near countries, where the two great divisions are sufficiently apparent.

PLATE XXVII.

Fig. 1. is intended to show that a succession of the oolite rocks, from the coral rag to the lias inclusive, has been deposited in Northern France, much in the same manner as in Southern England. The section is the same, reduced in height, as that which accompanies M. Boblaye's Mémoire sur la Formation Jurassique dans le Nord de la France, inserted in the Ann. des Sci. Nat., Mai 1829. From this it would appear, that the slates of the Ardennes had been elevated before the deposition of the oolite series, which seems to rest unconformably upon them. The sandstone represented beneath the lias is one of the rocks which have received the name of Quadersandstein.

This section affords an example of denudation. On this head M. Boblaye observes: " One of the most remarkable features of this country is observed

* Phil. Mag. and Annals of Philosophy, vol. vii. p. 197.

in the escarpments which the plateaux offer to the north, and the gentle slope they present to the south. They form either winding cliffs, or elevated capes, rising above the valleys of thc Meuse, of the Chiers, and of the Semois."

"This fact, observed and well described in England in all the districts composed of the oolitic series, shows the immense denudations that the less resisting rocks have suffered."

Fig. 2. is part of one of the sections, reduced in height, which accompany the Memoir of Professor Buckland and Mr. Conybeare on the South-western Coal District of England, Geol. Trans. (new series), vol. i. It shows that the carboniferous limestone and old red sandstone were disturbed previous to the deposit of the new red sandstone, the lias, and the inferior oolite. The three latter rocks are observed to overlap each other, and to come, in succession, into contact with the carboniferous limestone, precisely as different deposits in a basin come in succession into contact with the sides of the basin.

Fig. 3. is taken from one in Mr. Phillips's Illustrations of the Geology of Yorkshire, and is introduced to show the great thickness which the lias attains in that part of England. It also exhibits a part of the coal, shale, and sandstone, interposed between the great and inferior oolite of Yorkshire.

a. Alum shale, rich in ammonites, belemnites, nuculæ, amphidesmæ, unioniform shells, &c. Thickness, 140 to 180 feet.

b. Hard lias shale, containing nodules and lenticular masses of argillaceous limestones, sometimes coated with pyrites:—20 to 30 feet.

c. Alum shale, with a few courses of ironstone balls, and a remarkable line of sulphureous shale in the middle:—20 to 40 feet.

d. Numerous layers of firmly-connected nodules of ironstone, often septariate, and inclosing dicotyledonous wood, pectines, aviculæ, terebratulæ, &c.:—20 to 40 feet.

e. The marlstone series, consisting of alternations of sandy lias shale, and sandstones, which are frequently calcareous, and generally full of shells.

The reader should compare this section of the lias in Yorkshire, with the section which accompanies my paper on the Lias of Lyme Regis, Geol. Trans. (new series), vol. ii. pl. 3. The variations in development will be easily observed. The sandstone, shale, and coal series of the Yorkshire oolite is unknown in the South of England.

Fig. 4. is taken from the section accompanying Dr. Fitton's paper on the Strata which afford the Stonesfield Slate, inserted in the Zoological Journal, No. XI. (1827). In the memoir, (to which I must refer for details,) Dr. Fitton clearly shows that the Stonesfield slate is a part of the oolite series. This section explains itself.

Fig. 5. is part of one of the sections which accompany Professor Necker's Mémoire sur la Vallée de Vallorsine (Mém. de la Soc. de Phys. et d'Hist. Nat. de Genève, 1828). M. Necker presents us with a very detailed account of the various strata which repose on the protogine of that part of the Alps.

Above the mica slate, which may belong to the inferior system of rocks, there are in succession the following beds: 1. A sandstone, formed of numerous grains of quartz mixed with a few crystalline grains of felspar, and sometimes with a little talc or chlorite. At the Col de Salenton this sandstone forms two beds. The lowest, remarkable for grains of rose-coloured felspar, effervesces slightly with acids. 2. Red and green, argillo-ferruginous schist. This rock, thin in this section, is sometimes wanting; but on the east of the Vallée de Vallorsine, in the chain of the Céblancs, it alternates with the well-known Vallorsine conglomerate, which is but a similar schist filled with rounded pebbles of gneiss, mica slate, protogine, &c., among which we neither find true granite nor limestone;—an important fact, as it appears to show that the Vallorsine granite did not exist before the formation of the conglomerate. 3. A black schist with impressions of ferns. The vegetable remains are converted into thin shining talc. This schist, which seems to be a continuation of that noticed by M. Elie de Beaumont in other parts of the Alps, and which has given rise to some singular observations, is altogether wanting in the section before us: so little constancy is there in the development of beds, even within moderate distances. M. Elie de Beaumont has, as is well known, found these beds resting on, and covered by, others containing belemnites. From this circumstance, and from the zoological character of the rocks to which these can be apparently traced, it is inferred that these beds are equivalent to the lias. It should be remarked, that the vegetable remains are similar to those found in the coal measures. 4. Black or dark-blue gray limestone, filled with grains of quartz. This is the arenaceous limestone of the figure before us. 5. A black argillaceous schist, containing nodules of Lydian stone. Ammonites are found in this rock, as also in an argillo-talcose schist which alternates with it. 6. A gray calcareous and arenaceous schist, containing belemnites. This forms the summit of the Buet, 1578 toises, or 10,099 English feet above the level of the sea. The beds above enumerated, and not exhibited in the section before us, will be seen by reference to Plate XVII. fig. 1. where the whole section is given to illustrate the intrusion of granite.

PLATE XXVIII.

This Plate is intended to illustrate the red sandstone group, composed of the red and variegated marls (keuper, marnes irisées), the muschelkalk, the grès bigarré (bunte sandstein), the zechstein (magnesian limestone), and the rothe liegende (grès rouge).

Fig. 1. is a reduction, in height, of one of the sections which accompany M. Elie de Beaumont's Memoir on the Vosges, inserted in the Annales des Mines, 1827 & 1828. The highest rock in this section is a sandstone, considered by M. Elie de Beaumont as the lowest part of the lias; it is one of the sandstones which have been termed quadersandstein by German geologists. Beneath this are the variegated or red marls, containing gypsum, carbonaceous marls, and a bed of magnesian limestone: next, in the descending order, follows the muschelkalk, generally composed of a smoke-gray limestone, being occasionally dolomitic in the lower parts. "The muschelkalk," observes M. Elie de Beaumont, "is often rich in organic remains, of which the following are those most generally distributed: Terebratula vulgaris or subrotunda, Mytilus eduliformis, Cypricardia socialis, Ammonites nodosus, Ammonites semipartitus, and Encrinites liliformis," (Encrinites moniliformis, *Miller*).

Fig. 2. is a reduction, in height, of another section accompanying the memoir above cited. This shows the development of the grès bigarré beneath the muschelkalk, and the manner in which it rests on the rocks termed transition. The grès bigarré of the Vosges is, according to M. Elie de Beaumont, composed, at the base, of thick beds of fine-grained sandstone, with irregularly distributed plates of mica, affording good building stone. Above these are thinner beds, furnishing grinding-stones. Higher still, the rock splits into slates used for paving and roofing the houses. These slaty beds are micaceous: they

sometimes pass into a variegated clay used as brick earth, and then contain masses of gypsum. The grès bigarré of the Vosges contains, particularly in its upper beds, numerous vegetable remains, described by M. Adolphe Brongniart.

Fig. 3. is also taken from the same memoir, and shows the manner in which the grès bigarré rests, according to M. Elie de Beaumont, upon the grès de Vosges. At the same time it is right to state, that M. Voltz considers the grès de Vosges as the lowest part of the grès bigarré.

Fig. 4. & 5. are taken from the Richesse Minérale of M. Heron de Villefosse, Plate XXIII. and illustrate those limestone and other beds which have, by M. Von Humboldt, been included under the general name of Zechstein,—a name previously confined to one of the subordinate limestones. These beds afford a curious example of the importance frequently attached to local divisions. According to M. D'Aubuisson, the mean thickness of the copper slate is about one foot in the Mansfeld district, Thuringia, Franconia, and the Hartz. The zechstein is represented as sometimes from twenty to thirty yards thick; the rauchwacke, when pure and compact, one yard thick; when cellular, sometimes attaining fifteen to sixteen yards. The stinkstein varies from one to thirty yards. The asche seems very variable. It has been attempted to trace all these divisions even into South America.

Professor Sedgwick, in a paper On the Geological Relations and internal Structure of the Magnesian Limestone of the Northern Parts of England, (inserted in the Geol. Trans. (new series), vol. iii. p. 37—124.) considers that he can trace the equivalents of the copper slate (kupfer-schiefer), the zechstein, asche, stinkstein, &c. of the Thuringerwald, in the magnesian limestone of England: so that the minor causes which have produced certain variations of the deposit in Germany have extended into England. In the direction of France, however, the same causes do not appear to have equally extended, for the whole deposit is of very rare occurrence in that country. It would be curious to trace, if possible, the probable causes which have produced the partial development of the zechstein and muschelkalk. In England, the latter has never yet been detected. In the southern parts of France (Toulon, &c.) it has acquired considerable thickness.

It does not appear that the minor divisions of the zechstein deposit are observable even in the countries where the miners have established them.

M. D'Aubuisson observes, (Traité de Géognosie, tom. ii. p. 349.) "Nous avons distingué, dans l'assise supérieure de la formation, deux couches principales; le calcaire enfumé, et le calcaire fetide; on pourrait les regarder comme n'en formant qu'une, car leurs limites ne sont pas prononcées, leurs substances se mélangent souvent, et se mêlent quelquefois même avec le zechstein*."

It will be observed in the figures before us, that the rocks have been traversed by faults. In fig. 4. the fault seems to come to the surface: in fig. 5. this is not so apparent. In fact, judging from the numerous other figures given by M. Heron de Villefosse in his Richesse Minérale, it would appear that this geologist considers the asche to have been deposited after the fracture of the strata beneath; and if his figures be correct representations of nature, the evidence would seem in his favour, for large masses of fetid limestone are seen included in the asche near, and immediately over, the faults. M. Freiesleben, however, considers the portions of fetid limestone as of contemporaneous origin with the asche. It would be important to have this matter cleared up, for at present it might be supposed that, in these countries, the fetid limestones, &c. were fractured before the deposit of the asche; a supposition not in accordance with the assertion that, in the same countries, the asche passes into the rocks beneath.

It will be observed that in Fig. 4, a vein of cobalt occurs in the fault. Notwithstanding all that has been written on metallic veins, the filling of these veins is still a mystery; though, as a matter of course, we have not wanted theories, each of which has explained this subject most satisfactorily.

From the observations which have been made in Cornwall, it has been considered that some veins of that country afford good examples of fissures or faults, of various ages, filled with metallic and other substances. The facts contained in Mr. Carne's Memoir "On the relative Age of the Veins of Cornwall," Trans. of the Geological Society of Cornwall, vol. ii. p. 49-128, are of the greatest value in any inquiry connected with mineral veins. Mr. Carne's sections exhibit the fractures which this country has at different times received.

According to Mr. Carne, the following is the order of the disturbances in Cornwall: 1. The oldest tin lodes; 2. The more recent tin lodes; 3. The oldest

* In fig. 4. the stinkstein is represented immediately above the zechstein: in fig. 5. it is seen above the rauchwacke. Possibly there may be some error of shading in the original of fig. 4.

east and west copper lodes; 4. the contra copper lodes; 5. cross courses; 6. the more recent copper lodes; 7. the cross flukans (clay veins); and 8. the slides (faults with clay in the fissure). The above shows a succession of disturbances, which never would have been observed if the country had not been worked for profitable purposes. The same may, in a great measure, be said of the coal measures and of the sections which are now before us. If the various portions of country, which have been worked for profitable purposes, afford us so many examples of disturbance and dislocation, may we not infer that many large districts, which do not afford good natural sections, and which never have been, and are never likely to be, worked for profitable purposes, have been equally disturbed and fractured?

How the fissures have been filled, as we now see them, by metallic and other substances, is as yet unknown. Curious facts relating to the changes which the veins or lodes of Cornwall undergo, in passing from one rock into another, are brought forward by Mr. Carne in his memoir on the copper mining of Cornwall, Trans. Geol. Soc. of Cornwall, vol. iii. p. 35–85. He observes, "That a change generally takes place in lodes, when they pass from one rock to another, is well known; and although the lodes may be rich on or near the lines of the junction of different rocks, it is rarely the case that a lode which has been productive in one rock, continues rich long after it has entered another." * * * * "It is evident that lodes are as much affected when a change takes place in the same rock, as when they enter a different rock; when, for instance, the rock becomes harder or softer, more slaty or more compact; when there is a change in the direction of the strata, or even when the rock changes in colour (a change which probably also evinces an alteration in its component parts). In such cases the lodes become smaller or larger, harder or softer, different with respect to their constituent parts; and, what is of more importance, richer or poorer. These changes, although in some instances very small, are in others very striking: they perhaps do not in all cases bear the same invariable relation to the alteration of the rocks or strata, but of the fact itself numerous proofs may be produced." Carne, Geol. Trans. Cornwall, p. 78–81.

PLATE XXIX.

Fig. 1. is a proportional section of the coal measures and carboniferous limestone of the Forest of Dean, constructed from the section by Mr. Mushet, made from actual sinkings and observations on the surface, and inserted in the Memoir on the south-western coal district of England, by Professor Buckland and Mr. Conybeare, Geol. Trans. (new series), vol. i. pp. 288–290.

The continuous and horizontal lines in the part of the section marked as coal measures, represent coal seams. A greater thickness, with very few exceptions, has been given to these seams than they possess, as it was necessary to exaggerate in order to make them apparent.

It will be observed that, at the commencement of the deposit, the substances, whence the coal has been formed, were accumulated only at long intervals, being separated by various thick beds of sandstone and shale. Higher up in the section the accumulation of carbonaceous matter has been more frequent, the sandstone and shale beds being of less depth. From the Little Delf coal to the next coal seam above it, there is a thickness of 180 feet. We have then another series of coal strata, separated by comparatively small intervals. From this last accumulation of beds there is a thickness of 462 feet to the next series of coal strata; the highest in the section before us.

It is very generally supposed, in the present day, that the coal has been derived from vegetable substances. The abundance and variety of the coal plants is exceedingly great, and numbers have been figured and described in the works of Count Sternberg*, M. Adolphe Brongniart†, and Mr. Artis‡. Many of these plants are found in positions parallel to the stratification; but there are others which stand at right angles to the strata, as if they had been covered up by an accumulation of substances around them, but had not been uprooted. Mr. Buddle possesses some curious and very interesting information on this subject, derived from long-continued and attentive observation of the coal districts of the North of England. This information, it is to be hoped, he

* Flora der Vorwelt. There is also a French translation of this work by the Count de Bray.

† Prodrome d'une Histoire des Végétaux Fossiles; and Histoire des Végétaux Fossiles.

‡ Antediluvian Phytology.

will shortly communicate to the public. It appears that the coal is very differently developed in different parts of the same district. Mr. R. C. Taylor lately showed me sections of a part of the South Wales coal district, taken from the workings of the various collieries, in which this difference was very apparent. In fact, when we consider the manner in which the substances forming the coal were probably accumulated, it can scarcely be supposed that the areas occupied by coal beds would not vary considerably, and that these beds would not be differently developed in different places.

Fig. 2. is taken from Griffith's geological and mining Account of the Connaught Coal District (1818), and is inserted to show that the series of old red sandstone, carboniferous limestone, and coal measures, have been deposited much in the same general manner in this part of Ireland as in Southern England. In the Report on the Leinster Coal District by the same author, there are abundant examples of coal-measures contorted and broken into faults, which faults come to the surface, and therefore may have been comparatively recent, as well as ancient. It is evident that denudation has taken place, and that the continuity of the strata has been destroyed for considerable distances. For example, it would seem clear that the strata forming the summits of Lacka and Lugnaquilla mountains have once been continuous, and that this continuity has been destroyed by the removal of the intermediate portions, which once filled up the depression now existing between them.

PLATE XXX.

This Plate is a reduction of M. Von Buch's map of the country between the lakes of Orta and Lugano, which was at first privately distributed, but afterwards published, with some alterations, in the Annales des Sciences Naturelles, Novembre 1829. It is here introduced for the purpose of rendering some remarks on the following Plate more intelligible. At the first glance it will be observed, that the dolomite occurs singularly among the limestones, and that granite, red quartziferous porphyry, or pyroxenic porphyry, are not far distant from the dolomite. M. Von Buch considers that the pyroxenic porphyry, or *melaphire*, raised a great portion of the Alps, and that the gas disengaged at the same time entered into the fissures of the limestone, and converted a considerable portion of that limestone into dolomite. It is not my intention to enter upon the merits or demerits of this theory, but merely to point out the apparent change that the limestone has from some cause undergone. The dolomite occurs in such a manner among the limestones, that there seems great difficulty in considering it formed simply by the accidental mixture of carbonate of lime and carbonate of magnesia, the latter having been, by accident, particularly abundant in some places, while it was wanting in others. Continuous and adjacent portions of the same strata are sometimes dolomitic, and sometimes merely calcareous; and there would appear to be less difficulty in considering the dolomite an altered rock, than in supposing it originally deposited as we now see it.

PLATES XXXI. & XXXII.

These Plates are intended to illustrate some of the geological phænomena of the lakes of Como and Lecco. It will be at once perceived that the lakes in question occur partly among gneiss and mica slate, and partly among limestones and dolomite. The gneiss and mica slate of the northern part of the Lago di Como may be said to correspond on the eastern and western shores; so that, generally speaking, if the strata on the one side were continued across the lake to the strata on the other side, they would be found to be continuous portions of the same system of beds. The general dip of these strata is southwards. Contortions of the gneiss and mica slate are not common, they are in fact rare, on the shore; some do, however, occur at Musso, where white and gray saccharoidal limestone is interstratified with these rocks. Another included portion of saccharoidal limestone, which has furnished the materials for a considerable part of the celebrated Duomo at Milan, occurs in the same system, on the eastern side of the lake near Piona. It is remarkable for the large size of its crystalline grains. Another included mass is stated to occur near Dervio, but this I did not myself visit.

At the head of the Lago di Mesola the gneiss is quarried for flag-stones and other useful purposes, and sent to Milan. It might here be well termed stratified granite, the strata being generally thick. Dip highly inclined to the south. Not far from Riva, but on the opposite side of the lake, and near a little chapel named S. Fedelato, there is an appearance of granite veins, injected among the strata of gneiss. The granite is composed of white and black mica, white felspar, and colourless quartz. The main vein has the character of a bed interstratified with the gneiss, but from it proceed innumerable small veins, which cut in all directions. The gneiss becomes compact near the contact with the granite. Pieces of apparently altered gneiss are included in the granitic veins, are angular, and might be considered broken off from the mass of gneiss. The proof that the granitic veins are not here contemporaneous with the gneiss is certainly not so clear as in many other places; but they did appear to me as of posterior formation to the gneiss.

The gneiss and mica slate of the northern part of the Lago di Como is separated from the dolomite and limestone, on the south, by a red conglomerate mixed with a few other beds.

Fig. 2. Plate XXXII. affords a section of these beds near Bellano. The following are the strata which occur in the descending order:

1. Near Varenna the noted black marbles dip at a high angle to the S.S.W. Hence, for some distance to the N., thick, thin, and schistose beds of the same limestone are observed much contorted.

2. Thin beds of the same limestones, of a dark-gray colour.

3. Gray dolomite traversed by white veins. The section, made by blasting for the new road, afforded, in the spring of 1829, an appearance of this dolomite resting unconformably upon the edges of the limestones, No. 2. When the blasting shall have displayed more of the section, this appearance will be better explained. As it was, I gained little information from the actual shore, which was covered up, principally by tufaceous matter.

4. Very compact gray and reddish siliceous sandstone, passing into a fine-grained conglomerate, containing pieces of quartz and siliceous rocks.

5. Dark micaceous schist.

6. Brown siliceous sandstone.

7. Red conglomerate, containing rounded pieces of quartz and red porphyry. The cement has sometimes a porphyritic appearance.

8. Gray and siliceous sandstone with mica.

9. Reddish, gray, and brown schistose sandstones.
10. White gneiss with silvery mica: beds thick.
11. Mica slate, black mica.
12. Gneiss.
13. Mica slate: on the north of Bellano.

The conglomerate beds traverse the lake to the north of a little place named La Gaeta, and occur again on the north of the Monte San Salvadore, separating the mica slate from the limestone and dolomite on the Lake of Lugano, as has already been noticed by M. Von Buch (see Plate XXX.)*

It would be curious to inquire how far these conglomerates may be equivalent to those of the Vallorsine, and to those which separate the compact gray limestones of the Gulf of La Spezia from the inferior rocks of granular limestone and micaceous slate. I found conglomerates at the latter place, which, in composition, closely resembled those of the Vallorsine.

It will be observed by a glance at the map (Plate XXXI.), that on the south of this red conglomerate the Lakes of Como and Lecco enter into the great band of limestone and dolomite of the southern side of the Alps. A section of these limestones and dolomites, as observed on the Lago di Como, is given Plate XXXII. fig. 1.; but it will be observed by reference to the map (Plate XXXI.), that this section would afford a very incorrect idea of the mass of limestones and dolomite; for what appears as limestone in the Lake of Como, seems, judging from the direction of the strata, converted into dolomite in the Lake of Lecco. The main direction of the strata is sufficiently apparent in the mica slate, gneiss, and conglomerate on the north of the limestone and dolomite. By comparing the latter rocks, even at their junction with the former, on either side of the lake, the differences in mineralogical structure will be sufficiently apparent. On the south of La Gaeta there is a considerable thickness of dolomite extending along the coast to Menaggio, and including a mass of gypsum at Nobiallo; while on the opposite side there is little dolomite, much limestone, and no gypsum. It is useless to enlarge on the want of correspondence in the mineralogical character of the strata in places where they would, from the general direction of the beds, be supposed

* See also M. Von Buch's note on the dolomite, limestone, and porphyries of the Lago di Lugano, Ann. des Sci. Nat., Fev. 1827.

to present the same structure. This will be best seen by reference to the map, Plate XXXI.

Respecting the limestones on the southern part of the Lago di Como, it will be sufficient to observe that they are siliceous, and contain seams of chert near Como, then become, in the descending order, slaty*, with apparently little siliceous matter, and finally compact.

The limestones contain ammonites at Moltrasio, which greatly resemble the *Ammonites Bucklandi*, and are frequently of large size. Other ammonites have been discovered on the opposite coast which resemble *A. heterophyllus*. From these fossils it has been inferred that the limestones belong to the oolitic epoch; an inference probably correct respecting a portion of them, but more zoological evidence is necessary before we can decide on the character of the whole mass. The upper beds may represent the cretaceous group. All these limestones so pass into each other, that although part of them may be found eventually to represent one thing, and part another, it would appear a theoretical line that should separate them.

The limestones are greatly contorted on the southern part of the Lake of Como: an example is given Plate XXXII. fig. 5. Anthracite has been noticed in many places. I principally observed it near Varenna and Moltrasio.

The dolomite varies considerably in appearance. It is brown, gray, or white: when white, generally most crystalline. The rock frequently appears a sandy magnesian limestone. There are strata which are principally composed of carbonate of lime and a little magnesia; these generally occur where the limestones are intermixed with the dolomites, and may be considered as the passage of one rock into the other. Gypsum is included in the dolomite at Nobiallo and Limonta. The frequent occurrence of this substance among dolomitic strata is remarkable. In the Tyrol, and near Nice, crystals of carbonate of magnesia occur in the gypsum.

The next rocks to be noticed are the conglomerates, sands, and marls, commonly called tertiary, which rest upon the limestones. Near Como the conglomerate is very hard, and composed of pieces of granite, gneiss, mica slate, and other rocks of the Alps. Near Camerlata gray compact sandstone dips to the S.W. at a considerable angle; it appears interstratified with the conglome-

* These slaty limestones are worked for paving-stones and slates at Moltrasio and other places.

rates. Continuing the section southwards, we find a hill near Grandate composed of gray marly sand interstratified with gray sandstone beds and some conglomerate. Rising the hill near Capelletta, we perceive it composed for the most part of brown sandy marl, which seems to constitute the lower part of these beds on the east of Como. From the general dip of these beds they appear to rest unconformably on the edges of limestone strata on the east of Como. (Plate XXXII. fig. 1.)

That these conglomerate beds do rest unconformably on the siliceous limestone with chert, is well seen on the west of Como, particularly on the road to the Lago di Lugano, where the former cover the perpendicular or highly inclined strata of the latter. (Plate XXXII. fig. 3.)

Whether the conglomerate and other strata of the Dosso d'Albido (Plate XXXII. fig. 4.) belong to this system, or that to be next noticed, or were deposited at the bottom of the lake between the two epochs, it would be exceedingly difficult to say, as we are here without the aid of organic remains. A grayish-blue clay, somewhat fissile, and used for making bricks and tiles, rests upon highly inclined beds of brownish dolomite. The workmen informed me that they had never discovered any shells or other organic substance in the clay, which is here and there mixed with some small gravel. Above this, we find beds of various rolled Alpine pebbles, cemented by brownish sandstone, which sometimes predominates. To this succeed sandy and clayey beds, often mixed with pebbles.

These beds seem the prolongation of those which, at the foot of the mountains, extend from the vicinity of Lenno, by Cadenabia to Majolica, and which are also observed near Bellaggio.

The map (Plate XXXI.), and the sections (Plate VII. fig. 3. and Plate XXXII. fig. 1.), show the manner in which these blocks cover the country. They are found by thousands on the ascent from the Point near Bellaggio to the Monte San Primo. They are seen mixed with small pebbles above Regurola, on the Piano Persino, and in the Commune della Villa. These blocks vary much in size, and are frequently very large. One particularly remarkable for its dimensions occurs at the Alpi di Pravolta (Plate XXXIX.).

In reviewing the facts above noticed, the following inferences would seem probable.

1. The formation of gneiss, mica slate, saccharoidal limestone, and other rocks, which would appear to be nearly of the same epoch. Whether they have been altered, or not, by any causes acting upon them since their original formation, does not change their position in the series.

2. A conglomerate deposit, formed of pieces of the rocks No. 1, and of a red quartziferous porphyry, not observed on the shores of this lake, but which occurs at no great distance, in the country between the Lago d'Orta and the Lago di Lugano. This conglomerate shows that some causes, either of slow or quick operation,—it matters not which,—detached portions of pre-existing rocks, rolled them into pebbles, and deposited them upon the rocks No. 1.

3. A deposit of various beds of limestone.

4. The rocks previously mentioned have been elevated, and many strata have been greatly contorted.

5. A considerable destruction of previously existing rocks, which has furnished the materials for sandstones and conglomerates of great thickness; whether they have been formed slowly, or quickly, is of no importance to the fact, that they are derived from the destruction of previously existing strata. It would be interesting to ascertain if dolomite pebbles exist in this conglomerate. Should such pebbles be discovered in it, it would show that the limestones were mixed with dolomite previous to the epoch which produced the conglomerate. If they should not be found, it would seem probable that a change of the limestones into dolomite has been effected since the formation of the conglomerate.

