

segregation. A paper, on this subject, of Mr. George Maw's, put into my hands in May, 1863, gave me the first suggestion of this possibility.

I shall endeavour, as I have leisure, to present such facts to the readers of this Magazine as may bear on these three enquiries; and have first engraved the plate given in the present number in order to put clearly under their consideration the ordinary aspect of the veins in the first stage of metamorphism in the Alpine cherts and limestones. The three figures are portions of rolled fragments; it is impossible to break good specimens from the rock itself, for it always breaks through the veins, and it must be gradually ground down in order to get a good surface.

Fig. 1 is a portion of the surface of a black chertose mass; rent and filled by a fine quartzose deposit or secretion, softer than the black portions and yielding to the knife: neither black nor white parts effervesce with acids: it is as delicate an instance of a vein with rent fibrous walls as I could find (from the superficial gravel near Geneva).

Fig. 2 is from the bed of the stream descending from the Aiguille de Varens to St. Martin's. It represents the usual condition of rending and warping in the flanks of veins caused by slow contraction, the separated fragments showing their correspondence with the places they have seceded from; and it is evident that the secretion or injection of the filling white carbonate of lime must have been concurrent with the slow fracture, or else the pieces, unsupported, would have fallen asunder.

Fig. 3 is from the bed of the Arve at St. Martin's, and shows this condition still more delicately. The narrow black line traversing the white surface, near the top, is the edge of a film of slate, once attached to the dark broad vertical belt, and which has been slowly warped from it as the carbonate of lime was introduced. When the whole was partly consolidated, a second series of contractions has taken place; filled, not now by carbonate of lime, but by compact quartz, traversing in many fine branches the slate and calcite, nearly at right angles to their course.

I shall have more to say of the examples in this plate in connection with others, of which engravings are in preparation.

II.—ON SUBAËRIAL DENUDATION, AND ON CLIFFS AND ESCARPMENTS OF THE CHALK AND LOWER TERTIARY BEDS.

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[PART II.]

4.—Chalk Escarpments.

THE graceful outlines, smooth curves, and flowing contours of the Chalk hills are well known to southern geologists; indeed these hills are the most marked feature of the south-east of England. Those who hold that their form has been given by the sea, point to

the winding ridge, and say how like it is to many a coast with its succession of capes and coves; even so distinguished a writer as Sir C. Lyell remarking that "the geologist cannot fail to recognise in this view (of part of the South Downs) the exact likeness of a sea-cliff."¹ And truly it is so; but let us examine this likeness more closely, and it will be seen that the argument founded on it, plausible enough on the surface, is superficial only, and fails utterly when rigorously tested.

For this purpose let us place ourselves at some spot whence a large extent of these hills may be seen. None perhaps can be better than the hill crowned by Totternhoe Camp, in Bedfordshire, a projecting spur of the lower ridge of the Chalk (for there are two escarpments in that neighbourhood, one formed by the Chalk Marl and the bottom part of the flintless Chalk; the other and larger by the mass of the latter and the bottom part of the Chalk-with-flints). Thence let us look eastward southward and westward along the higher range, of which a long expanse unfolds itself to the view, across the Thames even to the "White Horse Hill" in distant Berkshire. The screen of even-topped combe-cut hills, shutting off all view beyond, with its succession of swelling headlands and incurved bays, at once impresses the mind with the notion of an old coast-line, and but little imagination is needed to picture the sea beating furiously against the jutting capes, or rippling gently up the sheltered hollows.

But having indulged in a very pleasant day-dream, and transported ourselves for the time to Dover cliffs, Beachy Head, or the great Chalk buttresses of the Isle of Wight, let us descend to sober prose and our mental photograph will quickly fade, and soon be but "the baseless fabric of a vision, leaving not a wreck behind." Reason asks what coast is this ridge like? it is not enough that it should be like a coast, but it should be *like a Chalk-coast*: "it is not a mere resemblance that should correlate different things; there should be a specific character in everything that is to be generalised."² The answer comes at once: it is like a coast along rocks of different hardness (the softer yielding to form bays, the harder resisting to form headlands), and not like one along a rock of much the same nature throughout—it is *not* like a *Chalk-coast*.