6. The strata have been again disturbed, and the rocks No. 5. raised at greater or less angles with the rest.

7. A lake may have existed, and deposits, such as those of the Dosso d'Albido, may have been formed at its bottom.

8. Huge blocks of granite, gneiss, &c. have been violently torn from the central parts of the Alps, and have, with smaller portions of the same rocks, been scattered over the mountains and valleys. That valleys and other inequalities of land previously existed, the mode in which the blocks occur, and their general line of direction, sufficiently testify. These blocks cover all pre-existing strata. So violent a rush would easily break up such deposits as those of

No. 7, and the two might become so mixed, that to observe their separation would be almost impossible.

9. The present order of things.—The changes which have taken place since the establishment of this order are well shown on the shores of the Lake of Como. By reference to the map (Plate XXXI.), it will be observed that the Adda enters the lake towards its northern end. It has, in fact, by bringing silt and other alpine detritus, cut off a portion of the lake, now known as the Lago di Mesola. This little lake is nearly filled up by the detritus borne down by the Adda and the Mera, and is very shallow*. Even the part which is now deep (between the Sasso Dozo and San Fedelato) is filling up by stones detached from the mountains, which fall so abundantly in certain seasons of the year, that it is then dangerous to pass near the coast in a boat.

All the smaller rivers tend to fill up the lakes of Como and Lecco, as will be seen by the map. These streams being more or less of the torrent kind, the detritus they bring down is not inconsiderable. Near Mandello and Abbadia (Lake of Lecco) the dolomitic detritus brought down from the valleys of the Neria and the Gerora has been cemented by calcareous matter, and has become very hard, now forming low cliffs, attacked by the little waves of the lake.

The period when the pyroxenic porphyry was intruded among the other strata has not yet been determined with accuracy. If it should be ascertained that blocks of pyroxenic porphyry are never discovered among the others scattered over the country,—and it has been stated they have never yet been seen,—it would seem to show that this porphyry did not exist on the surface before the dispersion of the blocks, although it does not show that the intrusion of the porphyry may not have been contemporaneous with the dispersion of the blocks.

The intrusion of the granite and red quartziferous porphyry is still more uncertain. If, however, they are always cut by the pyroxenic porphyry, they are of anterior formation to it.

Considering, for the moment, that the dolomite is an altered limestone, it would seem probable that the epoch of this alteration might be ascertained by

* Over a considerable portion of the lake, aquatic plants, commonly large rushes, rise through the water.

examining the conglomerates No. 5, and the transported blocks No. 8. Should pieces of dolomite be discovered in the conglomerates, the dolomite must have been formed previous to the conglomerates. Should any of the erratic blocks be composed of dolomite, this rock must have existed previous to the dispersion of these blocks. I have certainly observed dolomite blocks with the others, but always in suspicious situations, and where they might have fallen from the heights.

PLATE XXXIII.

This view is intended to illustrate the effects of existing causes. The fall of large portions of rocks from different heights, commonly termed the Fall of mountains, has often been recorded, but they generally differ from the fall represented in the view before us.

The Rouffi or Rossberg (5196 feet above the sea) rises opposite the Righi (6182 feet above the sea). The Rouffi is composed of beds of conglomerate, formed from the detritus of the Alps, commonly termed Nagelfluhe, a name applied much too generally to the Swiss conglomerates. It appears that a clay is interstratified with these beds, and that the strata dip at a considerable angle, about 45°. The clay becoming soft from the percolation of rain-water through the strata above it, and the thick superincumbent conglomerate beds losing their support, the latter were launched over the slippery and inclined surface beneath, and the valley below was covered with their ruin.

The slide of the strata here represented took place on the 2nd of September 1806, and covered a beautiful valley with rocks and mud. The villages of Goldau and Busingen, the hamlet of Huelloch, a large part of the village of Lowertz, the farms of Unter- and Ober-Röthen, and many scattered houses in the valley, were overwhelmed by the ruin. Goldau was crushed by masses of rocks, and Lowertz invaded by a current of mud.

The torrent of rubbish and mud which rushed into the Lake of Lowertz produced such a motion of the waters, that the village of Seven, situated at the other extremity, was inundated, and in great danger of being destroyed, two houses having been washed away. Live fish were found in the village of Steinen, thrown there by the flood. The lives lost were calculated from 800 to 900. Several travellers perished. It appears that there are traditionary accounts of former, though smaller, slides from the Rouffi or Rossberg.

The view from whence this Plate is taken was made on the 6th of September 1806, four days after the catastrophe.

PLATE XXXIV.

This Plate is taken from a view, made at the time by Captain Tillard, of the eruption which formed the Island of Sabrina near St. Michaels.

This eruption broke out in the sea on June 13, 1811, about a mile from St. Michaels. On the 17th, Captain Tillard, of His Majesty's ship Sabrina, in company with Mr. Read the Consul, and two other gentlemen, proceeded to the cliff nearest to it, and which was between 300 and 400 feet above the level of the sea. The appearance of the volcano, when not ejecting ashes, was that of an immense body of smoke revolving almost horizontally upon the water. Suddenly it would shoot up columns of the blackest cinders, ashes and stones, to a height of between 700 and 800 feet above the sea. The columns of ashes, &c., when at their greatest elevation, broke into branches resembling magnificent pines. These bursts were accompanied by the most vivid lightning, and by a noise like the continued firing of musketry and cannon intermixed. As the smoke rolled off to leeward, it drew up a number of water-spouts, which formed a beautiful and striking addition to the scene. Whilst Captain Tillard and his party were viewing the eruption, a crater began visibly to rise above water, though the volcano was then only four days old. By July 4th, a complete island was formed. Captain Tillard and some officers landed upon it. Its form was almost circular, and nearly a mile in circumference: its altitude about 300 feet. On the side facing St. Michaels was an opening from the crater to the sea, out of which boiling water ran in a stream; even at the outer edge nearest the sea it was too hot to keep the hand in it for an instant. About the length of two boats from the beach, which was composed of black ashes, &c., they found seven fathoms water, and at half a cable's length, twenty-five fathoms. This island afterwards sank beneath the level of the sea.

PLATE XXXV.

This Plate is also intended to illustrate the effects of existing causes.

Fig. 1. represents the elevation, and Fig. 2. is a plan of the Island of Sabrina, described in the preceding Plate.

Fig. 3. is a section of Pinhay Cliffs, Lyme Regis, Dorsetshire. It shows the manner in which the undercliff is formed, and the destructive effects of land springs.

Chalk and green sand rest upon lias. The two former rocks being more or less porous, the rain-water percolates through them, and is not stopped until it reaches a clay, formed by the lowest part of the green sand strata and the lias, when it is thrown out, in the shape of springs, in the neighbouring country. In the case of the sea coast before us, these land-springs undermine the superincumbent strata, which gradually slip forwards over the clay into the sea, where the softer parts are washed away, and the harder portions are ground down into the shingles of the beach.

It will be observed that the action of the sea, though directed against a rock of which the alternate strata are composed of marls, has destroyed less of the cliff than is carried away by the land-springs, that detach considerable masses at a time. In fact, the falling masses of the chalk and green sand in a great measure protect the lias cliffs from the ravages of the sea; even as on the adjoining cliffs of Whitelands and Dowlands, where the lias cliffs are lower than at the place where the section is made, entirely masking the lias, and presenting a confused assemblage of chalk and green sand.

Fig. 4. is a section of the shingle-beach between Seaton and the Axe River, Devon, and exhibits the manner in which low marsh land is protected from the destructive action of the sea by a shingle-bank thrown up by the sea itself. The prevalent winds being W. or S.W., the shingles travel along the coast from W. to E., and are derived from the cliffs to the westward, destroyed by the united action of the sea and the land-springs. For a further account of the formation of the shingle-beaches of this coast, see Geological Notes, and my paper on the Formation of extensive Deposits of Gravel and Conglomerate, Phil. Mag. and Annals of Philosophy, March 1830.

Fig. 5. is a section of part of the Chesil Bank, upon a smaller scale than that of the preceding figure. In this case, the bank, thrown up by the sea against itself, is separated from the land by a narrow stripe of water, called the Fleet, into which the tide enters from Portland Roads. This bank would seem to have existed soon after the period when the main land became dry land; for had it been otherwise, the main land would have been cut far back into cliffs of greater or less elevation, according to circumstances, by the destructive action of the heavy waves discharged with so much fury on this coast. The land is, however, not so cut back, though the rocks of which the country is composed would offer little resistance to the breakers. The cliffs are of trifling elevation, and the waves of the Fleet, aided by the land-springs, seem adequate to their production.

Fig. 6. illustrates the filling up of lagoons and saline lakes in tropical countries by means of mangrove trees. The lake, of which this figure is intended to afford a section, is situated near Albion Estate, Jamaica. It is protected from the sea by a pebble bank, through which there is a small opening, above the ordinary level of the sea, for the discharge of the surplus water of the lake, formed by the drainage of the rain-water from the land, and by the splash of the sea over the bank during heavy gales. The protecting bank has evidently been thrown up by the sea. This lake is not a solitary instance, for there are other and larger lakes of the same kind to the eastward of it.

The lake represented in the figure is tenanted by numerous alligators (*Crocodilus acutus* Cuvier), and by marine fish; which latter have probably been caught in by the bank, and have been gradually accustomed to the brackish water of the lake. It would be interesting to geologists to have the zoology of this and similar lakes well examined, in order to see what marine and fresh-water animals may be found to exist and multiply in the same waters. The bottom of the ponds is formed of a soft mud, into which the alligators force themselves when chased. This mud is probably formed by the washings from the land, and the decay of animal and vegetable matter. In it the mangrove trees strike their roots, or deposit their curious seeds.

The stilt-like roots of the mangrove prevent the accumulated soil from being removed, and thus land is gained. Such increase of land is very common in sheltered situations, as at the bottoms of creeks and bays and the mouths of rivers.

It may here be remarked, that the bank called the Palisades, at the end of which stands Port Royal (Jamaica), seems the effect of existing causes, and in some measure resembles the Chesil Bank, if we imagine the Fleet to be broader, and to be discharged into the sea by a break in the bank close to Portland. The prevalent and almost constant winds, producing breakers, on the south coast of Jamaica, are from the E. & S.E., and the drift of the beach is from E. to W., the direction of the Port Royal Bank. No part of this bank rises high above the sea. At Port Royal itself, even the graves are filled, in the lower parts, by sea water, which filters through the sand. The space between Port Royal and the main land of Jamaica opposite to it, seems to be kept open by the tide flowing up and down to and from Kingston. The polypifers are very active, and may perhaps stop this passage, if not prevented. If they did so stop it, the Kingston waters would become a long lake, which would be filled up through the agency of the mangrove trees, and the advance of alluvial land, protected from destruction by the Palisades or Port Royal Bank.

As a river (the Rio Cobre) flows into these waters, it becomes interesting to geologists to speculate upon the deposit of vegetable and animal matter that might take place, and the singular mixture of fresh water and marine animals that might exist in this lake, which would gradually become brackish, and then fresh; but which, from the nature of its protection from the sea, would be always liable to be overwhelmed by that sea, should the bank be burst through during a hurricane, or lowered by an earthquake.

PLATE XXXVI.

The view and sections in this Plate illustrate the effects of some existing causes in the island of Jamaica. The view has already appeared accompanying my remarks on the Geology of Jamaica. Geol. Trans. (new series), vol. ii.

The natural bridge near Mount Olive, connecting two sides of a ravine, through which a river flows, seems to show that this river has cut out the ravine. That the ravine is no rent or fracture, the natural bridge appears sufficiently to prove; for the portions of strata which form it could not have remained unbroken, while the other parts of the same strata were rent so close to them on either side. A road now passes over the bridge, the only communication between the two sides of the ravine for some little distance. The mode of viewing this natural bridge to advantage, is by descending the ravine on the side of the arch opposite to that here represented, by wading through the river, and by passing beneath the arch to the spot on which the figures are placed in the Plate, the sides of the ravine being too precipitous to permit a descent on this side. This natural bridge may in time be removed, as large masses of rocks are detached from the arch above, and as the river is continually cutting away the white limestone of the lower part. This operation is no doubt slow, but is nevertheless certain in its effects.

The section of the islet near Old Harbour, shows the increase of land by means of mangrove trees to the leeward of a shingle beach. The islet, strictly speaking, is not at Old Harbour, but is one of those comprised within the great bay formed by Cabaretta and Portland Points, and is nearer to Salt River than Old Harbour. Some bank, probably a coral bank, must have been originally formed, upon which the coral shingles were thrown up; no uncommon circumstance on the Keys of Port Royal, or on those of the bay in which this islet occurs. Protection being once afforded, the mangrove trees established themselves, and accumulated silt, mud, and drift rubbish about their roots; land became gradually formed to leeward, and kept advancing in that direction, while increased protection was given to the whole mass by additional shingles piled on the bank to windward, and by the binding power of the tropical seaside creepers. In time the land would become too dry for the support of the mangrove trees; other sea-side trees would appear, and eventually even cocoanut trees might establish themselves.

The phænomena exhibited in the falls of the Roaring River, situated on the north side of Jamaica, are very singular, and such as I have never seen exhibited elsewhere, although the causes necessary to produce the effects required would seem to be merely running water highly charged with carbonate of lime, and the vigour and power of tropical vegetation. In fact, the Roaring River is simply a great body of water charged with carbonate of lime, which, after being precipitated over the face of a cliff, rushes amid a forest, the roots of the trees in which it seldom dislodges, but on the contrary binds down firmly by a stalagmitical deposit. The water, in fact, rushes into the forest, which it does not uproot, and there divides into several streams, which cascading in all directions, produce a roaring sound,—whence the river has been named. In this instance, numerous roots and branches of trees must necessarily be included in the stalagmitic deposit; but the causes being local, the effects are local, and the rock so formed must be of inconsiderable extent.

PLATE XXXVII.

The sections contained in this Plate have already appeared in the Geological Transactions (new series), vol. ii., with one exception (Fig. 5), and are intended to exhibit some of the geological phænomena of Jamaica. To my Memoir, above cited, I must refer for a detail of the various rocks: it will here be sufficient to call attention to the larger divisions which may be made among them. The most modern deposits are those now going on at the bottoms of sheltered bays,—the mangrove trees, abundant in such situations, greatly promoting the increase of such deposits. This deposit reposes upon that next mentioned, in such a manner that it becomes exceedingly difficult to separate the one from the other. Good examples of these deposits are observable on the coasts where the plains of Vere, St. Dorothy, and Liguanea come to the sea.

The next deposit, in the descending order, is a series of gravel, sand, and clay beds, in which the former greatly predominates. No causes at present in operation in the island of Jamaica seem adequate to the production of this gravel, which is distributed in great plains at the base of the mountains. Fig. 1. between Kingston and Somerset; Fig. 2. between the Mangrove district and Stony Hill; Fig. 3. surrounding the projecting portion of white limestone at St. Dorothy's Rectory; Fig. 4. between the Long Mountain and the St. Andrew's Mountains; and Fig. 5. resting upon Savanna conglomerate. This conglomerate occupies a position inferior to the gravels above mentioned, and is composed like it of rounded pebbles, which were probably derived from the Jamaica rocks. I will not pretend to draw fine lines of distinction between the Savanna conglomerate and the superincumbent gravels, sands, and clay, which are of considerable thickness. The conglomerate may probably be referred to that class of deposits, commonly called tertiary. The whole as a mass appears to have been derived from the partial destruction of other strata, and has not suffered any violent disturbance since deposition. Now all the other stratified rocks in the island do exhibit marks of disturbance; and I cannot avoid connecting the disturbance of the strata and the formation of the conglomerate and gravel with each other, and supposing that the rounded pebbles were formed by the violent agitation of waters at the time the strata were upheaved. The causes now existing in Jamaica tend to destroy and carry away the conglomerate and gravel, and do not add to them.

The next deposit is the white limestone. Its upper beds are chalky, sandy and marly, and even compact. The central part principally formed of compact strata, sometimes interstratified, with thick beds of red marl and sandstone, as also with white chalky marl. In the lower part, are beds of yellowish white limestone, containing an abundance of organic remains; cerithia, echinites, spines of echinites, &c. Beneath these limestones there are beds of sand and marl, the latter containing fibrous gypsum, and often associated with blueish gray compact limestones.

What this series of beds may represent, it would be premature, in the present state of our knowledge, to conclude. I would by no means attribute much importance to the fossils (enumerated Geol. Trans. new series, vol. ii. p. 170). Our present knowledge of the distribution of organic remains is too limited to permit us to draw general conclusions respecting them. The relative importance of this white limestone series will be seen by reference to the various figures. Future observations may probably enable geologists to make divisions in this mass, which is of great collective thickness, and to separate the upper from the lower; in fact there are some rocks skirting Jamaica which may perhaps be advantageously separated from it. I allude to those small cliffs of white limestone which occur at different places between the mouth of the Plantain Garden River and St. Ann's Bay. It would be curious to ascertain how far the organic remains contained in them differ from the inhabitants of the present seas. They appear much like coral reefs raised above the level of the sea, and brought within the destructive action of the breakers. A patch of these rocks occurs at Forster's Cove (Fig. 2.).

The next deposit is a series of conglomerates, principally formed of trappean rocks, among which trap rocks themselves are singularly mixed: see Figs. 1. 2. and 4. In Fig. 2. the mass of trap rocks appears interposed between these conglomerates and the red sandstone; in Fig. 1. between them and the white limestone; and in Fig. 3. it appears to have pierced through the white limestone, upheaving the strata on either side. There would therefore appear to be no constancy in the relative situation of the trap; and though apparently interstratified, it may have pierced the beds, dividing them in the planes of their stratification. Yet the trap pebbles, forming the conglomerate, show that trap rocks existed somewhere near, of sufficient consolidation to be broken and ground down into pebbles.

The next series in the descending order, consists of a considerable thickness of red sandstone and conglomerate, in which carbonaceous strata, with seams of coal sometimes occur (Fig. 4.). These strata will be found described in the Geol. Trans. (new series), vol. ii. p. 157, &c. At the time I wrote the memoir mentioned, I referred these rocks, though with hesitation, to the epoch of the medial or carboniferous rocks, principally in consequence of their mineralogical character. I do not, however, now see any good reason for so doing; the mineralogical character of rocks is of so little importance that, of itself, it would be valueless, even in determining a series of rocks in Britain and Italy. It therefore can be of no service in determining the relative antiquity or identity of rocks in Jamaica and Europe. For the same reason I am far from considering that the rocks named grauwacke, in the memoir alluded to, have been proved to be identical with the sandstones &c. which have been termed grauwacke in Europe. Further and more detailed information must be afforded of the rocks in the neighbouring continent of America, before we can hope to arrive at any satisfactory conclusions respecting those in Jamaica. I am the more anxious to leave the question of the equivalents of the Jamaica rocks entirely open, as statements that certain rocks, found in distant countries, are identical with certain rocks found in Europe, are highly mischievous when this identity has not been perfectly proved. Such statements may suit the temporary purpose of the theorist, anxious to form the whole surface of the globe after the model of his own or neighbouring lands, but can only retard the progress of real geology.

PLATE XXXVIII.

Fig. 1. exhibits the fault, noticed p. 29, and is taken from the Transactions of the Geological Society of Cornwall, vol. iii. p. 331.

Fig. 2. illustrates some remarks on the veins of Cornwall, Pl. XXVIII. This section of Trevaunance mine accompanies Mr. Carne's Memoir (Geol. Trans. Cornwall, vol. ii.). It will be observed that the old tin veins are cut and heaved by the more modern tin veins, and that these veins are cut and heaved by the east and west copper veins.

Fig. 3. is a view of the large block of granite noticed, Pl. XXXI. as occurring at the Alpi di Pravolta, on the ascent of the Monte San Primo. The granite is composed of white felspar, colourless quartz, and black mica, with large crystals of felspar. It rests upon slaty shale and compact gray limestone, which dip N.W. about 40°. It has lost little of its angular character by decomposition, and had evidently not suffered much from attrition before it was thrown, with many thousand others, upon the northern face of the Monte San Primo. This rush from the north has apparently filled up a considerable portion of a pre-existing valley at the Villa di Commune. The northern face of the mountain would appear to have first received the shock; after which many blocks would seem to have been carried by eddies into situations behind the shoulders of the mountain, where we now see them.

Fig. 4. exhibits the stratification of the Mont Blanc on its north-western side, facing Chamonix. It is taken from M. Necker's Memoir on the Vallorsine, (Mém. de la Soc. de Phys. et d'Hist. Nat. de Genève, 1828,) and perfectly corresponds with sections which I have myself made. It is here introduced to show the danger of forming conclusions respecting the stratification of a high mountain from an examination of its base alone; for it will be observed that, though the beds dip apparently beneath the mountain at its base, they are perpendicular not far inwards.

Fig. 5. is a section of the southern side of the Diablerets by M. Elie de Beaumont, inserted in M. Brongniart's Mémoire sur les Terrains Calcaréo-Trappéens du Vicentin, 1823. It is here inserted, to show how little knowledge may be acquired by examining a mountain on one side.

It is clear that a person investigating the structure of this mountain, and directing his attention only to its eastern side, would have no knowledge of the rocks on the western side, and that a whole series of interesting beds would be quite unknown to him. Again, a geologist making a section up its western side, and not observing the curvature of the strata, would be led to suppose that certain beds alternated, while in fact they were only twisted. Errors of this kind are by no means unfrequent, particularly among high mountains like the Alps, which are often difficult of access, and can sometimes only be visited under very favourable circumstances.

This figure also possesses another interest at the present time. It was the first Alpine section in which organic remains, considered tertiary, were observed in rocks which bore no mineralogical resemblance to those then known as tertiary, but which would once have been termed transition. M. Brongniart considered the beds No. 4. 5. and 6. as tertiary, bent in such a manner as to appear inferior to older rocks. No. 6. contains Nummulites, Ampullariæ, Melania costellata *Lam.*, Cerithium Diaboli *Al. Br.*, Turbinellæ, Hemicardia, Cardium ciliare *Brocc.*, Caryophylliæ, and Madreporæ. No. 7. is an aggregate of quartz grains united by a calcareous cement, and is black and micaceous. No. 8. a compact limestone containing chert, and some indeterminable organic remains. The rocks No. 2. and 3. would seem to contain belemnites, and may be of the same epoch as No. 8. and 9. which form the top of the mountain. The highest parts of the Diablerets are about 10,500 feet above the sea.

Here perhaps we have beds of the same epoch as those, the tertiary and secondary character of which has been disputed, and which may afford an example of the passage of one of these supposed great natural divisions into the other.

PLATE XXXIX.

This Plate contains a view and section of the celebrated Falls of Niagara. The view is taken from a sketch by Captain Basil Hall, which he very kindly permitted me to select from his portfolio. The section is constructed from the information of the same gentleman. Other views of the Falls by Captain Basil Hall, taken with the camera lucida, have been published in his Sketches.

The view here given has been selected as affording a good idea of the flat country which the river flows through before it arrives at the Falls, and of the commencement of the deep cut that it has made, and is continuing to make, in the horizontal strata of which the country is composed. The Niagara is now, in fact, cutting a gorge, which may in time reach back to, and drain, Lake Erie.

The section shows the manner in which this ravine is formed. Mr. Robert Bakewell, jun. has inserted an account with a very illustrative bird's-eye view of this country, in Loudon's Magazine of Natural History for March 1830. He there states, that the upper bed is formed of diluvium, containing large blocks, and varying in depth from 10 to 140 feet. Beneath this is a "bed of hard limestone containing a few imperfect organic remains: this stratum is about 90 feet in thickness; it extends nearly over the whole country in a horizontal direction, and forms the bed of the river above the Falls. This limestone rests on a bed of loose shale rock, nearly of the same thickness: it is exceedingly fragile, and crumbles into small pieces in being removed from its native bed; the shale also contains some pieces of hard argillaceous limestone."

Captain Hall informs me, that the cutting back of the Falls is not caused immediately by the whirlpool, which it might be supposed undermined the harder rock, but by the violent gusts of wind charged with water, which act against the shale, remove it from beneath the limestone, and throw it down in a kind of talus, on the top of which those persons walk who pass beneath the Falls. From the removal of this shale, the limestone above loses its support, and falls; and thus the cataract cuts its way back, adding slowly, yet surely, to the length of the ravine which it has already formed.

PLATE XL.

The object of the principal figure in this Plate is to show the proportion which the elevation of the highest mountains bears to the radius of the earth. That the most elevated peaks of the Himalah are insignificant protuberances will be at once observed; and it may be asserted, that from figures of this nature a more definite idea of the relative importance of things is obtained than from pages of description. To one who looks at such a diagram, it will be obvious that slight and unequal contractions of the mass of the earth would produce changes of the surface, which we should consider important; and it may occur to him that mere thermometrical differences beneath the earth's crust might be sufficient to raise whole continents above the level of the sea, or plunge them beneath it.

A line has been drawn representing a depth of one hundred miles below the level of the ocean, in order to show that great disruptions of our planet's surface might take place, and might be produced by causes acting at that depth without the mass of the world being much affected by it. How insignificant do our *tremendous* dislocations, *stupendous* mountains, and the like, become, when we contemplate such a figure as that before us!

The other figures are intended to illustrate the proportion which the mass of the earth bears to that of the sun.

THE END.

LONDON:
PRINTED BY RICHARD TAYLOR,
RED LION COURT, FLEET STREET.

ALERE FLAMMAM

Fig. 1. Section. YORKSHIRE.

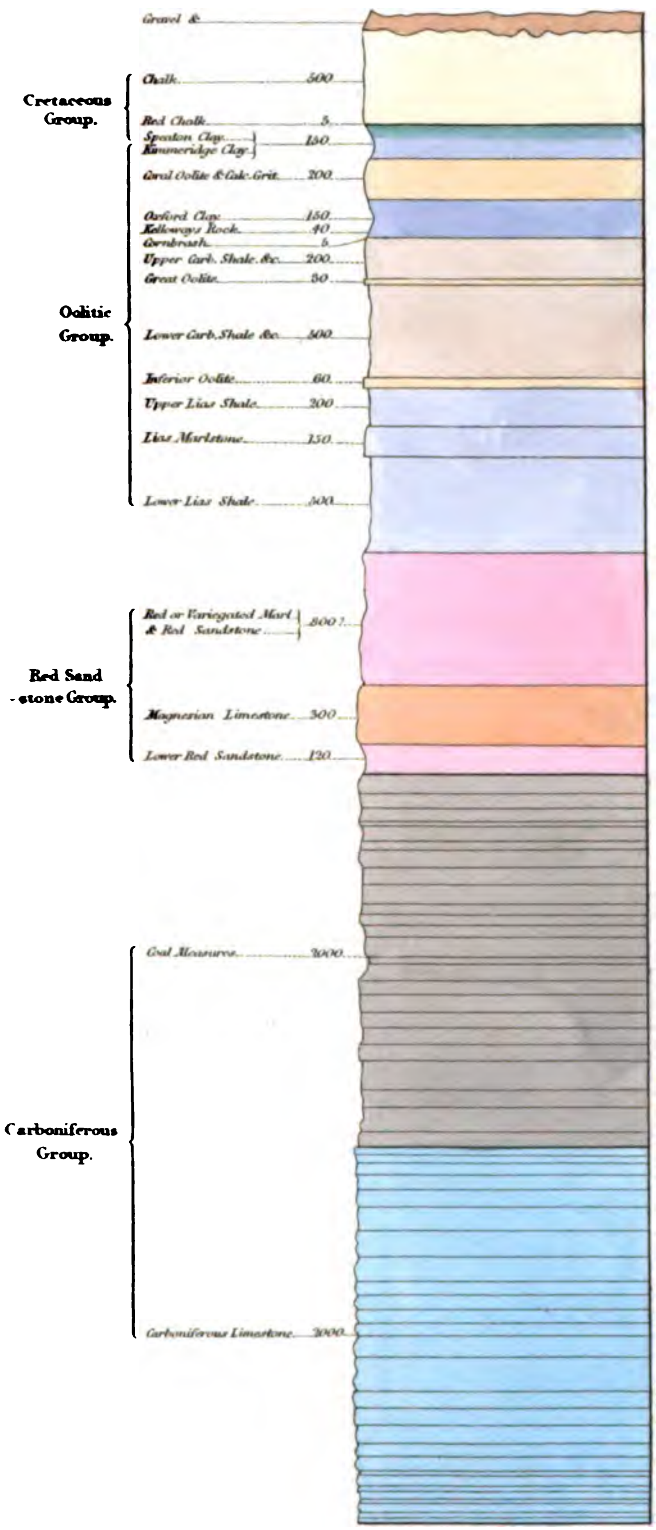
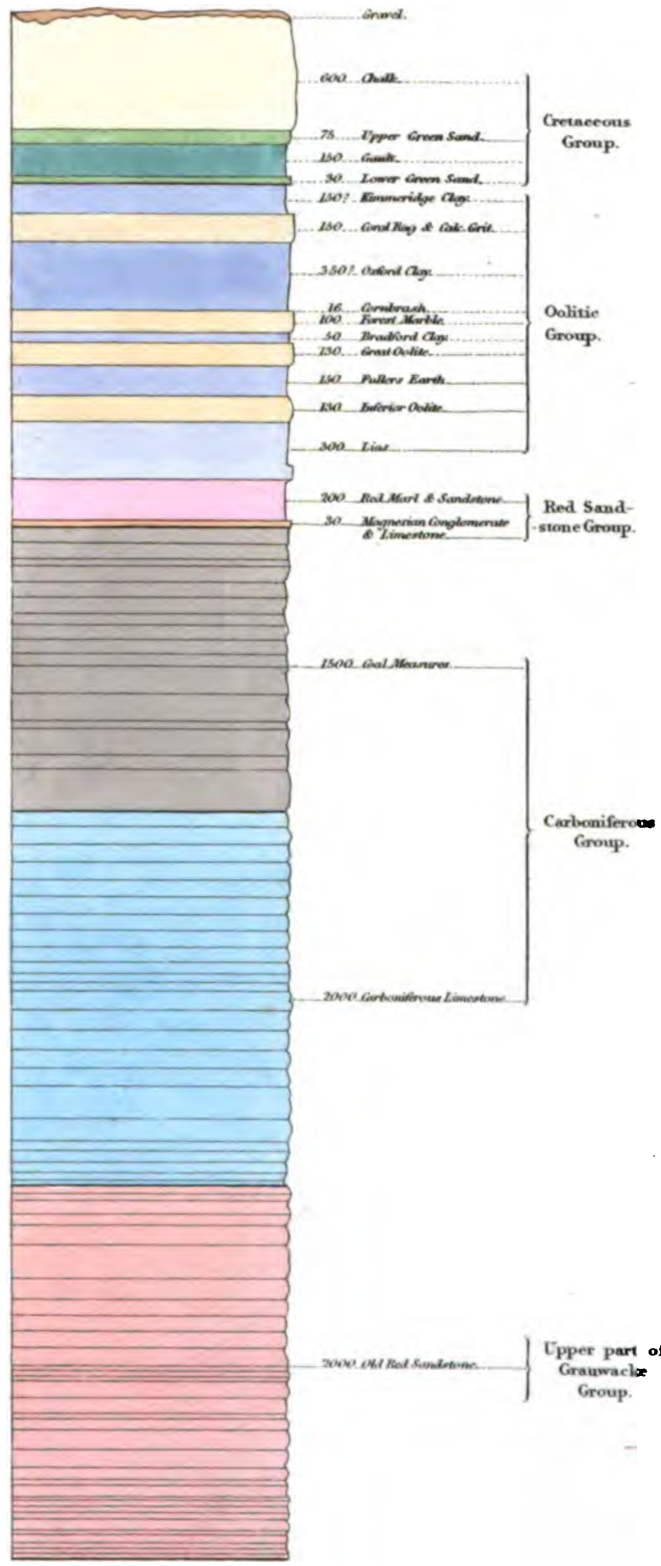
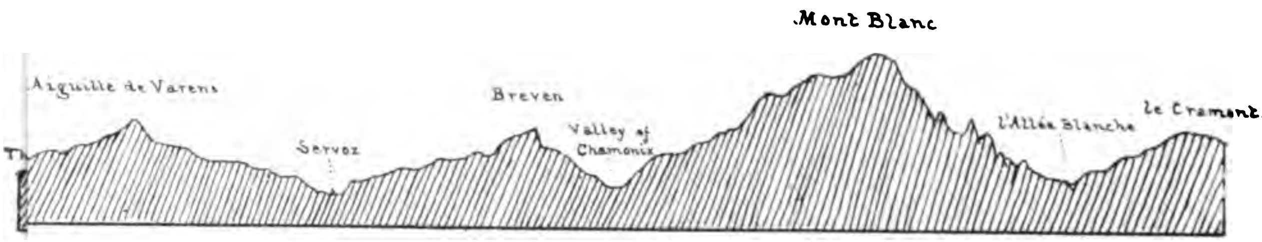


Fig. 2. Section. WILTS. & SOMERSET.



H. T. de la Beche.


Mont Blanc
Aiguille de Varens
Servoz
Breven
Valley of Chamonix
L'Allée Blanche
Le Cramont.

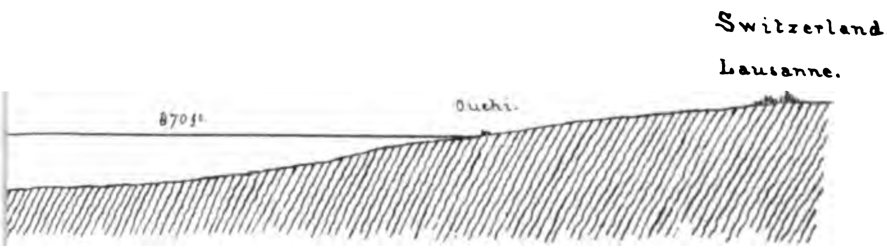

Switzerland.
Lausanne.
870 ft.
Ouchi.

Fig. 7.

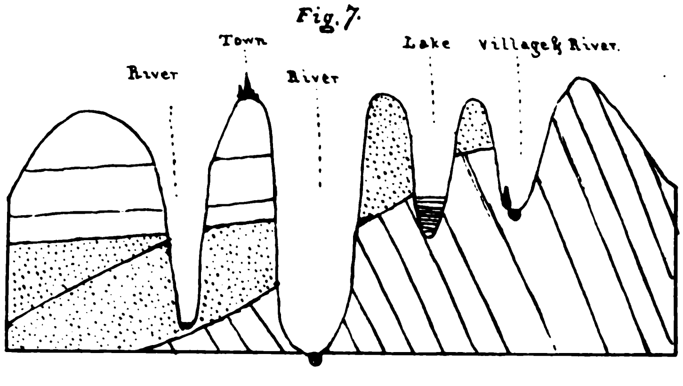
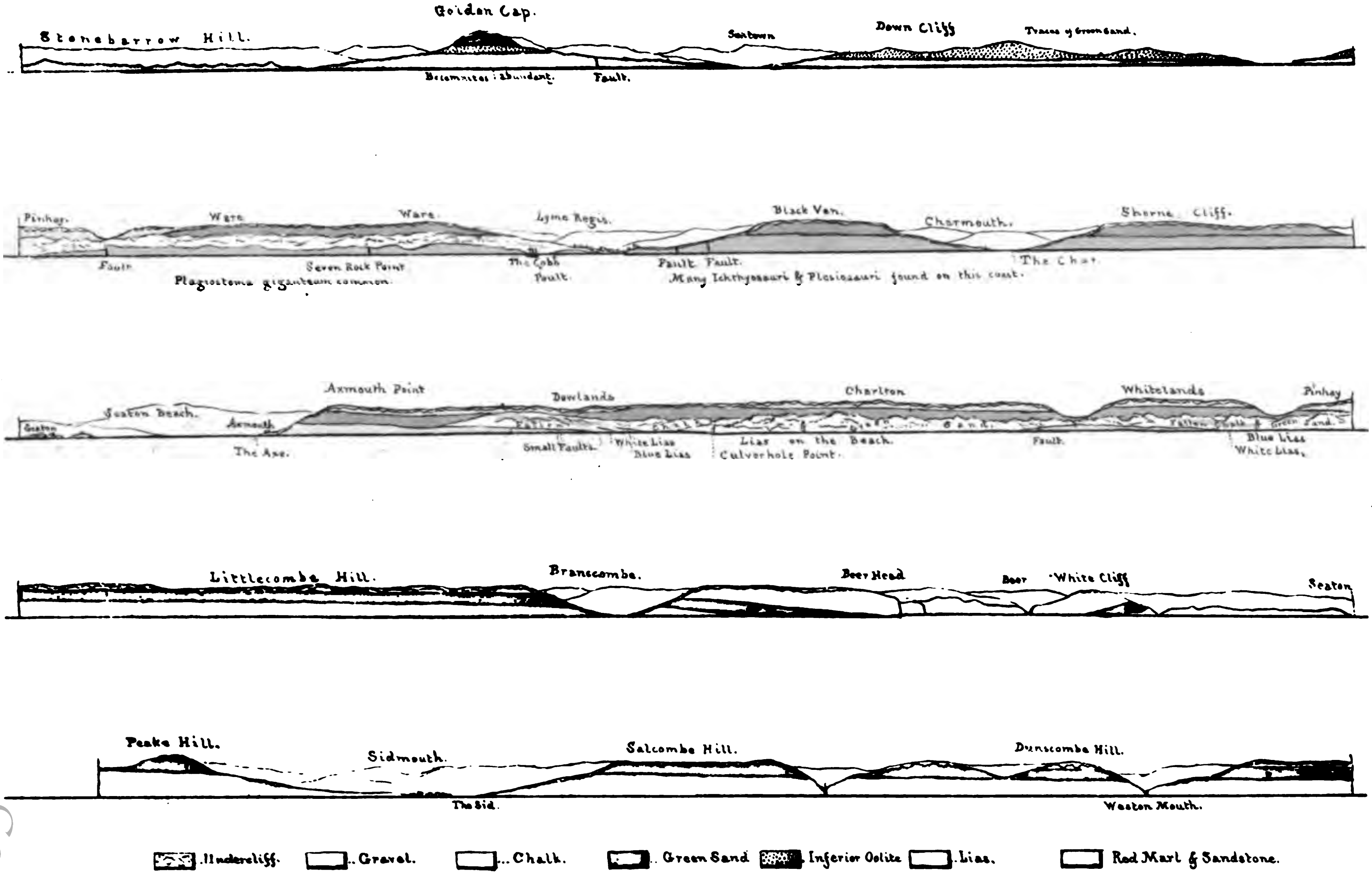

Town
River
River
Lake
Village & River.

Plate 3.

Overlap of Chalk and Green-Sand, Dorset & Devon.



H. De la B. del.

Overlap of Chalk and Green-Sand, Normandy.

Fig. 1.

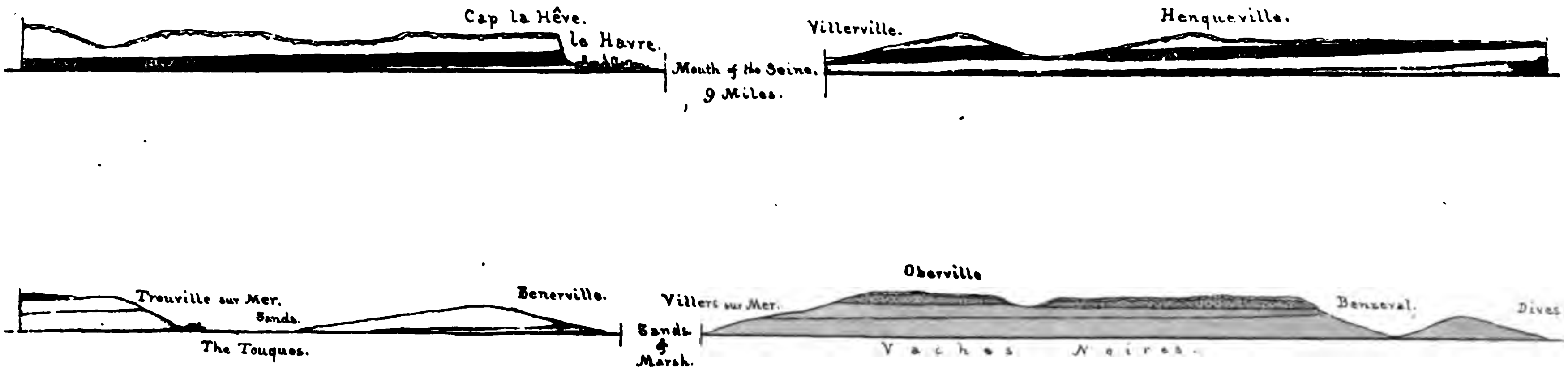
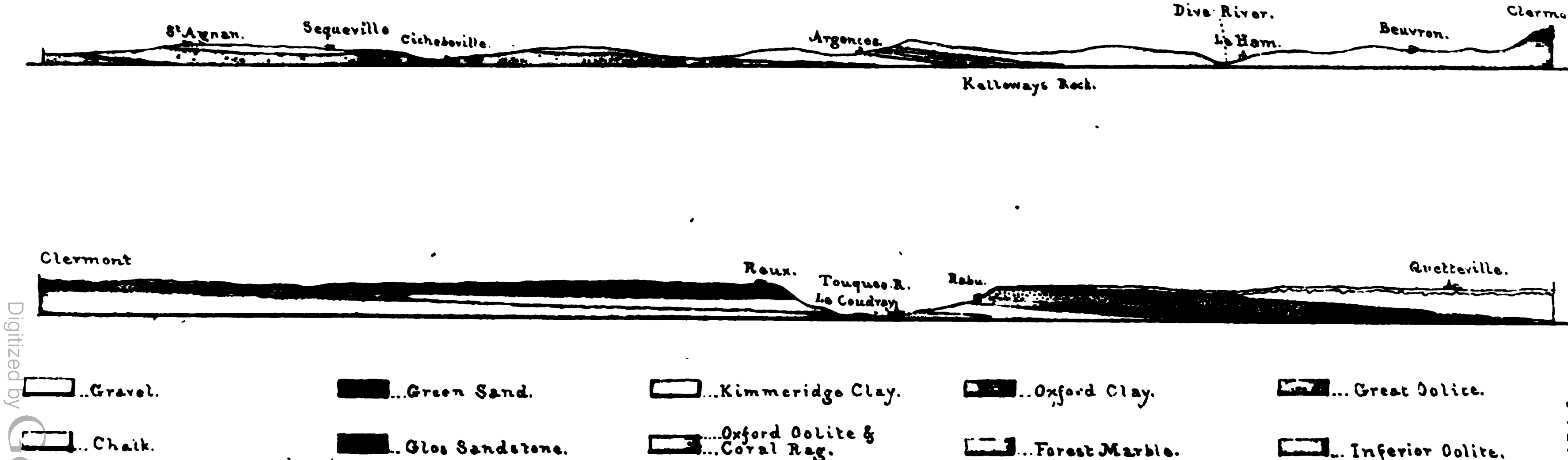


Fig. 2.



N. T. de la B. del.

Plate 4.

Faults.

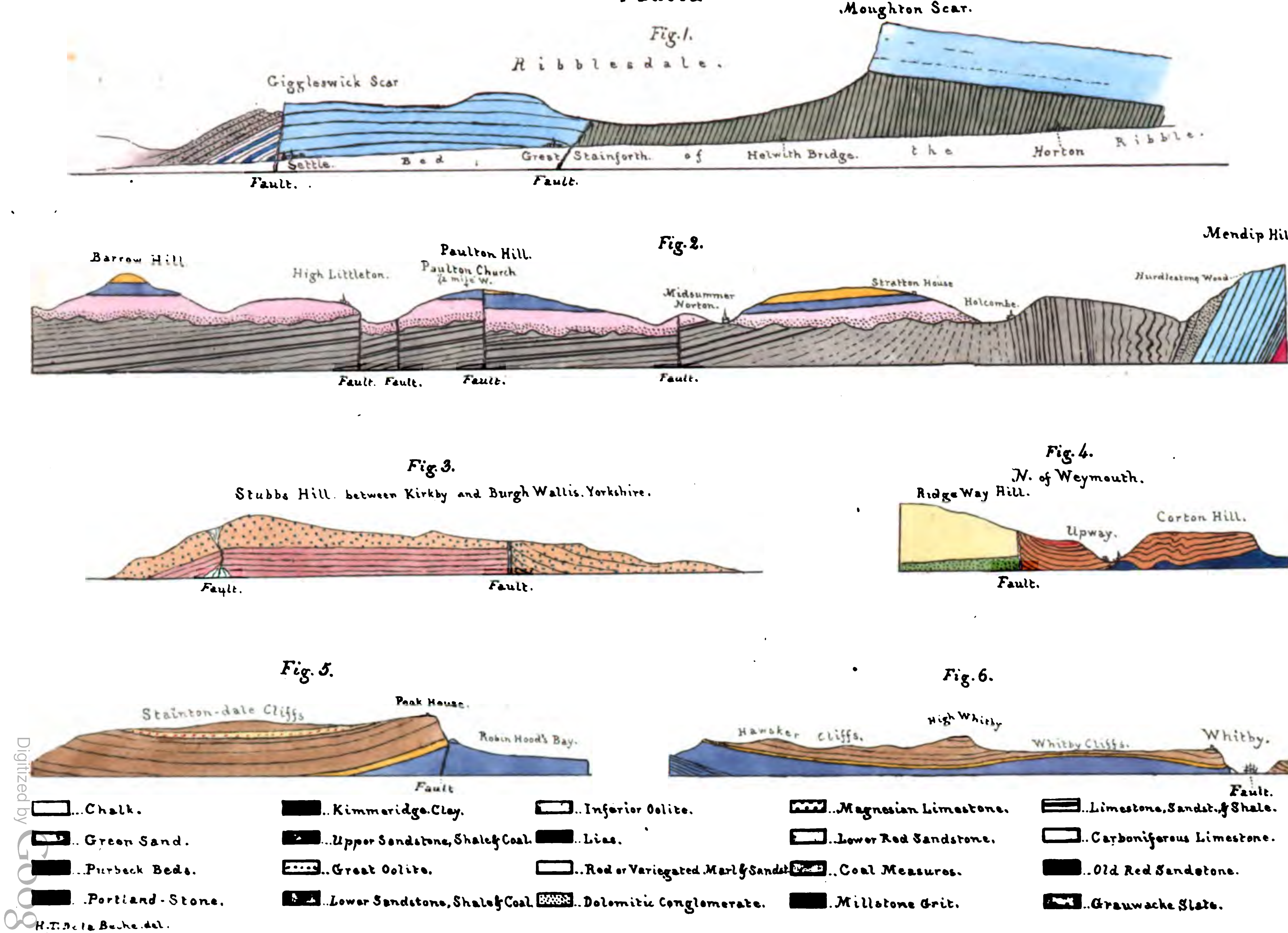


Plate. 5.

Faults in Coal Measures.

Coal Pit Heath near Bristol.

Fig. 1.

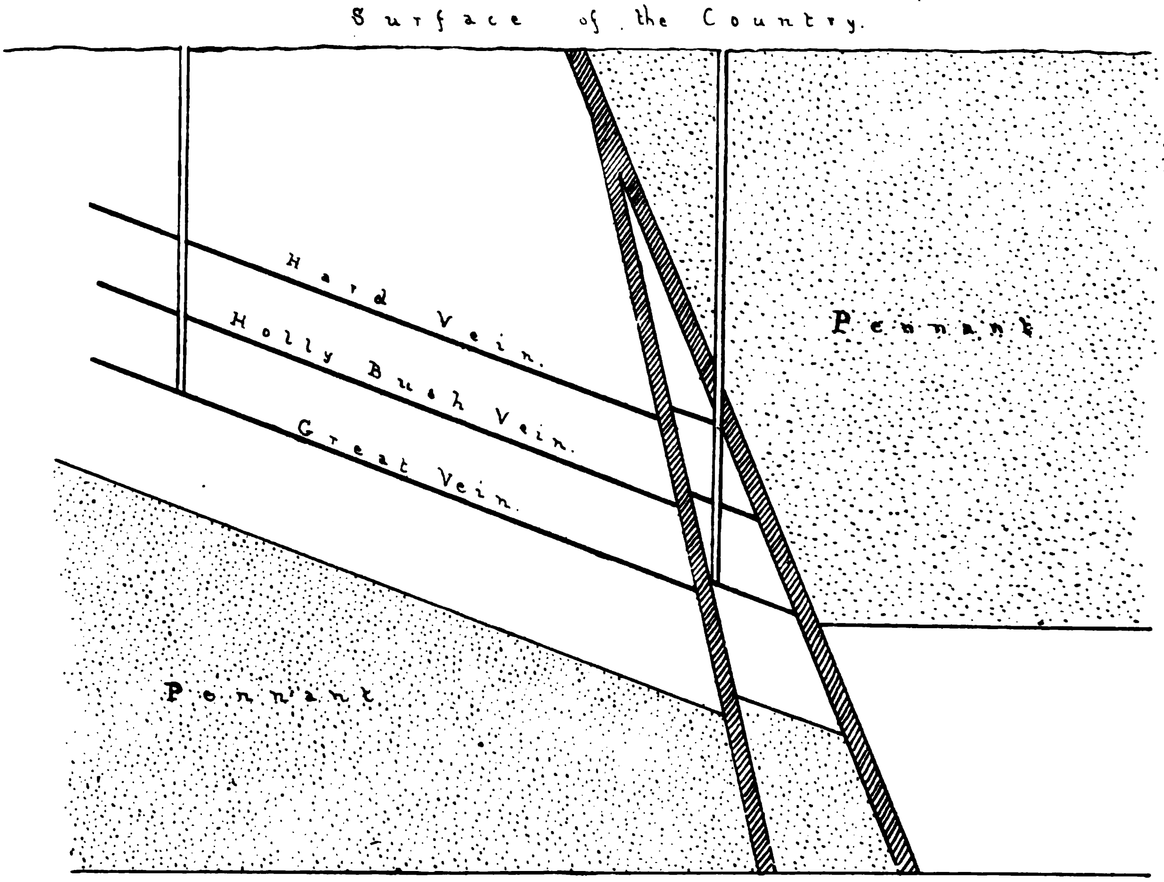
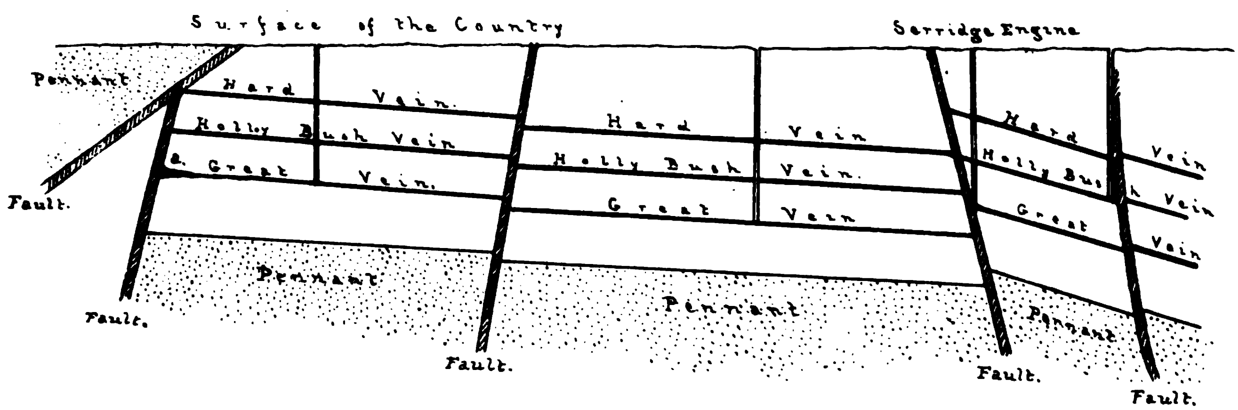


Fig. 2.