Now let us examine the great escarpment more closely. Firstly, we shall find that at its foot there are powerful ever-flowing springs, thrown out generally at the out-crop of the Totternhoe stone,³ which of course contain much carbonate of lime, as is shown by the not uncommon occurrence, further down the streams, of twigs thickly encrusted. Such constant taking away of matter from the Chalk must wear away that rock; and, given unlimited time, is enough to get rid of any quantity of it. This is almost a mere matter of multiplication; if so many tons are carried away in a year, a

¹ Elements of Geology, Ed. 6, p. 359 (1865). Sir Charles now allows, however, that the likeness is deceptive, see p. 449.

² Hutton, "Theory of the Earth," vol. i. p. 489.

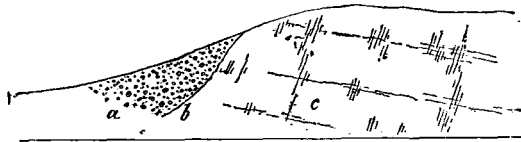
³ The top bed of the Chalk Marl, see Quart. Journ. Geol. Soc., vol. xxii. p. 398.

thousand times as many will be carried away in a thousand years, other things being equal, and so on.

Secondly, if the escarpment were an old sea-cliff weathered down into a slope, it ought to show some such section as that in Fig. 1, in which a *talus* rests against the weathered face of the cliff, only the higher part of the hill being of bare Chalk. But this is not the case; large pits are common along most Chalk escarpments, and they show a more or less clean face of rock from top to bottom. The supposition that subaërial denudation may have cut back the hill, and destroyed the cliff with its *talus* and beach, has been noticed before. I question, too, if there is a known case of an old cliff that has weathered to so long and smooth a slope as that of a Chalk escarpment.

Next let us turn to the country at the foot of the hills, taken up by the flintless Chalk and the underlying beds. What sort of surface-deposit is found there? is it made up of water-worn pebbles like those on our present shores? No indeed, but we commonly find, on the contrary, broken and subangular flints, like those of our old river-gravels, sometimes simply scattered over the surface, at

FIG. 1.—Section of an escarpment on the supposition that it is an old cliff.



a. Talus. b. Face of old cliff. c. Bare Chalk.

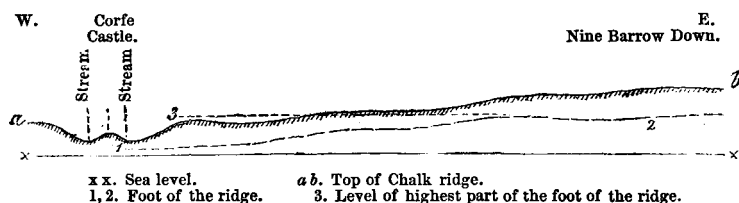
others abundant enough to form small patches of gravel. In Buckinghamshire there are thin spots of such far out on the wide plain of the Gault. What can these flints be but the insoluble residue of the great mass of Chalk that has been slowly dissolved away, not pounded and worn by the waves? the remains of which latter kind of process should be looked for rather in such deposits as the old Tertiary pebble-beds of Kent, and the shingle-flats of the south-eastern coast.

It is not at one spot only that these things may be seen, but more or less along Chalk escarpments generally. In some places too a small stream runs for miles at or near the foot of the ridge: thus a branch of the Mole near Dorking, and a branch of the Stour near Ashford.

[Whilst the first part of this paper was in the press I was taking a holiday-ramble in the Isle of Purbeck, and noticed there a good and marked example of the fact that the bottom of an escarpment is sometimes at a higher level at one place than the top at another. The level of the Chalk ridge falls westward from Nine Barrow Down to Corfe Castle by three sloping steps, giving rise to four different levels (not counting the still lower conical hill on which the castle stands), the western of which is lower than the bottom of the escarpment under the higher parts, as shown in Fig. 2.