H. T. de la B.

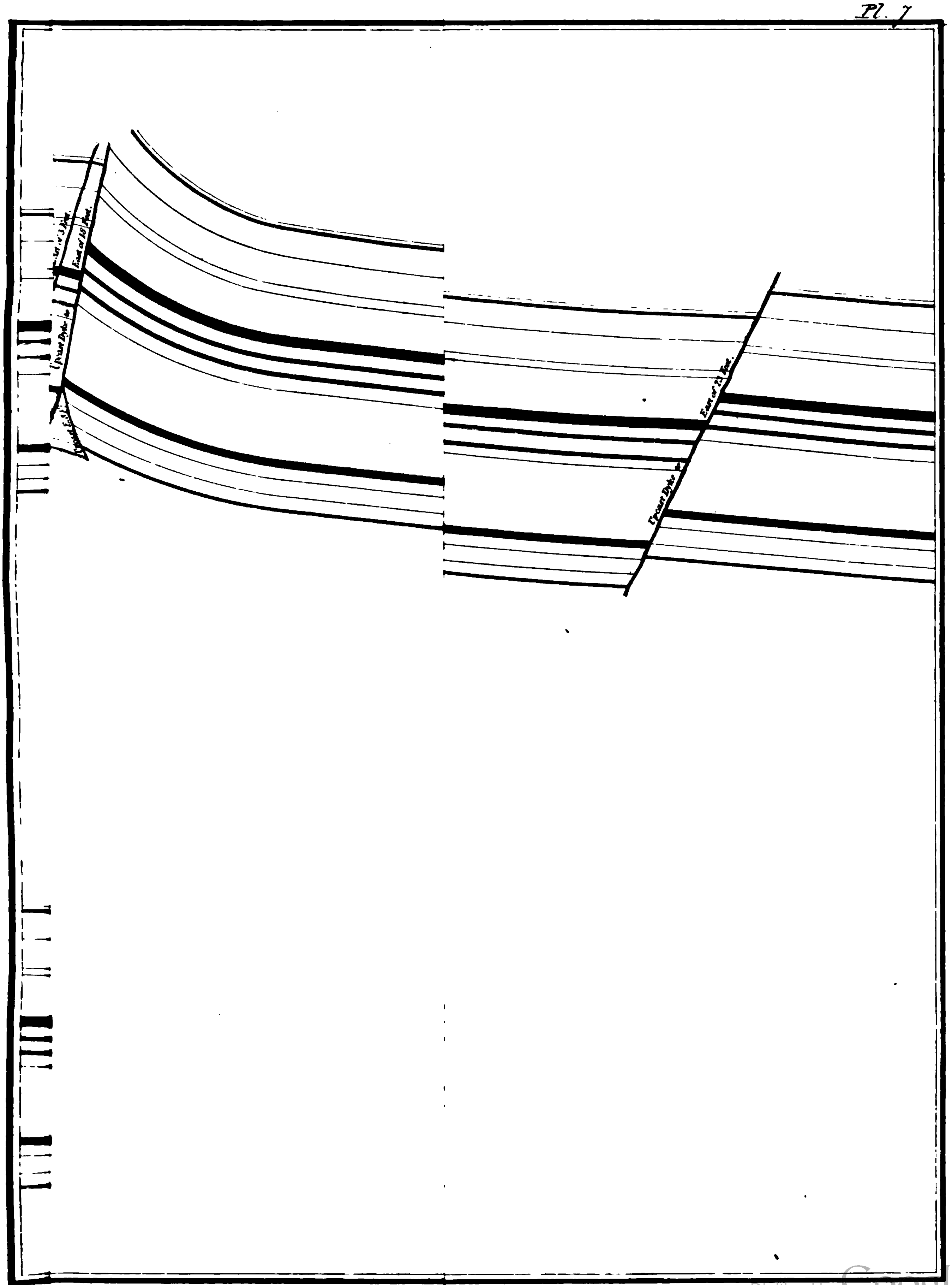

East of 18 Feet
Upcast Dyke
East of 23 Feet
Upcast Dyke

Fig. 1.

Upheaved Strata forming Mountains.. Alps. St. Gothard to the Rigi.

Fig. 2.

Connexion of Changed Strata & Igneous Rocks.... Alps.

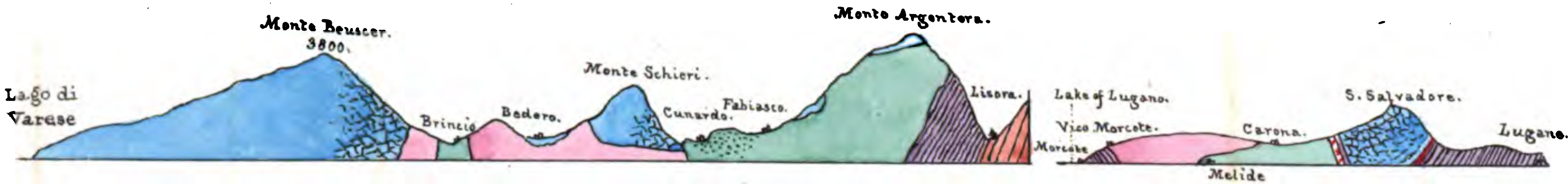
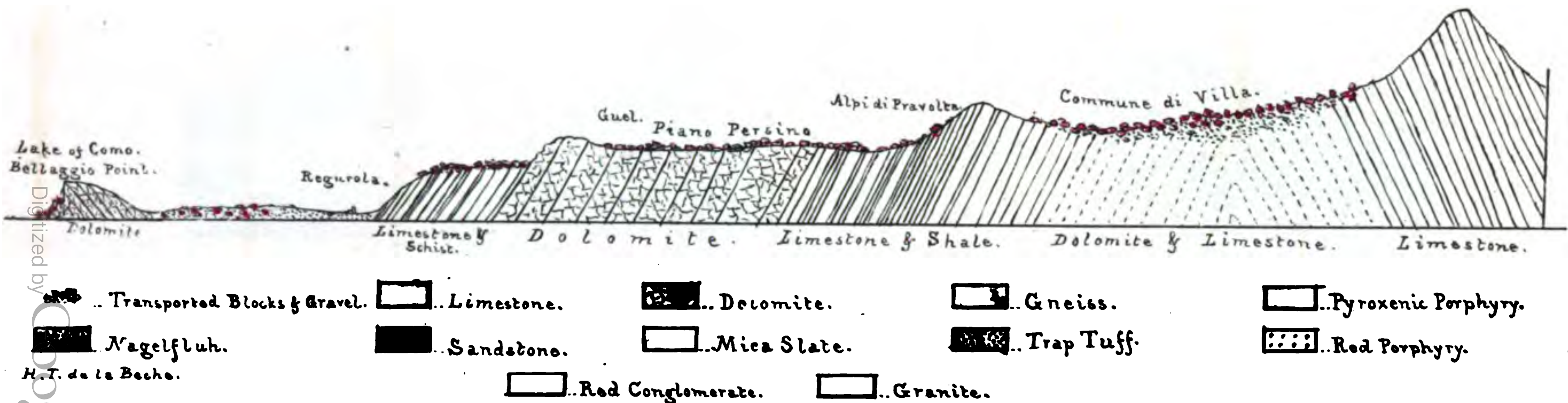


Fig. 3.

Transported Blocks & Gravel... Alps.



H. T. de la Beche.

Plate 8.

Plate 9.

Disturbed Strata, Dolomite, & Igneous Rocks. Tyrol.

Fig. 1.

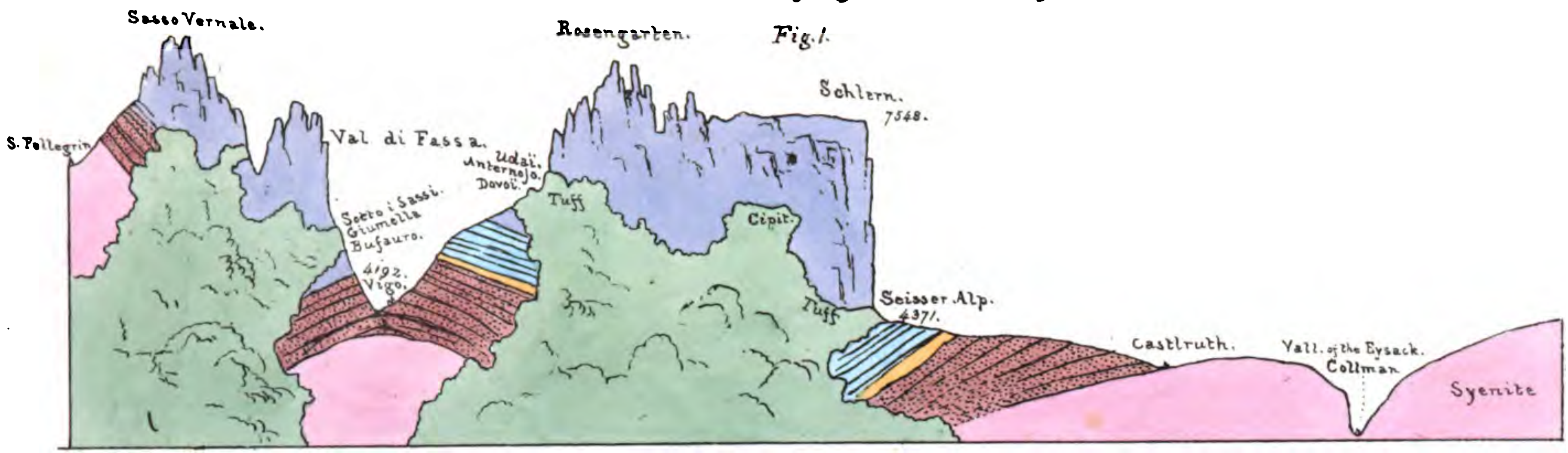


Fig. 2.

Feigenstein.

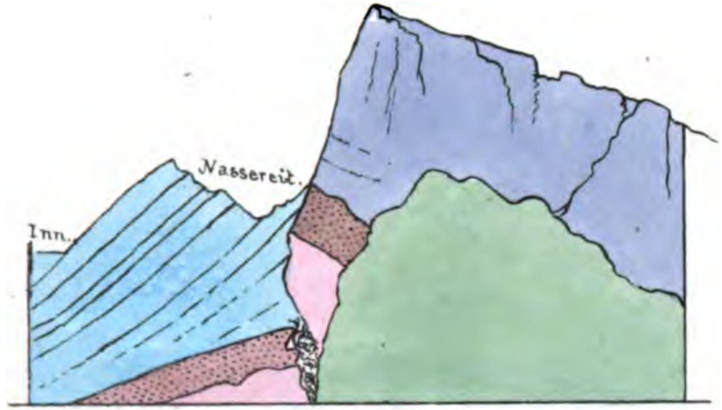


Fig. 3.

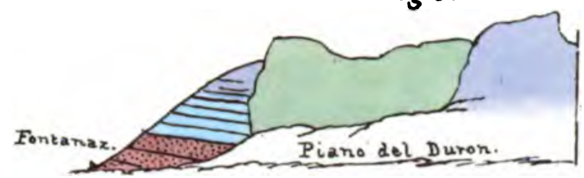


Fig. 4.

Sotto i Sassi.

.. Limestone. .. Dolomite. .. Gypsum. .. Red Sandstone. Red Quartzife-rous Porphyry. Pyroxenic Porphyry.

H. T. De la Beche. del.

Overlying Masses and Veins of Trap. Western Islands, Scotland.

Fig. 1.
East Coast of Trotternish, Sky.

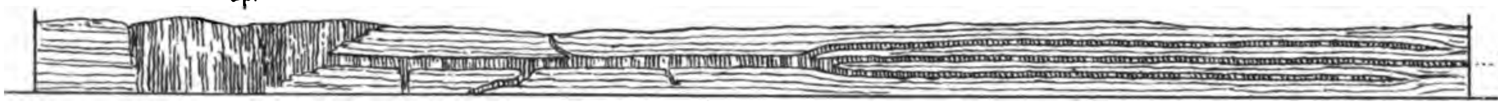


Fig. 2.
Cliffs to the N. of Ru na braddan, Sky.

Fig. 3.
In Loch Eyshort, Sky.

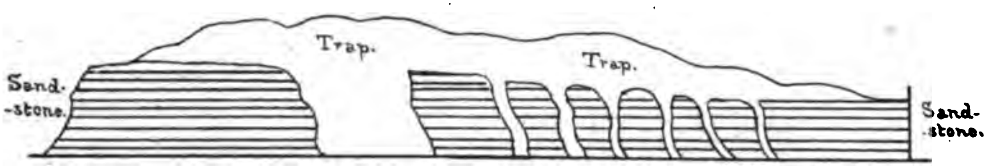
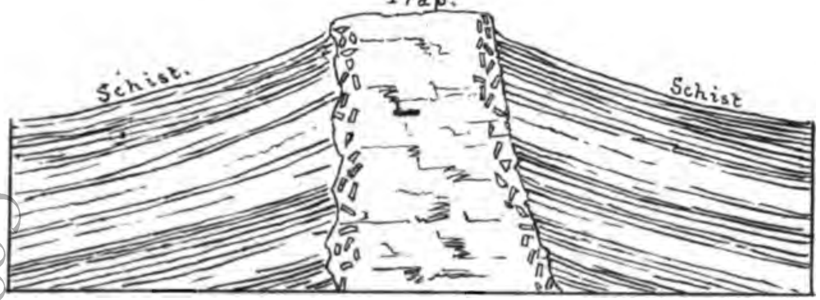


Fig. 4.
Sky.

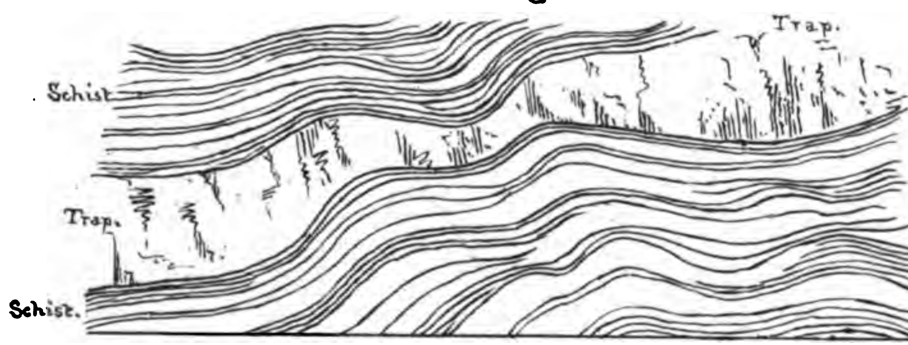
Fig. 5.



Trap dyke entangling fragments of schist. Soil.

R.T. de la B.

Fig. 6.



Vein of Trap conforming to the schist, in Lunga.

Plate 10.

Overlying Masses and Veins of Trap. Western Islands, Scotland.

Fig. 1.

East Coast of Trotternish, Sky.

Fig. 2.

Cliffs to the N. of Ru na braddan, Sky.

Fig. 3.

In Loch Eyshort, Sky.

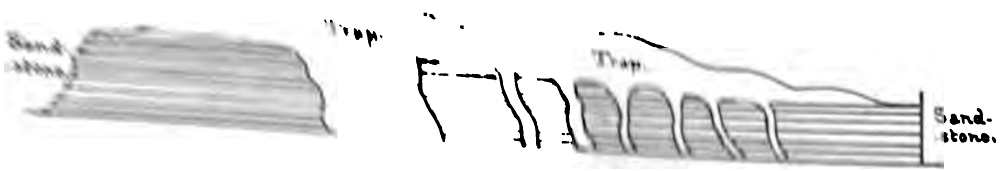
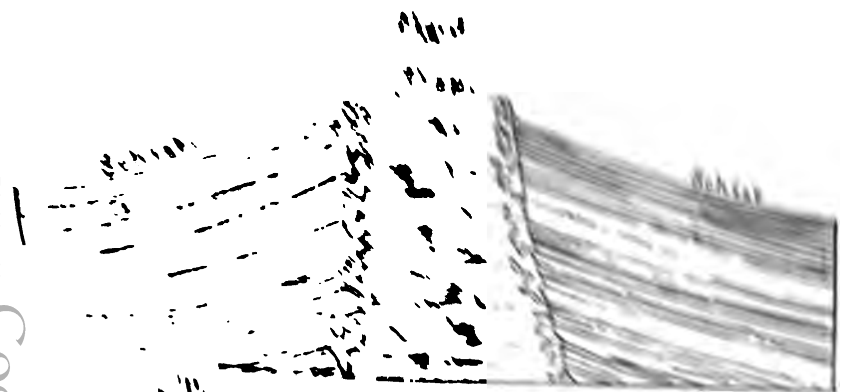


Fig. 4.

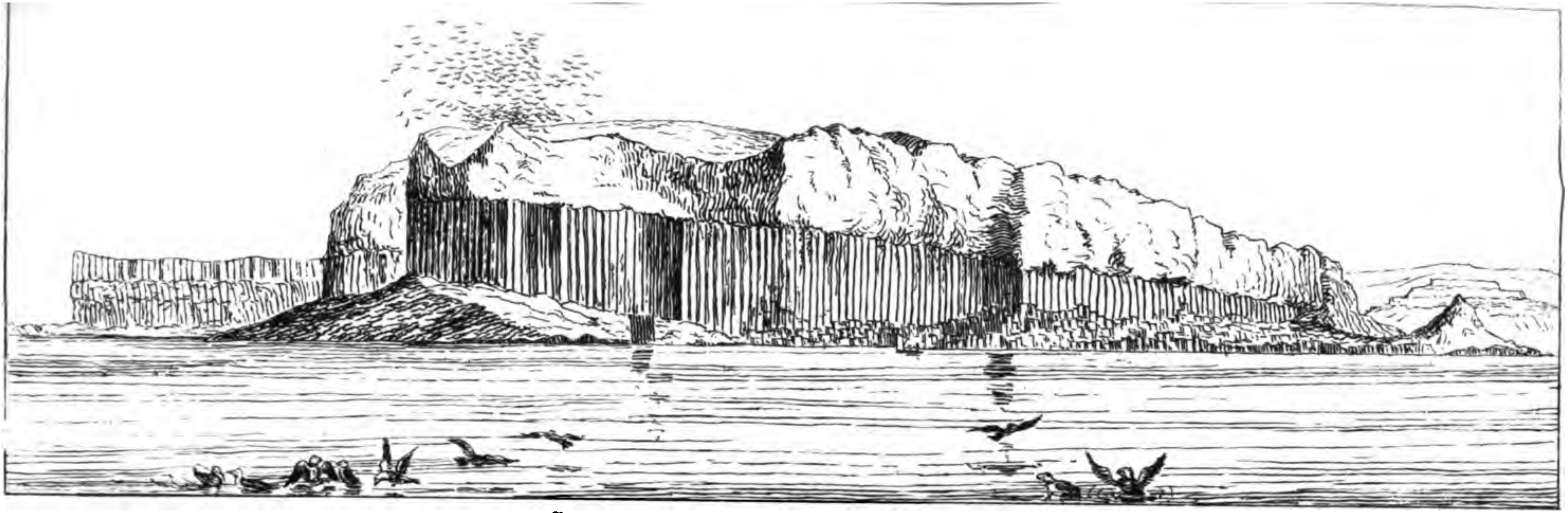
Sky.



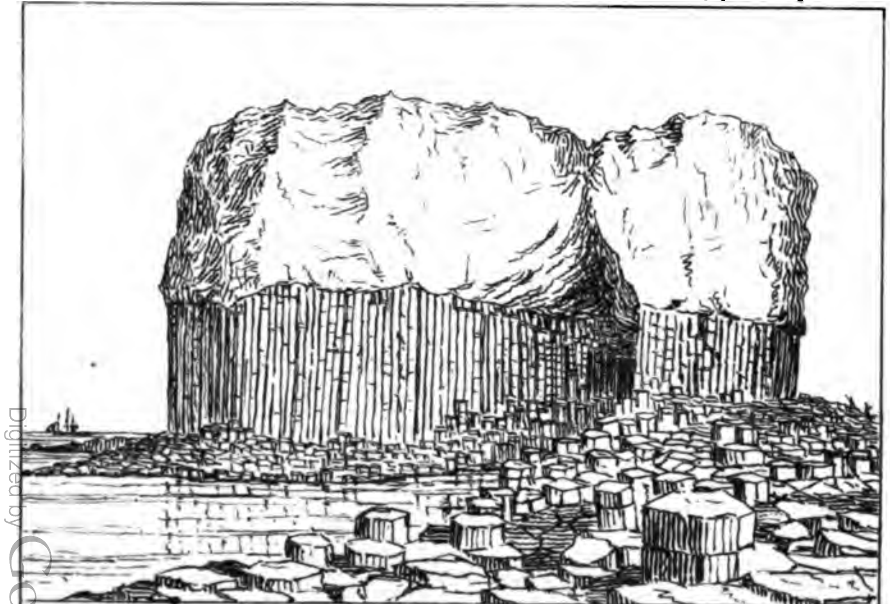
Trap dyke entangling fragments of schist. Soil.

Fig. 6.

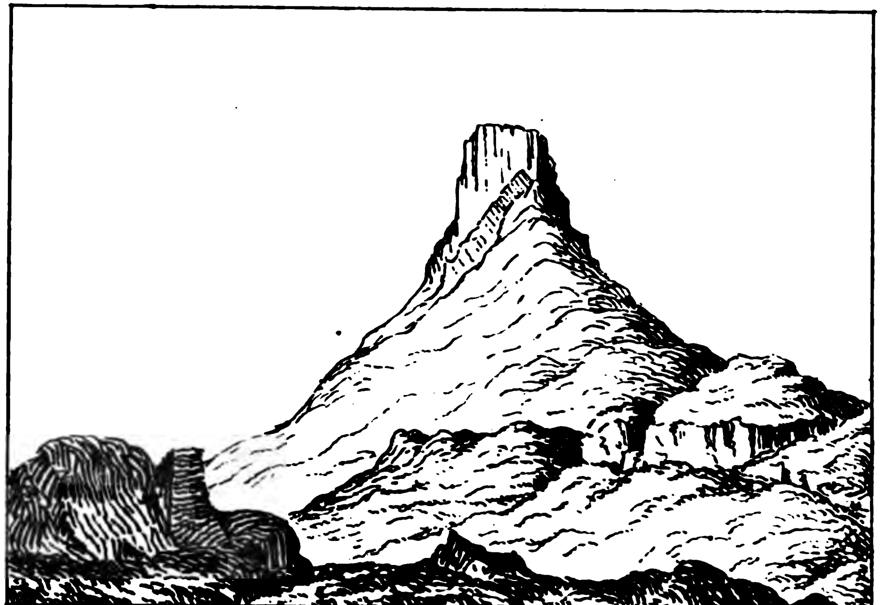
Vein of Trap conforming to the schist, in Lunga.



Staffa from the South West.



Fingal's Cave, Staffa.



The Scuir of Egg.

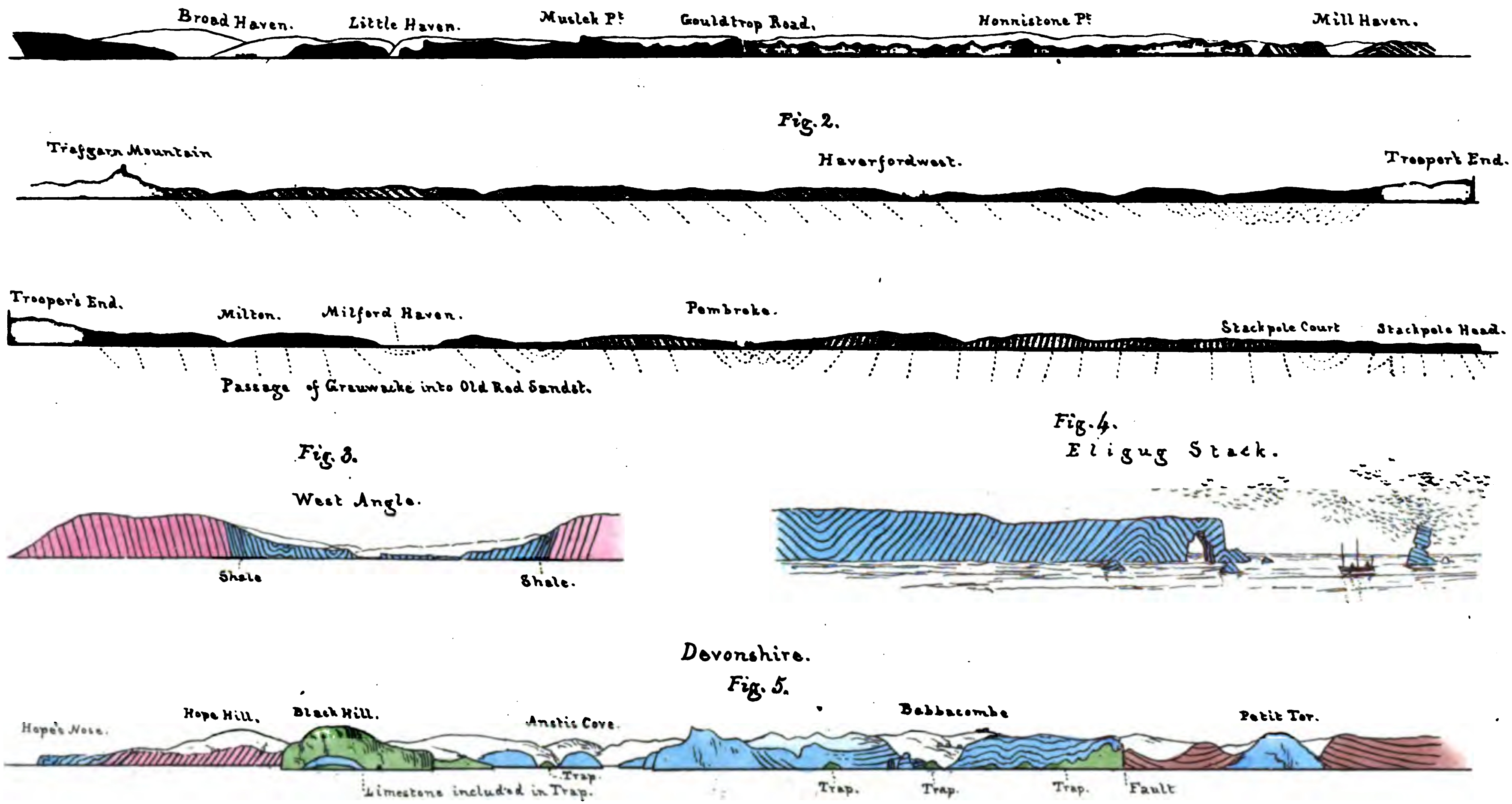
H. T. de la B. from Dr. Macculloch.

Trap Rocks, Western Islands, Scotland.

Plate 11.

Connexion of Trap with Disturbed Strata.

Pembrokeshire.



..... Exeter Red Conglomer. .... Coal Measures. .... Carboniferous Limest. .... Old Red Sandstone. .... Grauwacke. .... Trap.

H.T. de la Beche. del.

High Teesdale, &c.

Association of Trap with Carboniferous Limestone.

Fig. 1.

Section above Middleton.

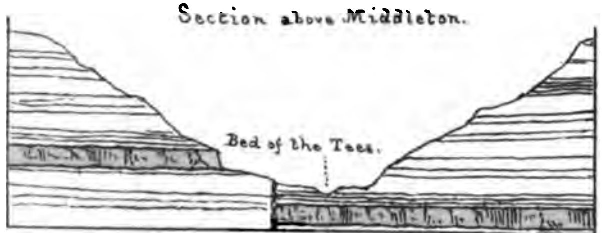


Fig. 2.

Near Greengate Farm, in Lunedale.

Fig. 3.

Right bank of the Lune, near Lonton.

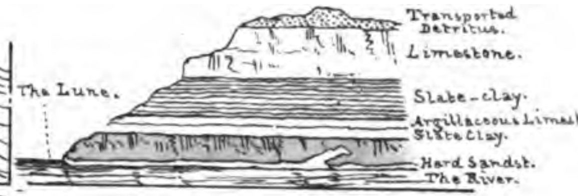


Fig. 4.

Left bank of the Lune near Lonton.

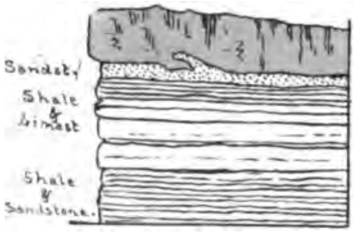


Fig. 5.

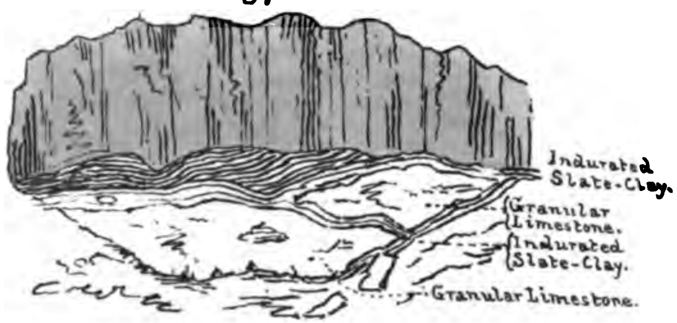
Teesdale.

Fig. 6.

Section, commencing immediately below Caldron Snout.

Limestone, Sandstone, & Slate-Clay.

Fig. 7.



Alteration of Rocks in contact with Trap, near Caldron Snout.

Fig. 8.

Alteration of Rocks in contact with Trap, at White Force.

☐ .. Trap.

H. T. de la B.

Overlying Masses & Dykes of Trap.

Cleveland Dyke, Durham & Yorkshire.

Fig. 1.

Preston Quarry on the Tees.

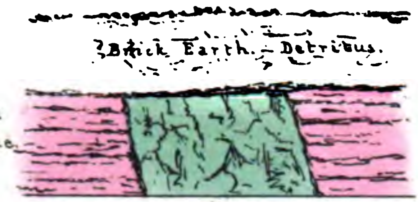


Fig. 2.

Langbargh Quarry.

Fig. 3.

Bolam Quarry

Island of Anglesea

Fig. 4.

Dulas Harbour.

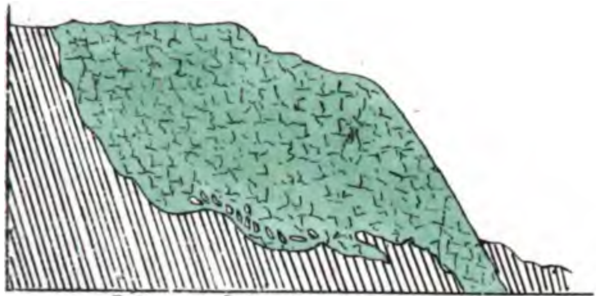
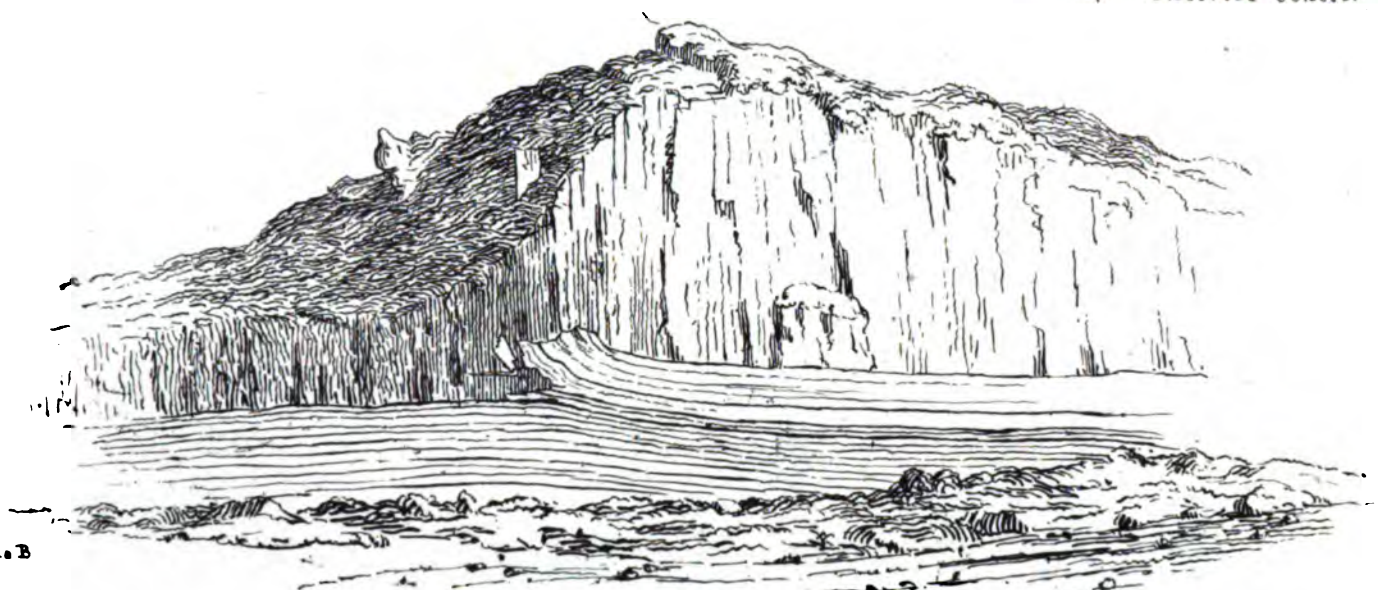


Fig. 5.

Between Beaumaris & Garth-ferry.

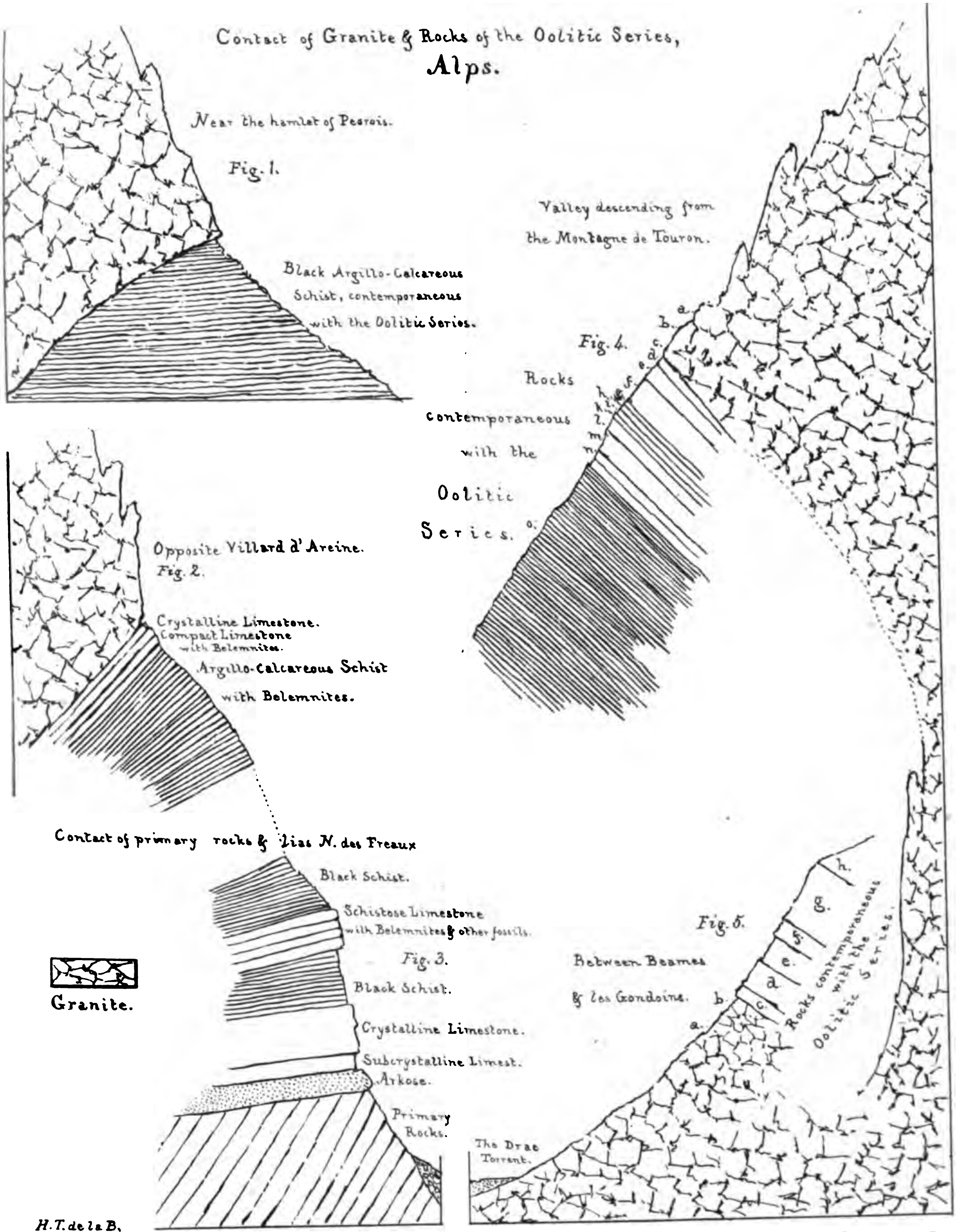
Fig. 6.

Between Beaumaris & Garth-ferry.



H.T. de la B

Fig. 7. Junction of Sandstone & Trap, Stirling Castle, Scotland.


Contact of Granite & Rocks of the Oolitic Series,
Alps.
Near the hamlet of Pesrois.
Fig. 1.
Black Argillo-Calcareous Schist, contemporaneous with the Oolitic Series.
Valley descending from the Montagne de Touron.
Fig. 4.
Rocks contemporaneous with the Oolitic Series.
Opposite Villard d'Areine.
Fig. 2.
Crystalline Limestone.
Compact Limestone with Belemnites.
Argillo-Calcareous Schist with Belemnites.
Contact of primary rocks & Lias N. des Freaux
Black Schist.
Schistose Limestone with Belemnites & other fossils.
Fig. 3.
Black Schist.
Crystalline Limestone.
Subcrystalline Limest.
Arkose.
Primary Rocks.
Granite.
Fig. 5.
Between Beames & les Gondoins.
Rocks contemporaneous with the Oolitic Series.
The Drac Torrent.
H. T. de la B.

Contact of Granite & Rocks of the Oolitic Series, Scotland.

Fig. 1.

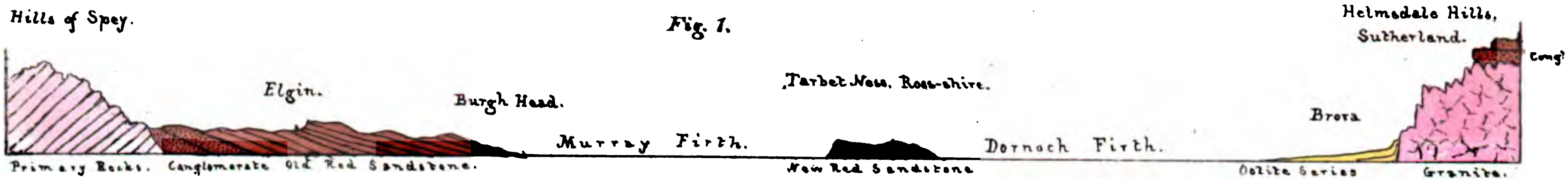


Fig. 2. Contact of Granite & Rocks considered Secondary, Scotland.

North Coast of Caithness, near Sandside.

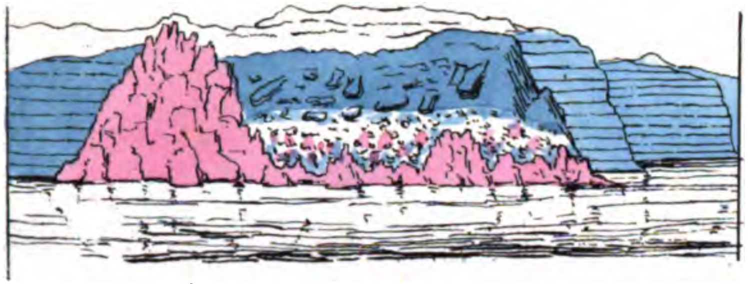
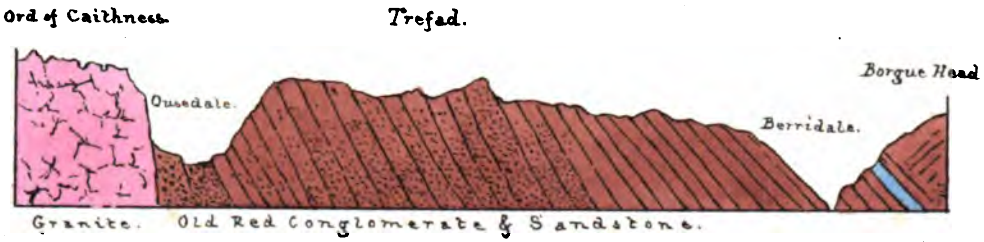


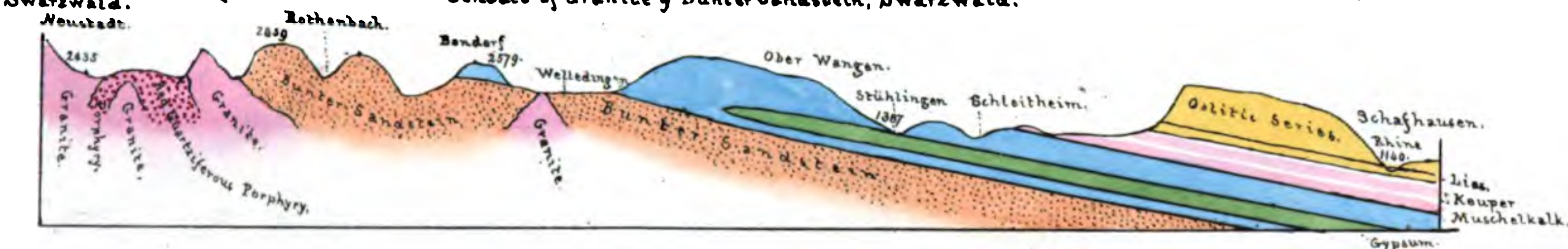
Fig. 3.



Contact of Granite & Bunter Sandstein, Swarzwald & Odenwald, Rhine.

Fig. 4.

Contact of Granite & Bunter Sandstein, Swarzwald.



H. T. de la Beche.

Plate 16.

Intrusion of Trap Rocks.

Fig. 1.

Saarbrück Coal District.

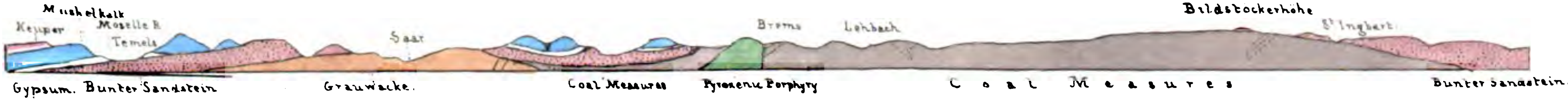


Fig. 2.

Saarbrück Coal District

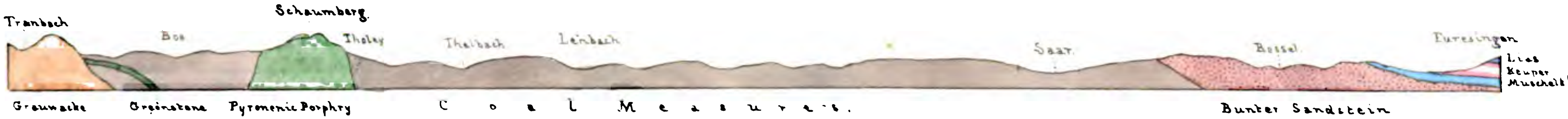


Fig. 3.

North Part of the Vosges.

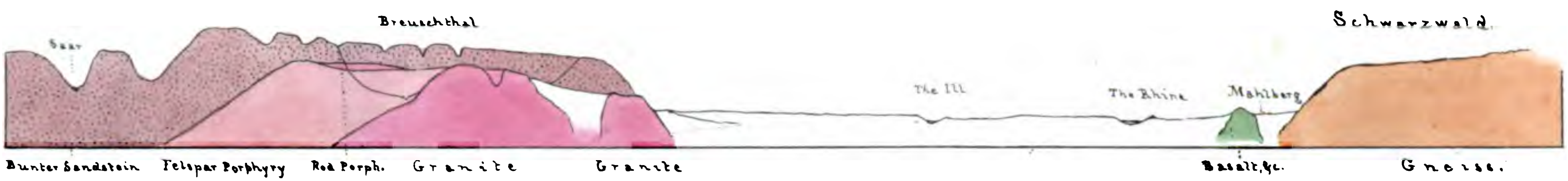
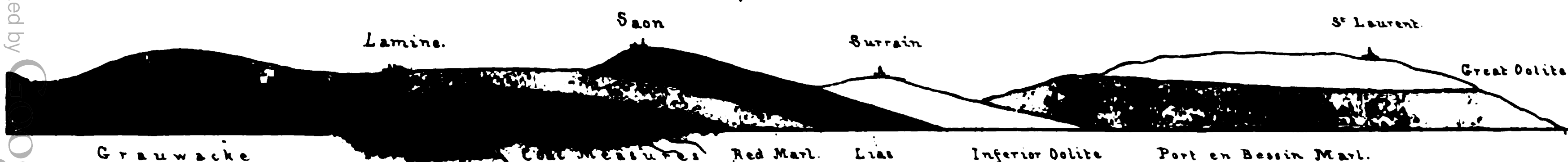
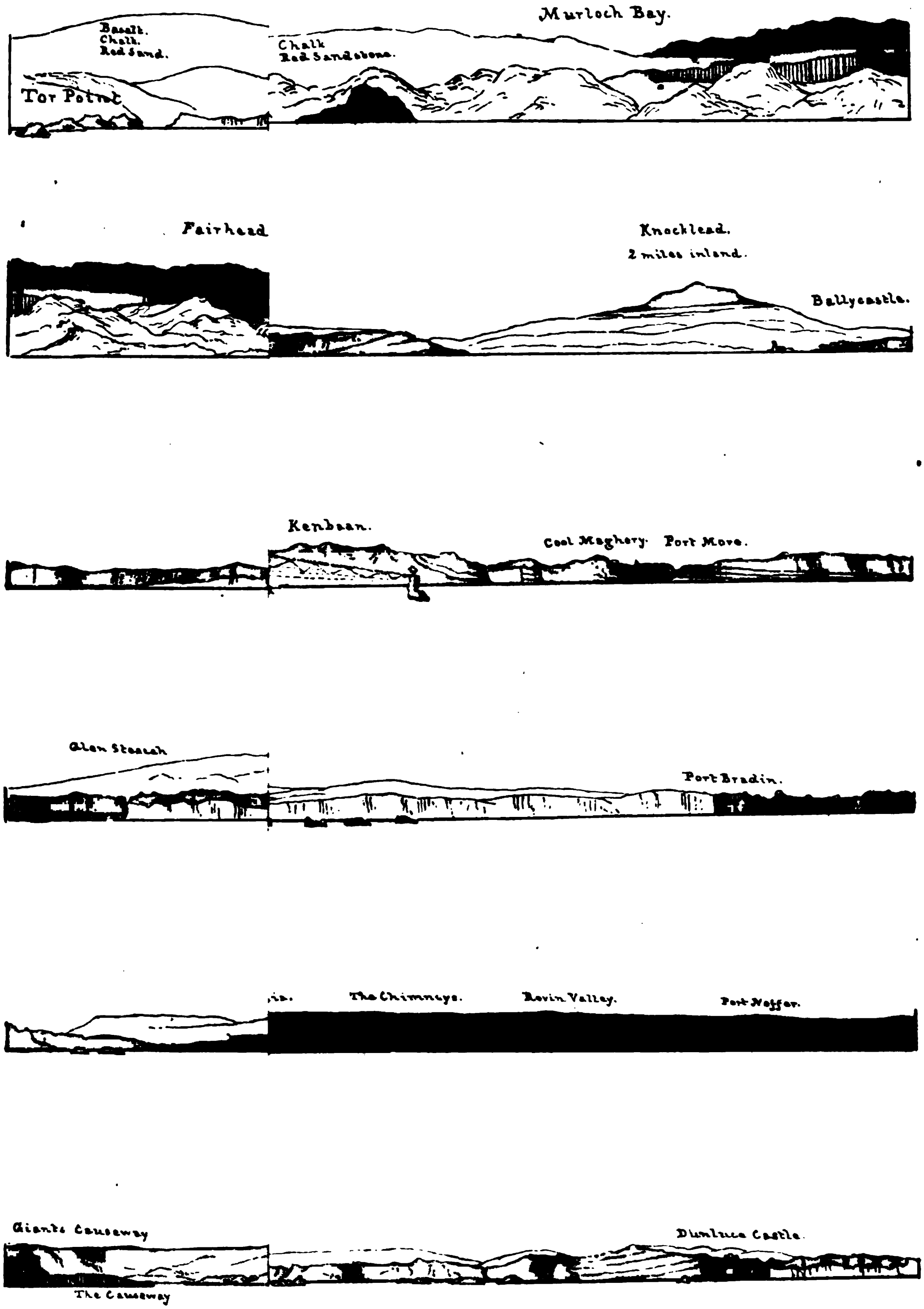


Fig. 4.

Department of Calvados, Normandy.



H. T. de la B.

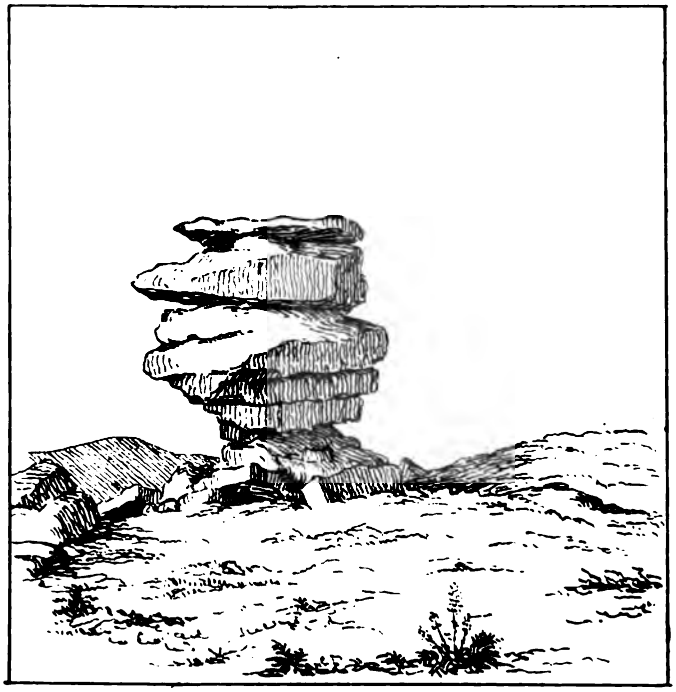


Basalt.
Chalk.
Red Sand.
Tor Point
Chalk
Red Sandstone.
Murloch Bay.
Fairhead
Knocklead.
2 miles inland.
Ballycastle.
Kenbaan.
Cool Maghery.
Port Move.
Glen Steacah
Port Bradin.
The Chimneys.
Rovin Valley.
Port Noffer.
Giants Causeway
Dunluce Castle.
The Causeway

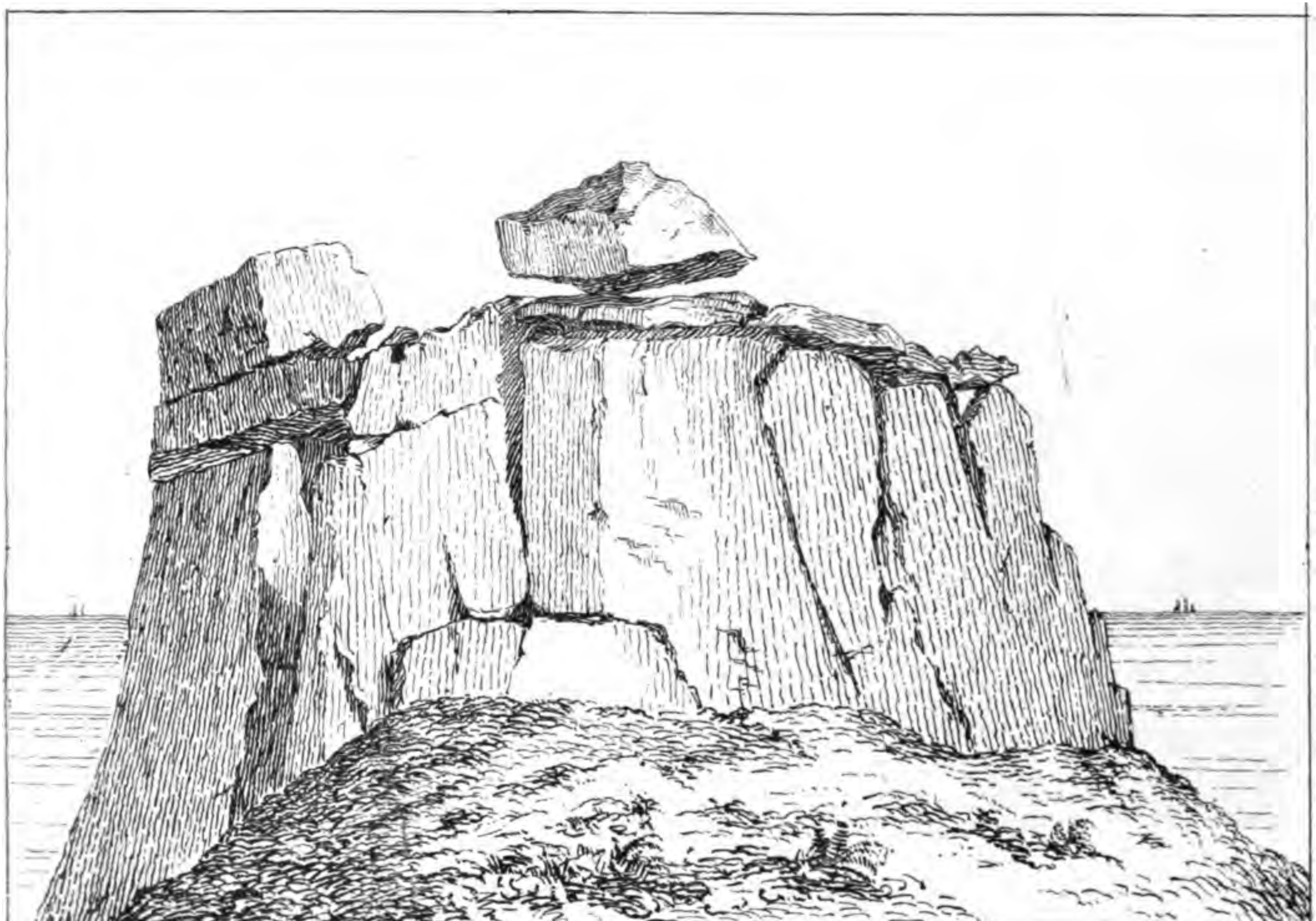
H.T. de la B.

Effects of Meteoric Influence.

Vixen Tor, Dartmoor.



Cheese-Wring, Cornwall.

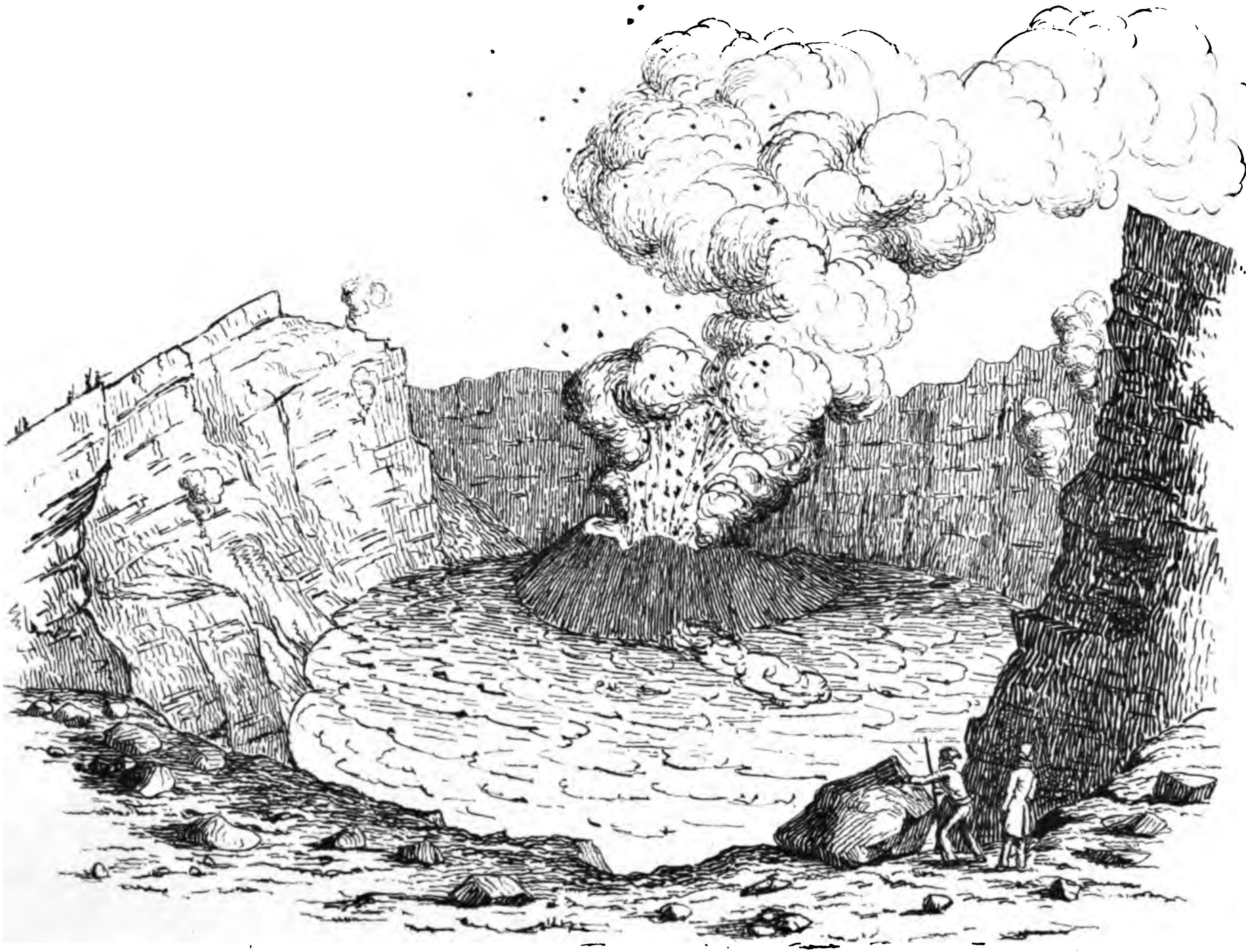


Logan Stone, Land's End.

Pl. 21.

from the BREV

Plate 22.



H. T. de la Beche del.

Crater of Vesuvius, Feb.ry 15, 1829.

Organic Remains in Caverns, Osseous Breccia, & Iron Ore in Clefts of Rocks.

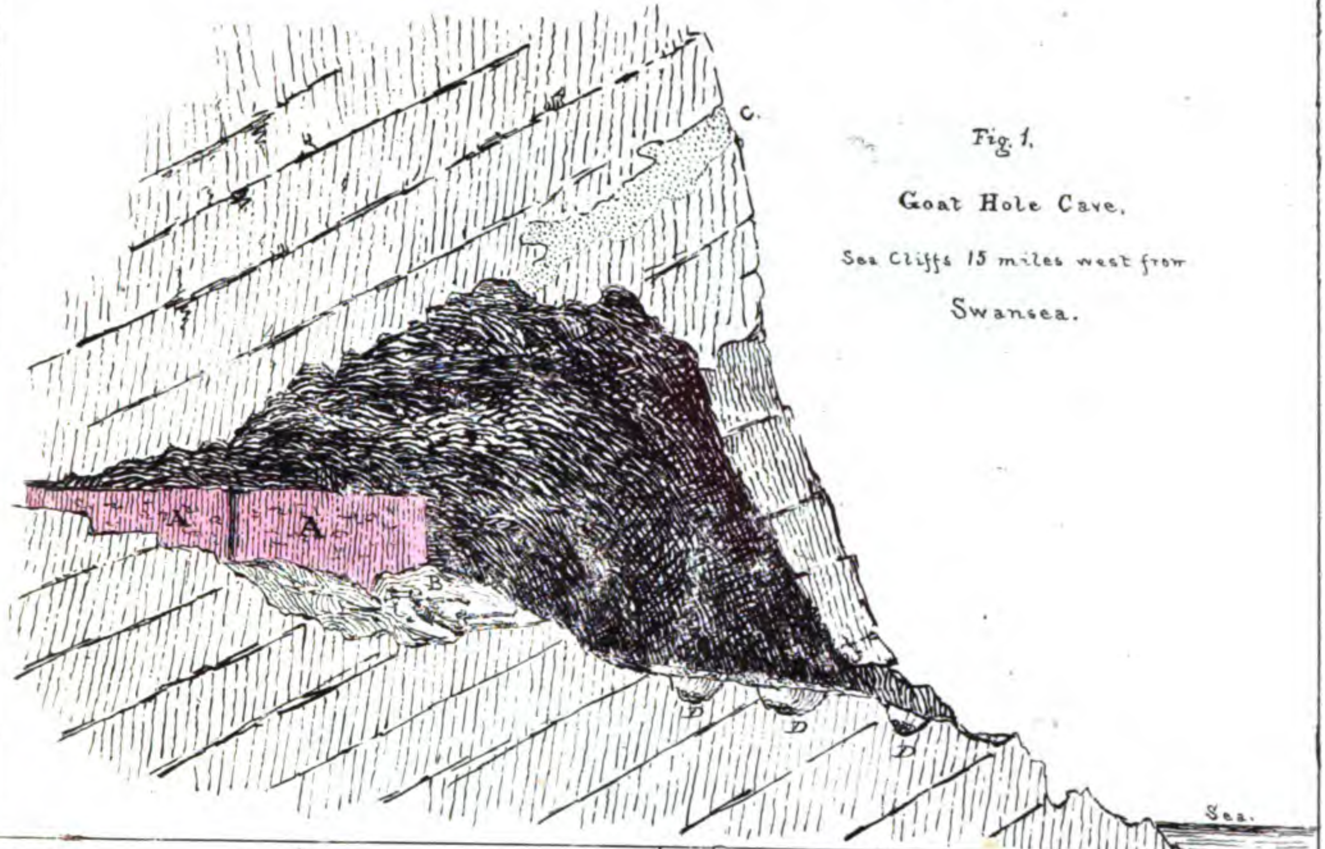
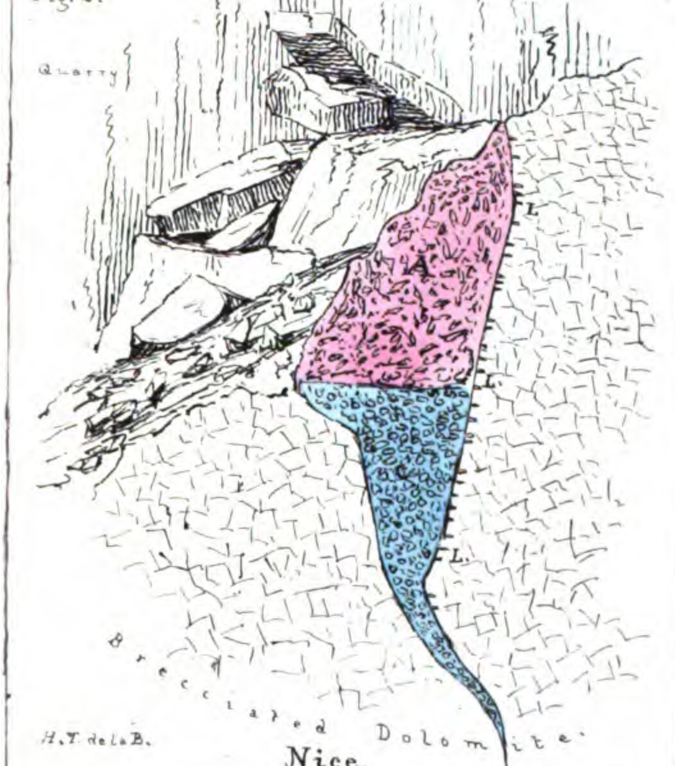


Fig. 1.
Goat Hole Cave.
Sea Cliffs 15 miles west from Swansea.

Fig. 2.



Nice.

Fig. 3.
Mettenberg in the Jura.

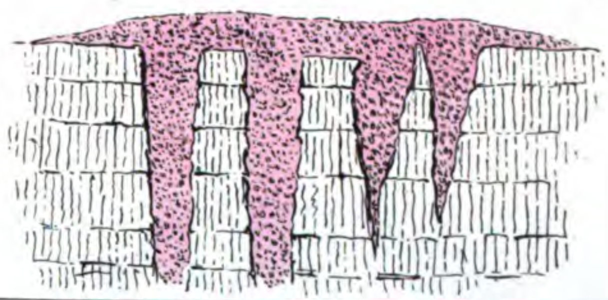
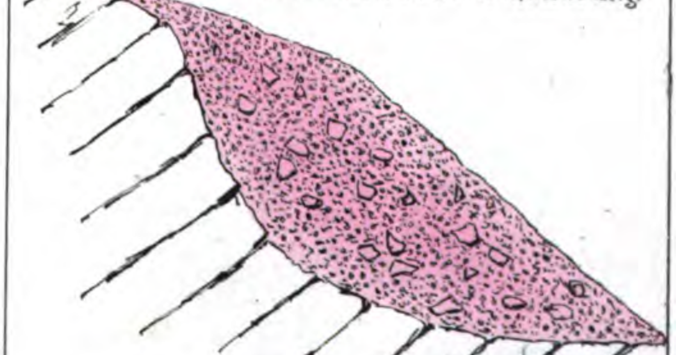


Fig. 4.
Mine named the Charbonniere, Mettenberg.



Supercretaceous Rocks.

Fig. 1. Paris Basin & Normandy. Isle of Wight. Fig 2.

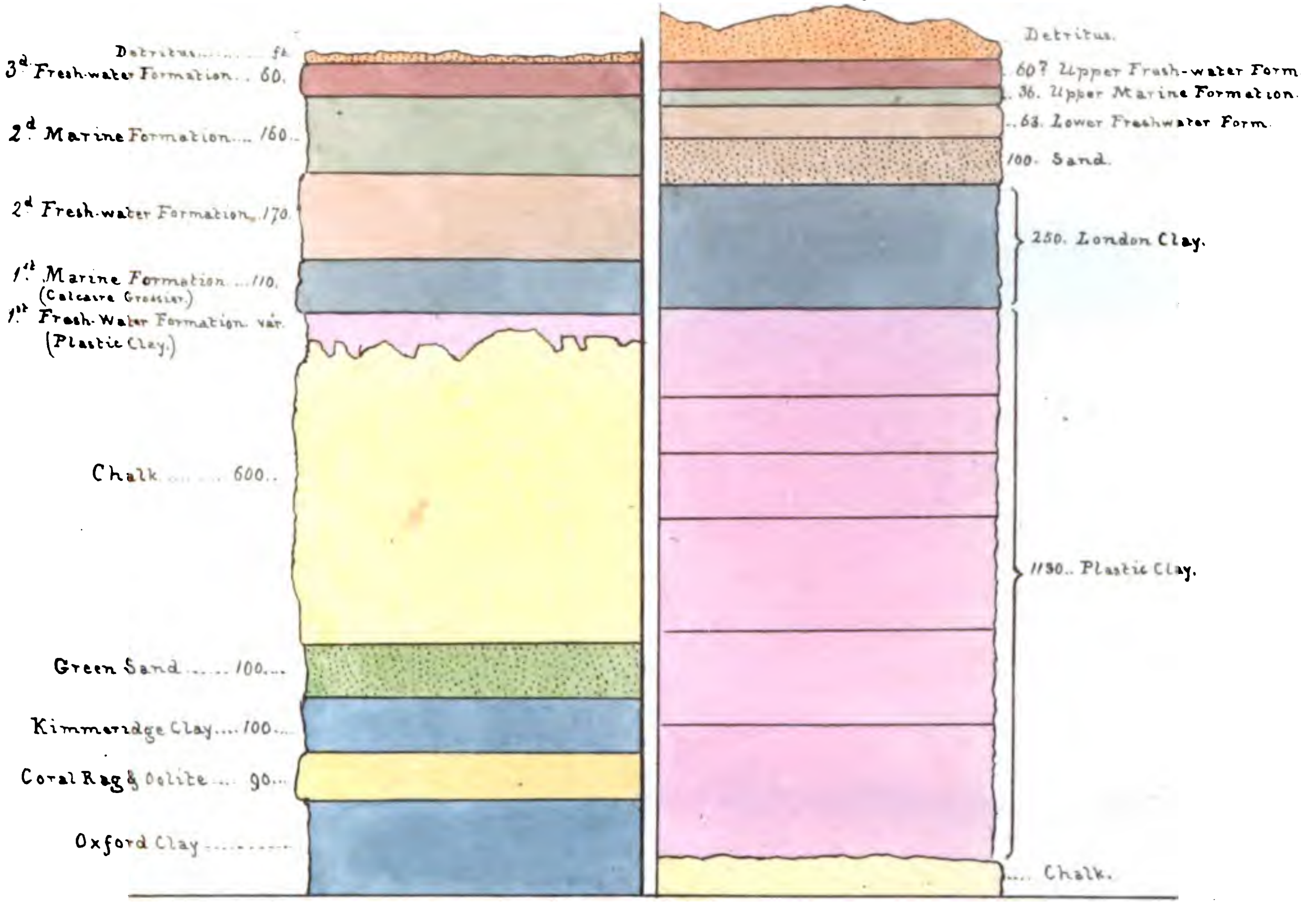


Fig. 3.

Provence

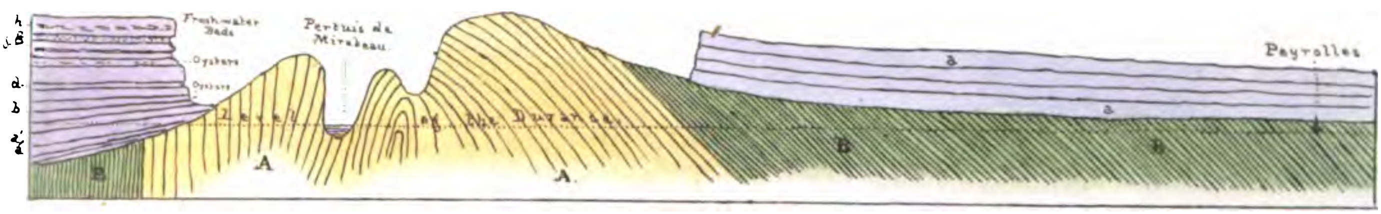
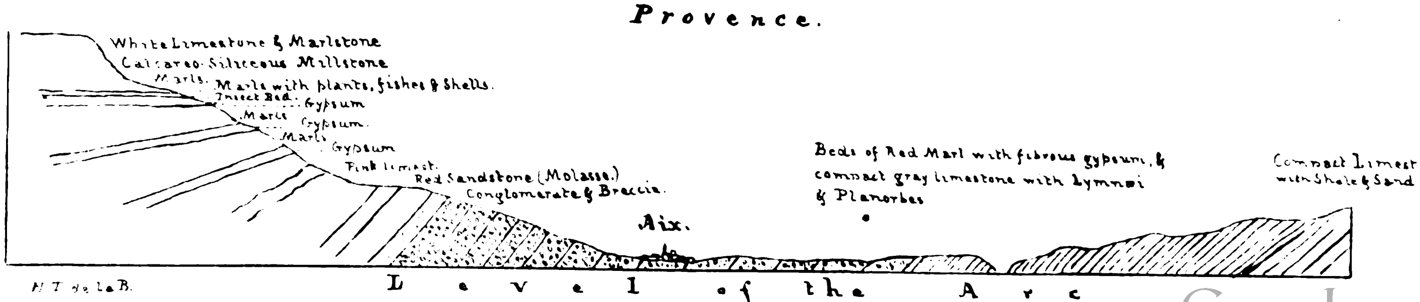
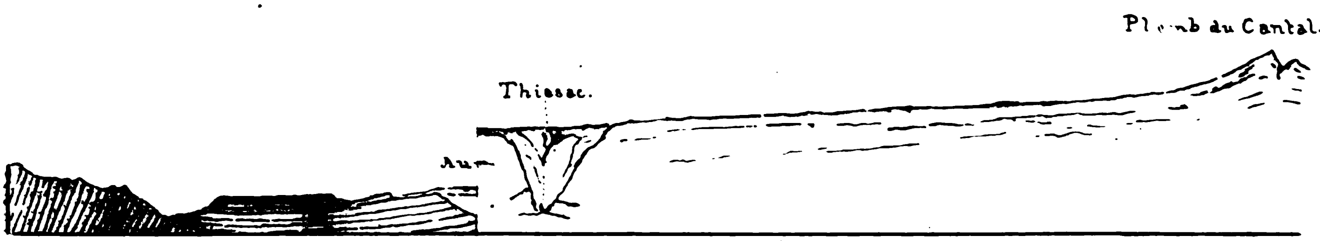


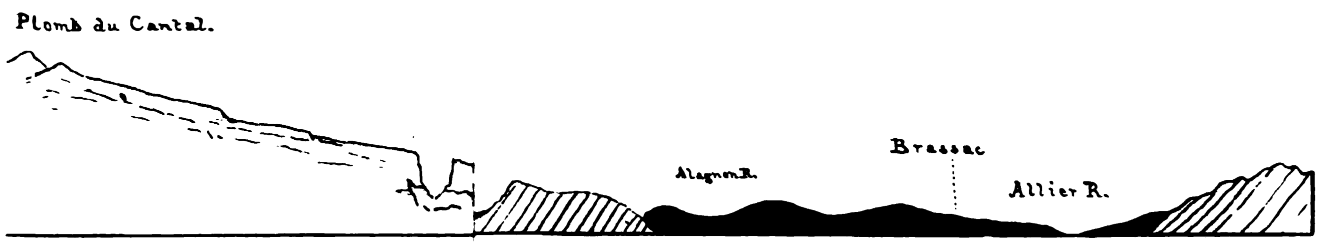
Fig. 4

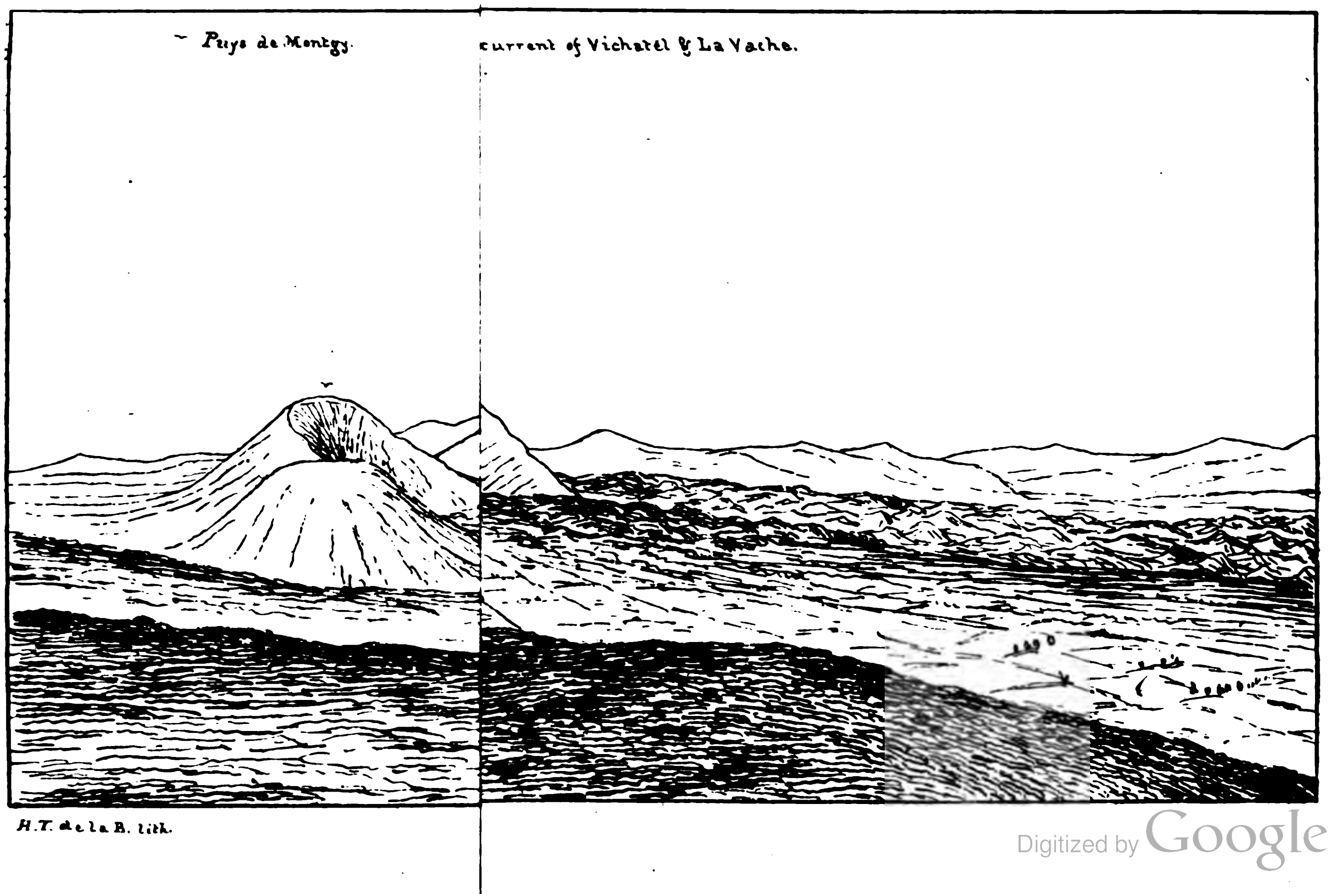
Provence.





ocks.





H.T. de la B. lith.

Cretaceous Group.

Fig. 1.

Section of the Weald.

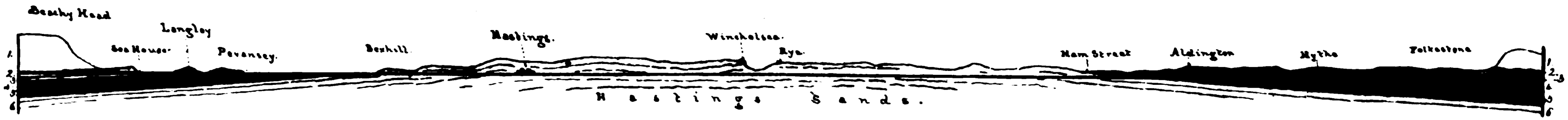


Fig. 2.

Fig. 3.

Roundaway Hill

Fig. 4.

Valley of Orglandes.

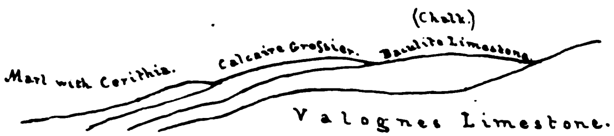


Fig. 7. Quarry at Freville. Cotentin.

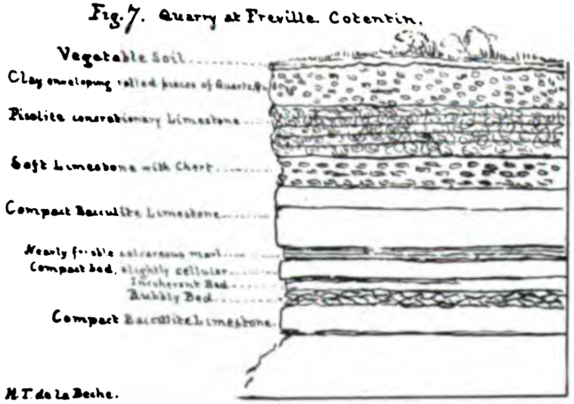


Fig. 5

Chalk & Green Sand near le Havre.

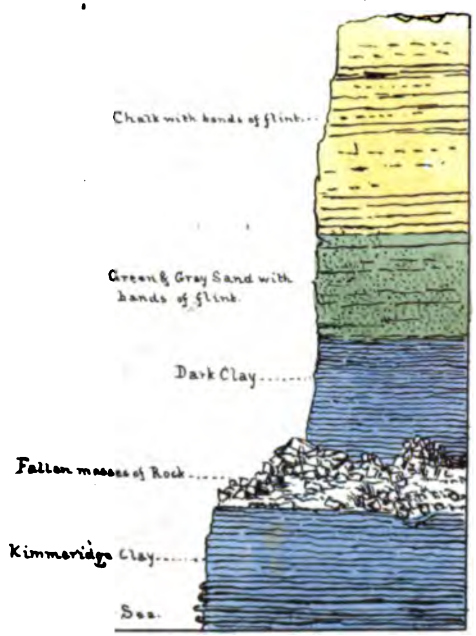
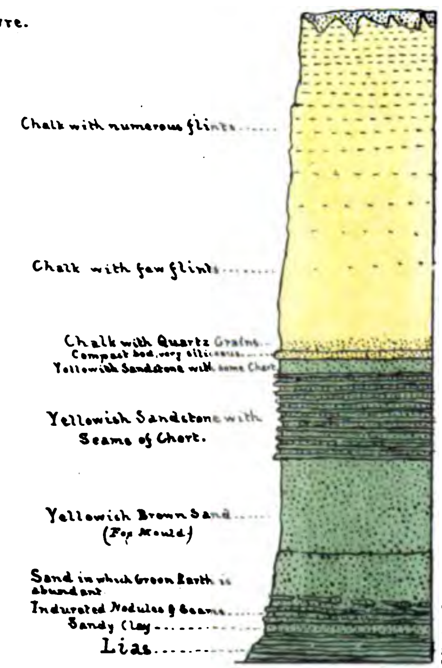


Fig. 6.

Chalk & Green Sand, Lyme Regis.



Rocks of the Oolite Series.

Fig. 1.

Oolite Series between Herbeaumont & Florenville, N. of France.

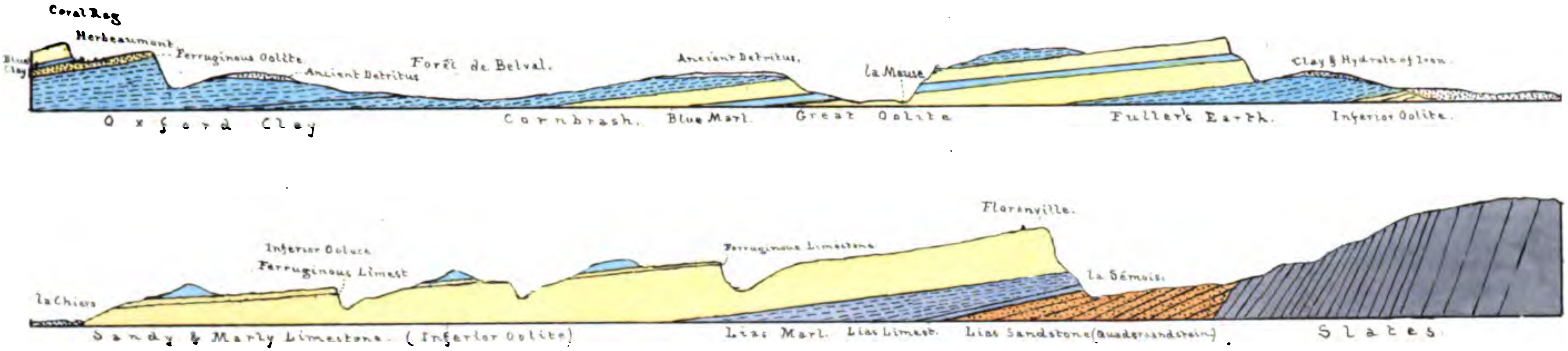
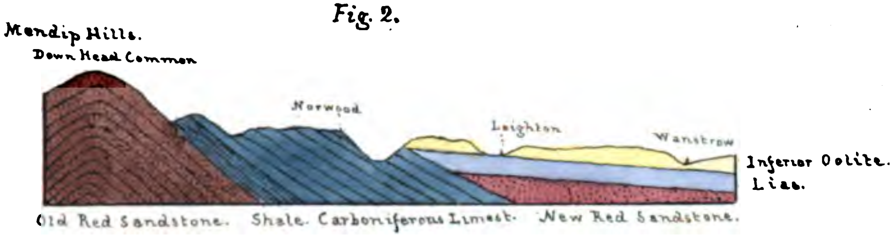


Fig. 2.



The Buet. Fig. 5.

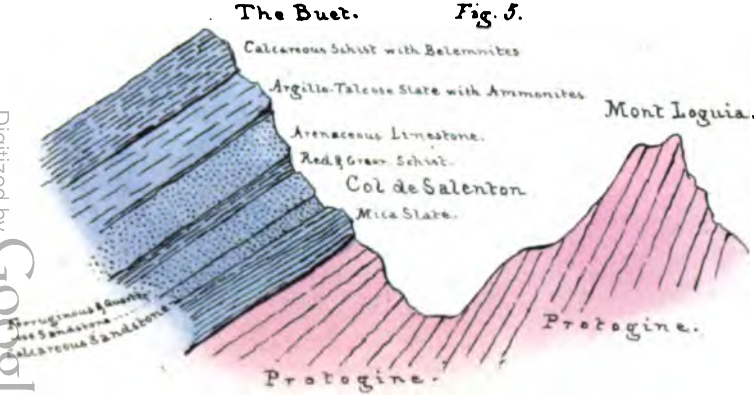


Fig. 3.

Boulby Cliff. Yorkshire.

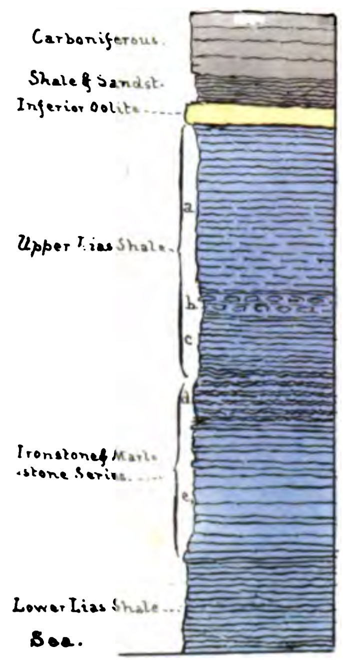


Fig. 4. Stonesfield Slate.

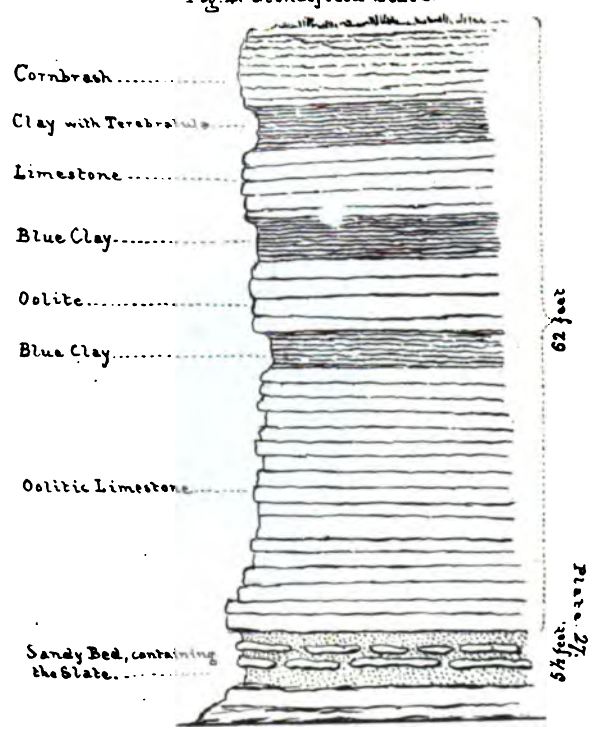


Plate 27.

H. T. de la B.

Red Sandstone Group.

Fig. 1. Depᵗ des Vosges.

Fig. 2. Depᵗ de la Moselle.

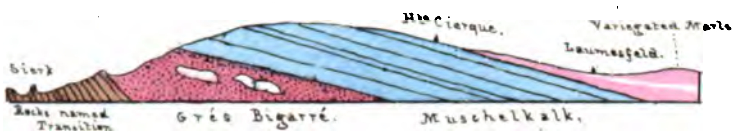
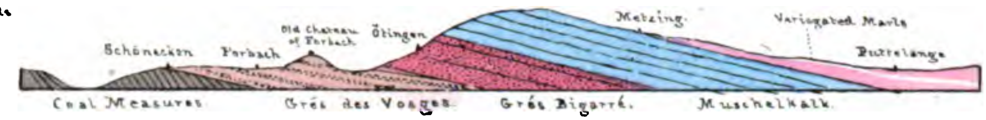


Fig. 3. Depᵗ de la Moselle.



Mines of Riegelsdorf. Fig. 4.

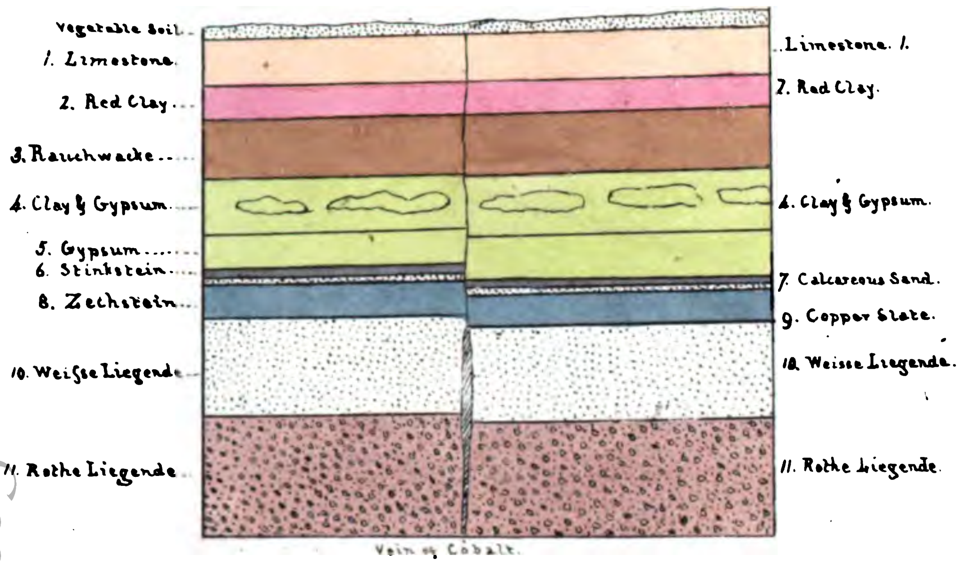
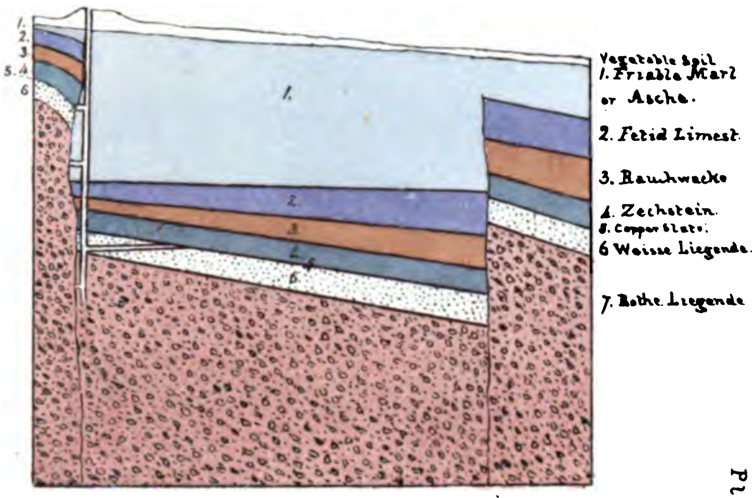


Fig. 5.

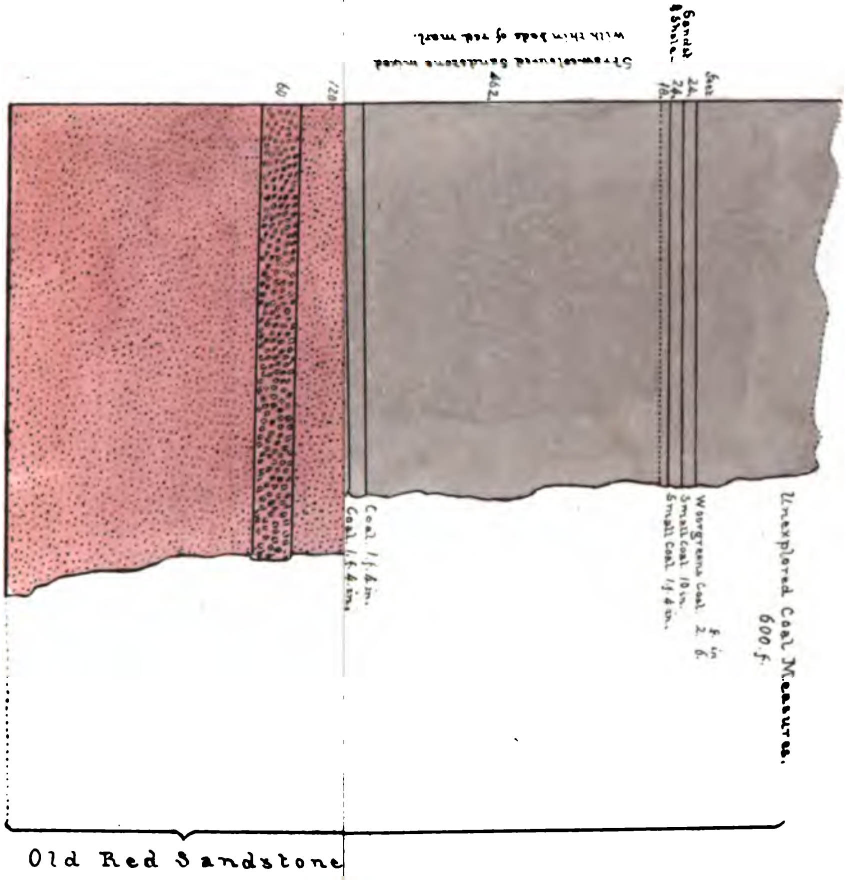
Section in the district of Wetterkreutz.



H.T. de la B.

Plate. 28.

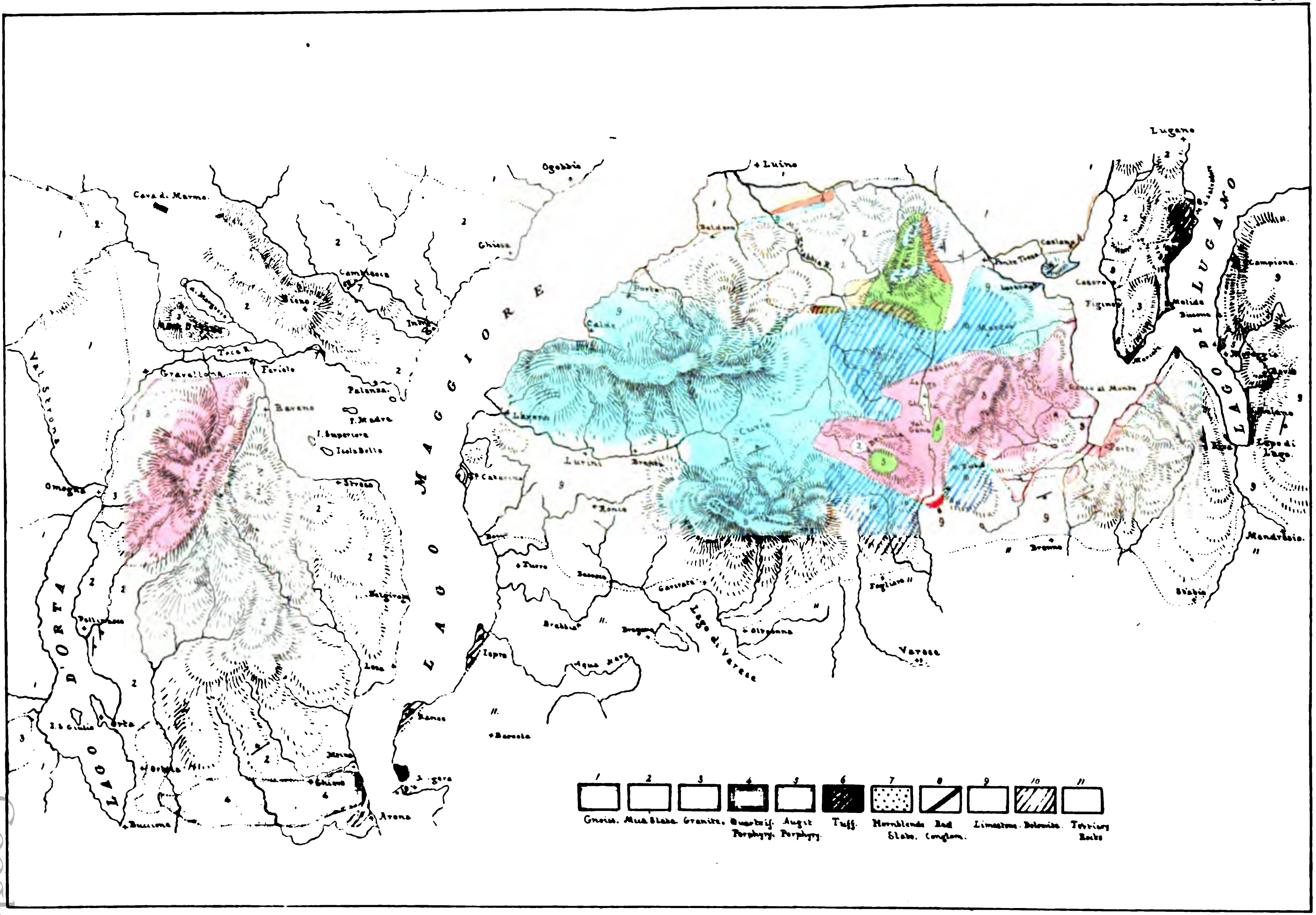
Carb. Limest. & Coal Measures, Forest of Dean.



H. T. de la Beche.

Plate 29

GEOLOGICAL MAP OF THE COUNTRY BETWEEN THE LAKES OF ORTA & LUGANO — BY LEOPOLD VON BUCH.

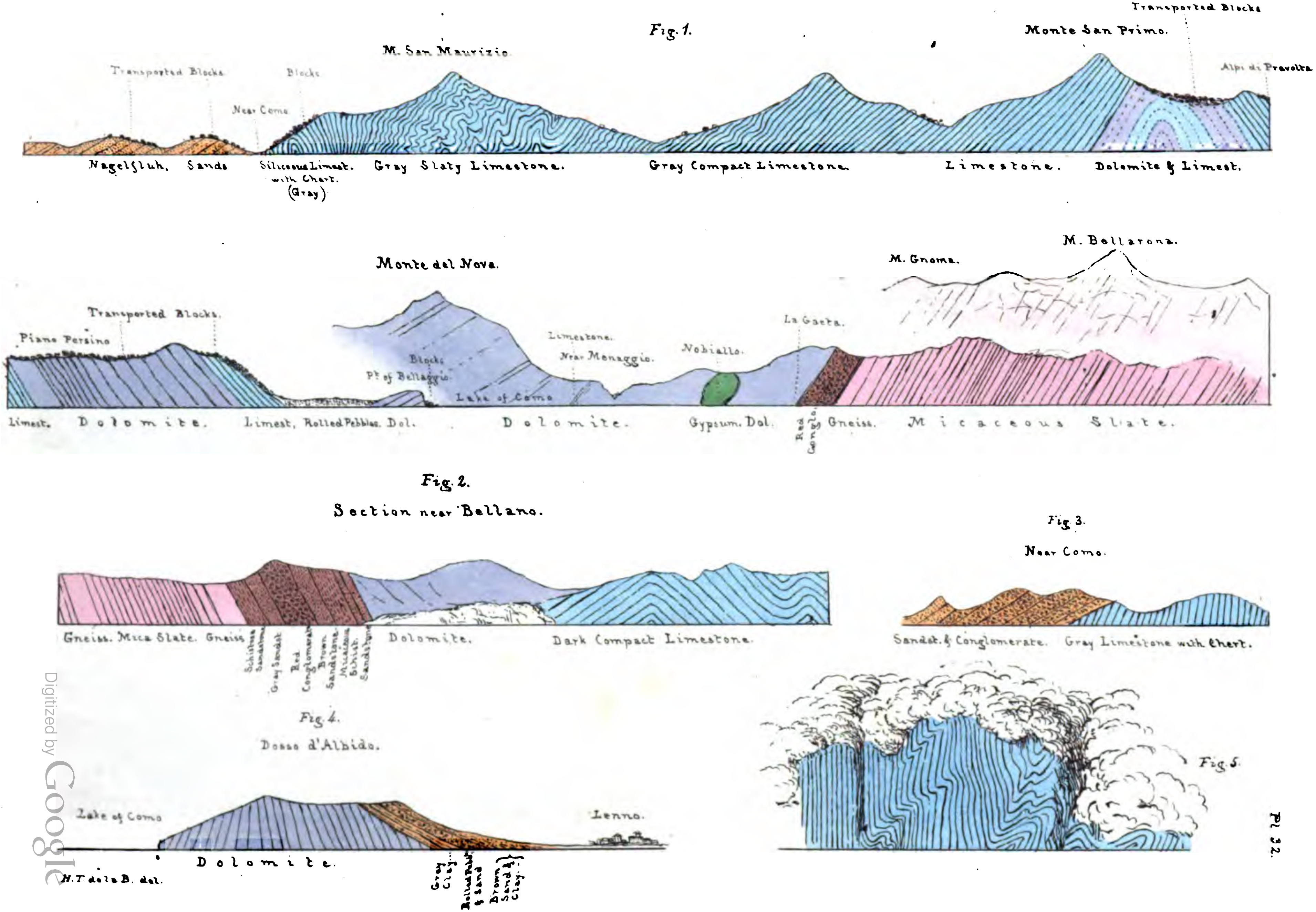


H T de la Beche lithog.

Pl. 31.

Pl. 31.

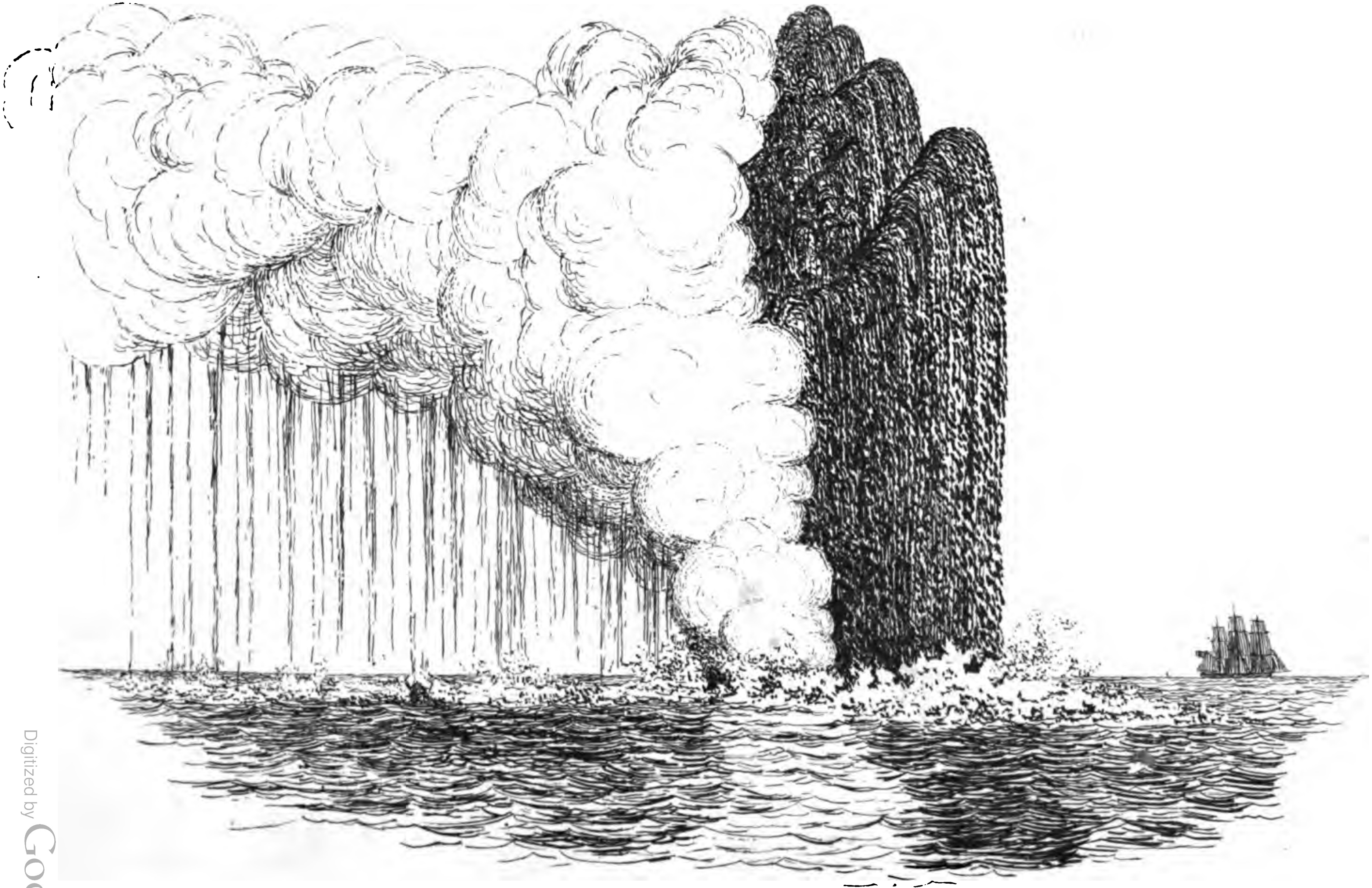
Lake of Como.



Pl 32.

H. T. de la B. lithog.

Fall of the Rouffi or Rossberg, Switzerland.
Sept^r 2. 1806.



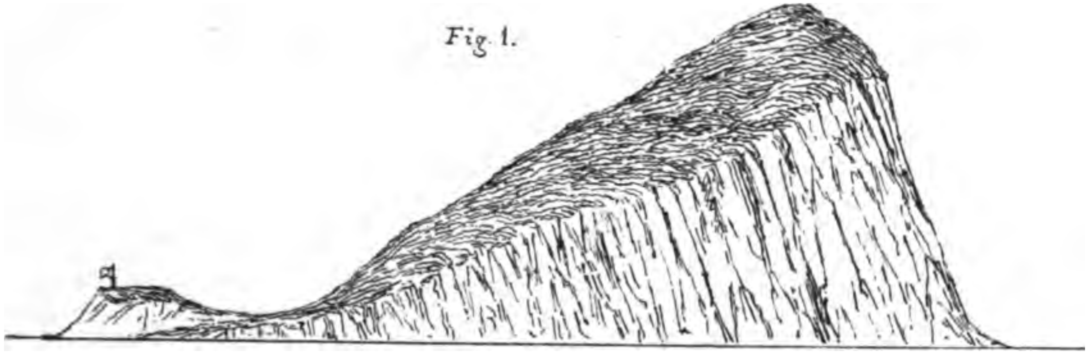
H. T. de la B.

Island of Sabrina.
Thrown up June 13th. 1811.

Effects of existing Causes.

Island of Sabrina.

Fig. 1.



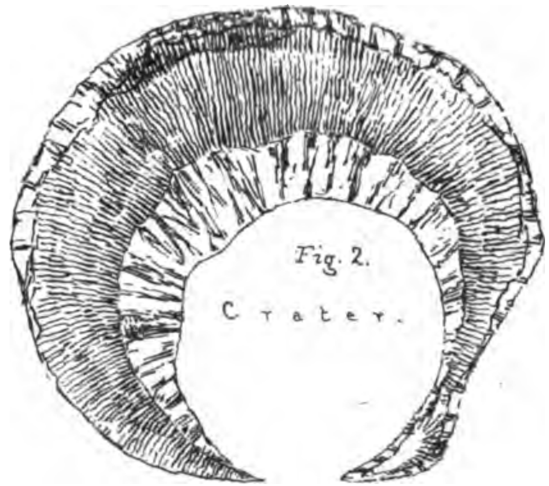


Fig. 2.

Fig. 3.

Pinhay Cliffs, Lyme Regis, Dorset

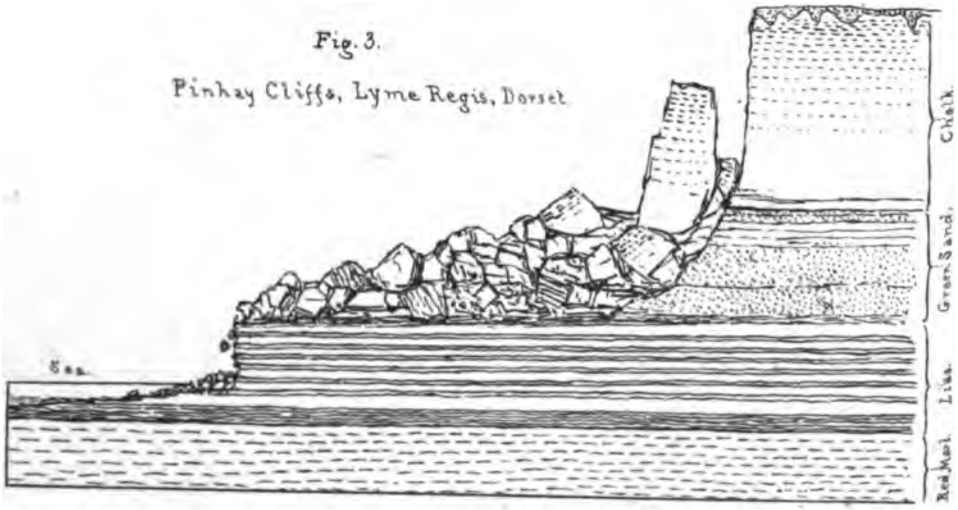


Fig. 4. Shingle Bank between Seaton & the Axe.

Fig. 5. Chesil Bank.

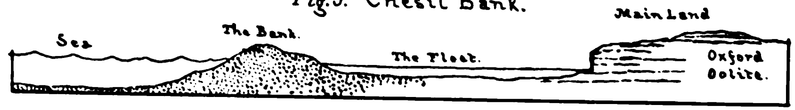


Fig. 6.

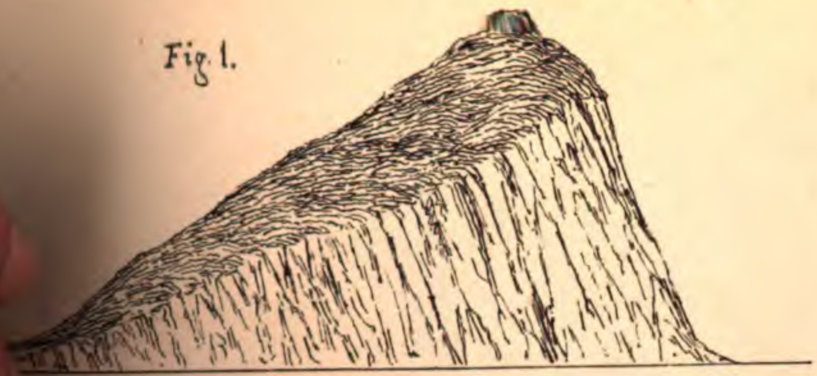
The Ponds, Albion Estate, Jamaica.

H. T. de la B.

Effects of existing Causes.

Island of Sabrina.

Fig. 1.



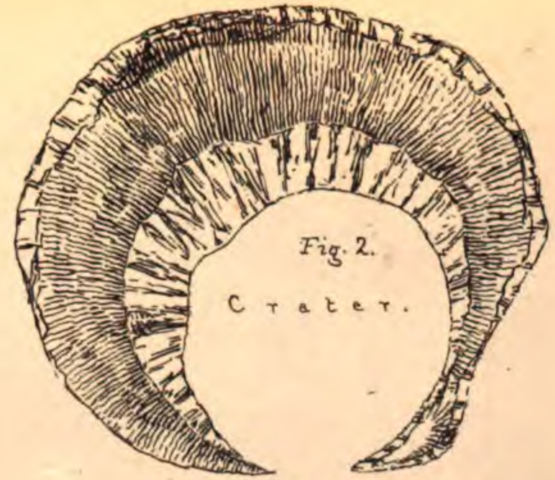


Fig. 2.

Fig. 3.

iffs, Lyme Regis, Dorset.

Fig. 4. Shingle Bank between Seaton & the Axe.

Fig. 5. Chesil Bank.

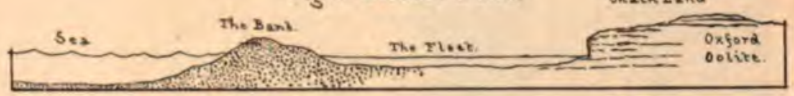
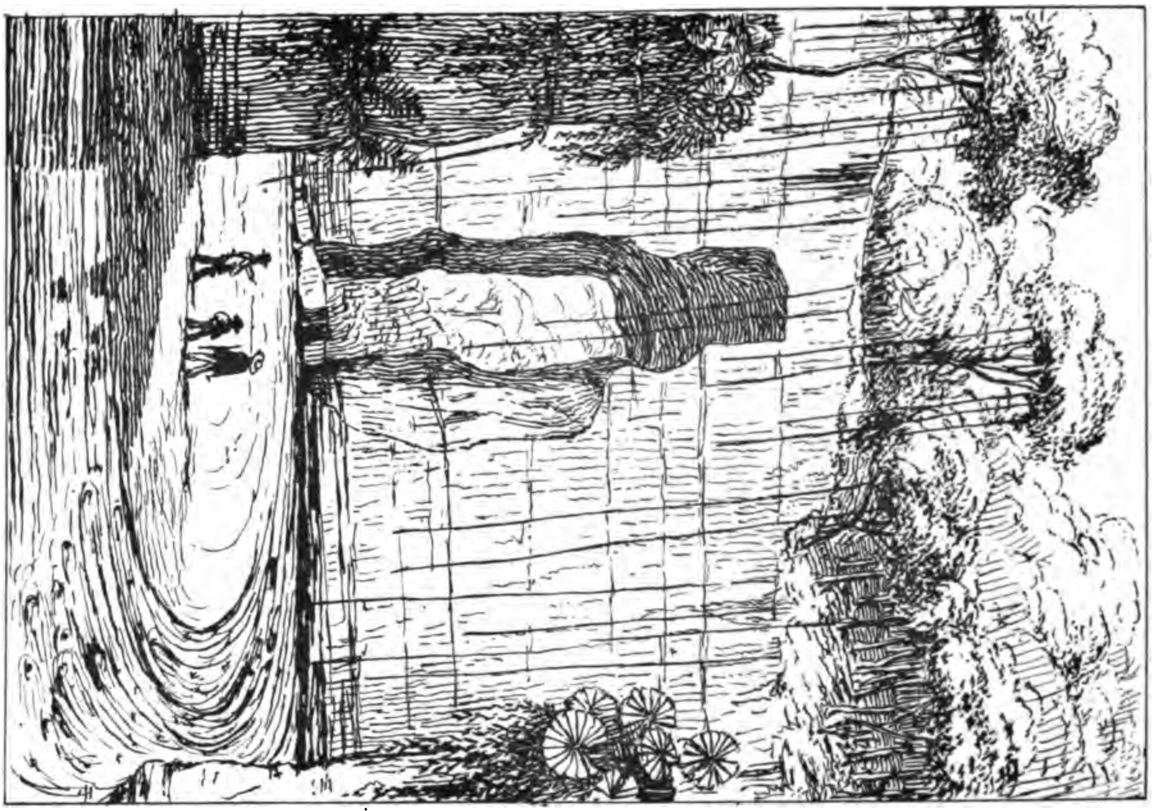


Fig. 6.

The Ponds, Albion Estate, Jamaica.



Natural Bridge, near Mont Olive.
St. Thomas in the Vale.

Island at Old Harbour.

H T de la Beche del

Jamaica.

Fig. 1.
Section from Kingston to Buff Bay.

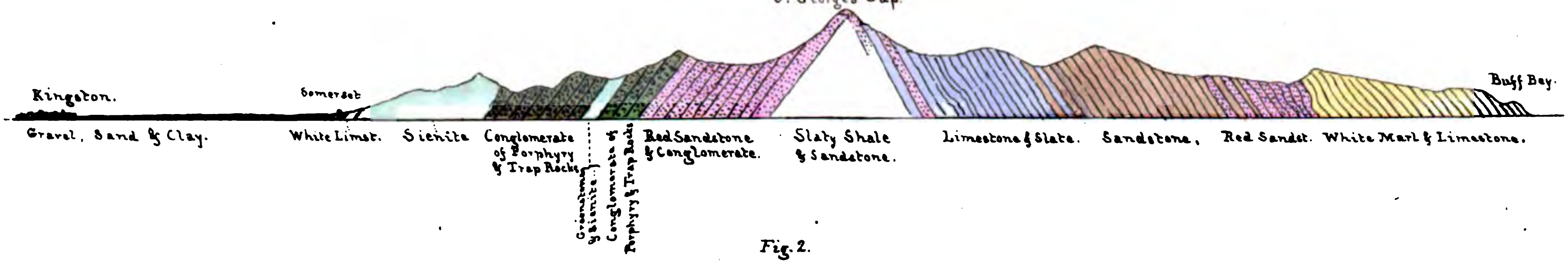


Fig. 2.
Section from near Kingston to the N. coast, St. Mary's.

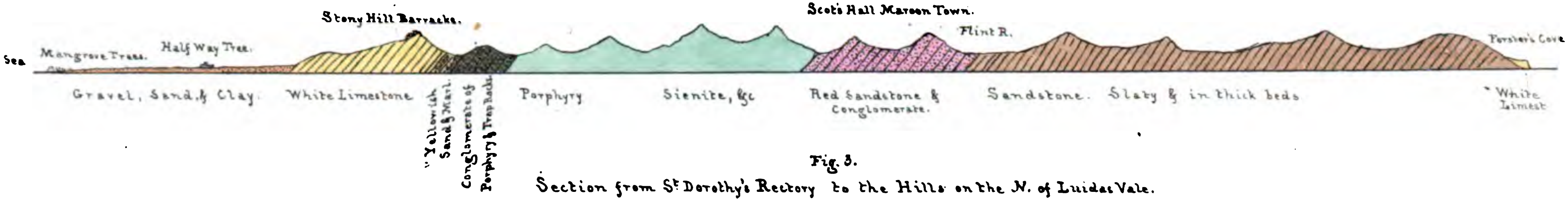


Fig. 3.
Section from St. Dorothy's Rectory to the Hills on the N. of Luidas Vale.

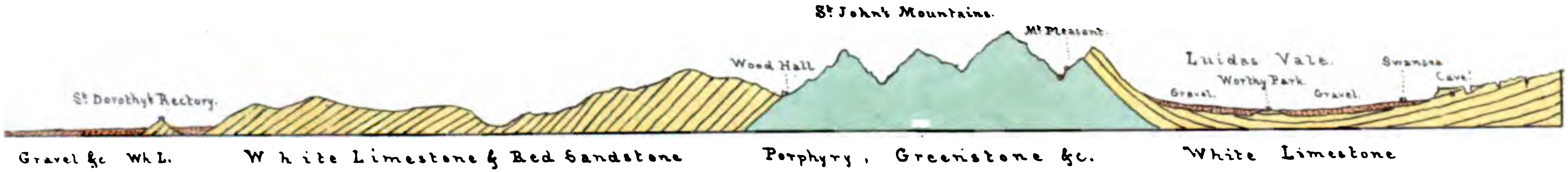


Fig. 4.
Section from the Sea to Catherine's Peak.

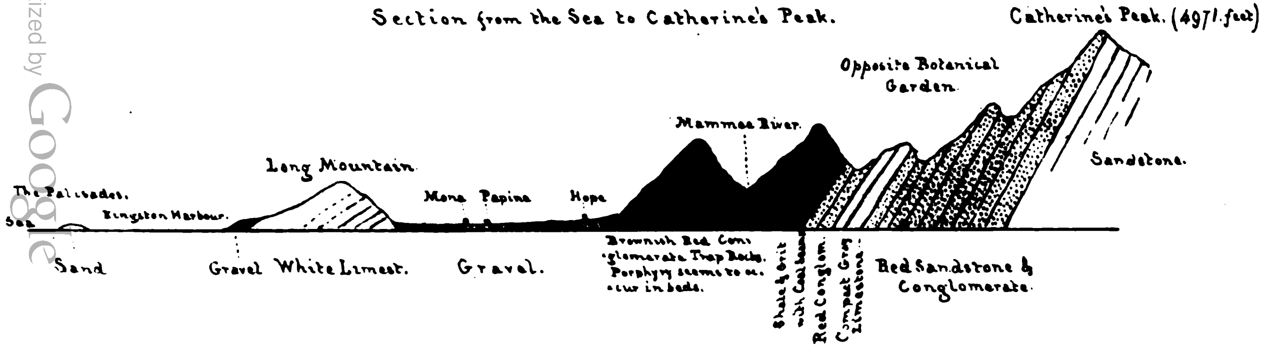
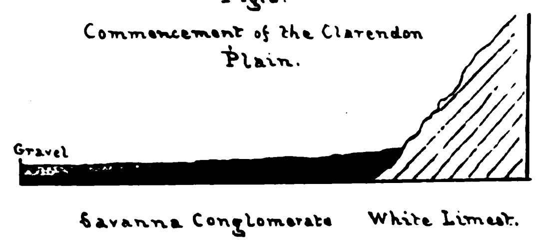


Fig. 5.
Commencement of the Clarendon Plain.



Pl. 37.

H. T. de la B.

Fig. 1.

Consolidated Mines, Gwennap, Cornwall.

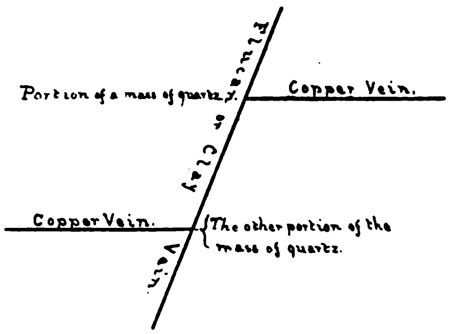


Fig. 2.

Trevaunance Mine, Cornwall.

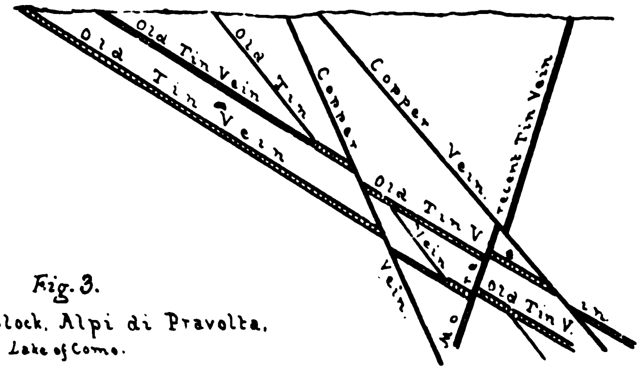
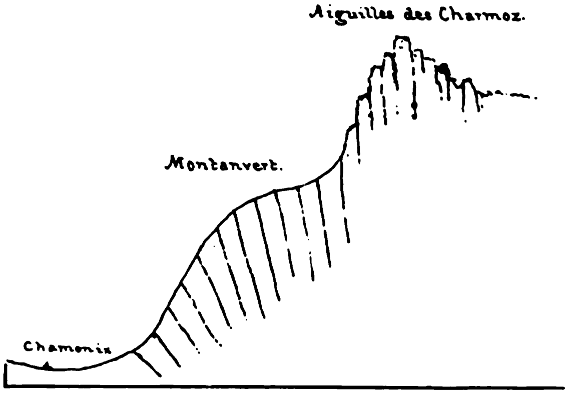


Fig. 3.

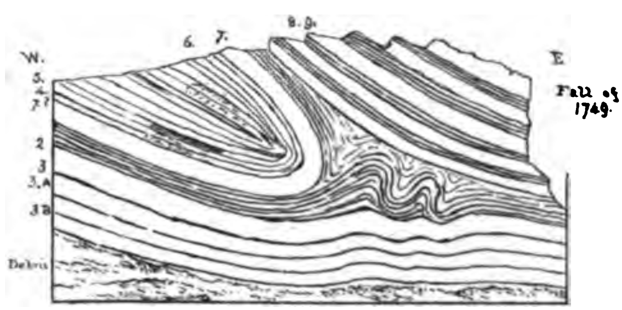
Transported Block, Alpi di Pravolta, Lake of Como.

Fig. 4. Strata of Mont Blanc.



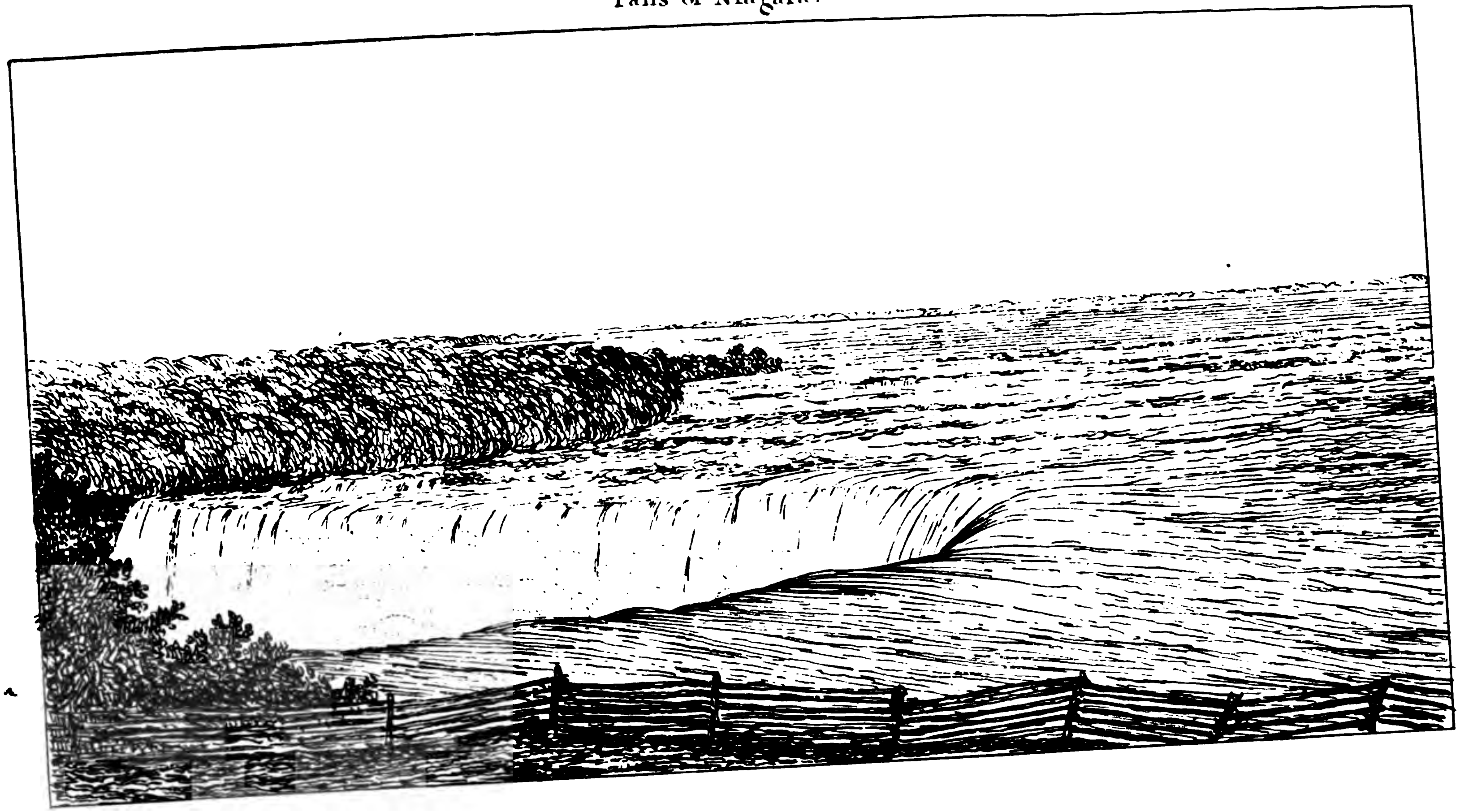
H.T. de la B.

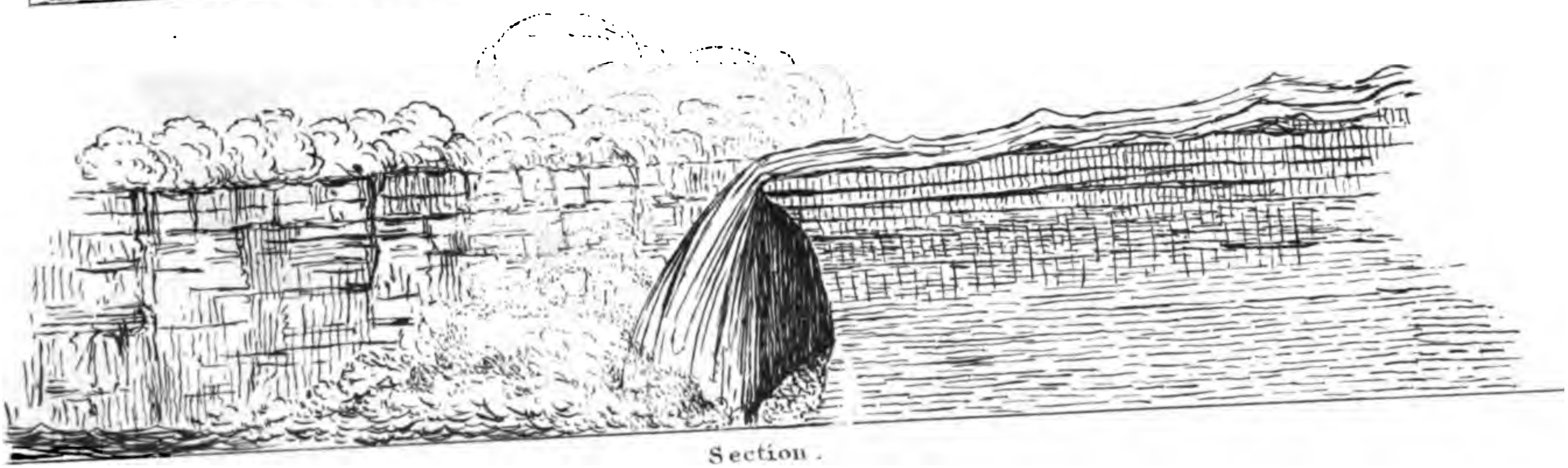
Fig. 5. South Side of the Diablerets. Vallais.



Plateau des Chalets d'Anzeindaz.

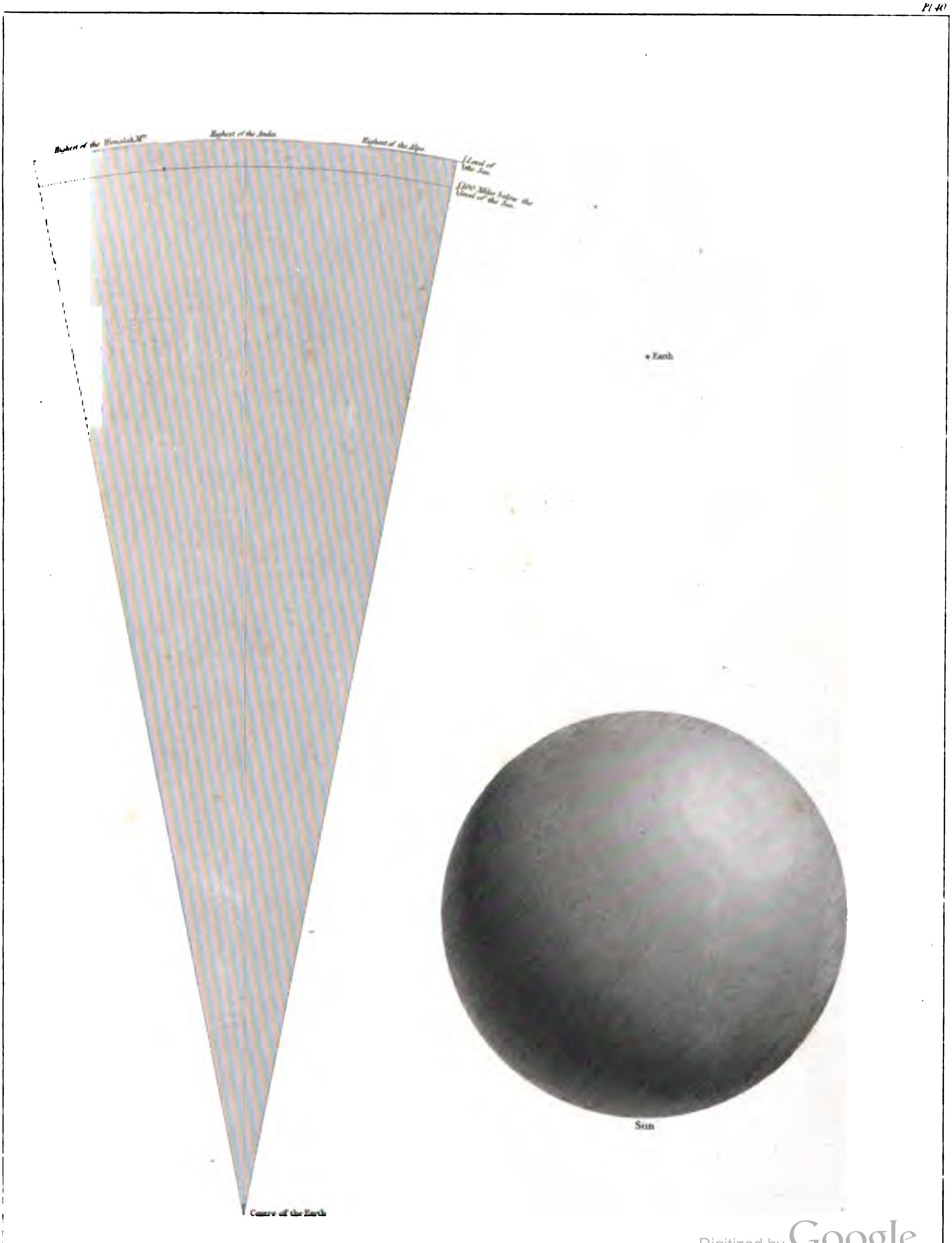
Falls of Niagara.





Section.

H. T. de la B. lithog.



Highest of the Himalah Mᵗⁿ
Highest of the Andes
Highest of the Alps
Level of the Sea.
Miles below the Level of the Sea.
Earth
Sun
Centre of the Earth