This is an exceptional case of quick fall in the level of a Chalk escarpment, and I cannot see how such a ridge can have been formed as a sea-cliff, which has of course a level base. To explain away the difficulty of the rise of the base-line by supposing that there have been local sinkings or upheavals, is a groundless and unwarrantable assumption until such changes have been *proved*, not simply imagined.]

FIG. 2.—Rough outline of the form of part of the Chalk ridge in the Isle of Purbeck.



5.—Tertiary Escarpments.

The escarpment of the Lower Tertiary beds is neither so high nor so steep as that of the Chalk; nevertheless it often forms a well-marked ridge with a somewhat winding course, as on the north and north-west of London, from Rickmansworth to beyond Hatfield, along which line the Colne flows south-westward and the Lea eastward at the foot of the hills, receiving on their way streamlets that run down the slopes and carry off the sand and clay of which those slopes consist. Some of these streams are simply the result of the drainage of a clay-country, others start as springs from the Drift gravel which caps the London Clay on the high grounds, and some end their course in swallow-holes in the Chalk.

The thickly wooded hills of "the Blean," between Canterbury and Faversham, show many examples of swallow-holes, the largest of which have been described by Mr. Prestwich.¹ When near the top one sees springs, thrown out from the gravel by the London Clay, and down the slopes there are small water-courses; but outside the close woods, which end mostly at the foot of the hills, the ground is generally dry, the water having sunk into holes at the junction of the Tertiary beds and the Chalk, which may commonly be seen at the re-entering angles of the line of outcrop of the latter formation. From the southern point of these hills to Grove Ferry and the Reculvers, the London Clay, which forms by far the greater part of that district, is wholly cut off by the Stour and the Wantsume channel, not a particle I believe existing on the right side of the river, and the Oldhaven and Woolwich Beds occur only as outliers; in other words, the left bank of the Stour is an escarpment of London Clay, etc.

In many places the outcrop of the Chalk, and of the beds between it and the London Clay is masked by a loam, which is nothing but

¹ Quart. Journ. Geol. Soc., vol. x. p. 222 (1854).

the "rainwash" of the slopes of clay and sand, and is sometimes thick enough to be worked for bricks. If so much has been left, how much more must have been washed away altogether,—all, be it remembered, being the product of mere surface-denudation.

London Clay hills show many traces of landslips, as may be well seen on the left side of the Lea, where some of the sharper slopes are made quite irregular by the many falls.

Whilst, therefore, Chalk is in great part carried away in chemical solution, the clays and sands of the Tertiary beds are wasted by mechanical means.

Where the dip is at a high angle the Lower Tertiary formations have no escarpments, or, at all events, give rise to but a slight feature, as in the Isle of Purbeck, the Isle of Wight, and Surrey; whilst where the beds are flat, or dip at a very small angle, they have a good escarpment, as in Berkshire, Hertfordshire, and Kent. The great difference which the amount of dip has had in causing the denuding powers to form a flat or a slope may be well seen in the Isle of Wight, where the vertical beds of Alum Bay are in a valley between the Chalk ridge and the rising ground formed by the gently inclined higher series of Headon Hill.

West and north-west of London there is a peculiarity in the range and outcrop of the Lower Tertiary beds worthy of notice here. The escarpment trends nearly north-east and south-west along a line through Twyford, Rickmansworth, and Hatfield, roughly parallel to which, and a few miles from it outward, are a number of outliers (like skirmishers thrown out from the main body) ranged along a line from the hills near Wargrave and Beaconsfield, through Chalfont St. Giles, Sarratt, Abbot's Langley, St. Alban's, Digswell, Datchworth, and Bennington. Again, inwards from the escarpment, but also parallel to it and a few miles from it, there are a few inliers along a line through Windsor, Pinner, and Northaw. The outliers I look on as the relics of a former escarpment, and the inliers as the signs of a future one. The outliers mark a line where denudation has been delayed (I do not say stopped); the escarpment perhaps one where it is now delayed; and the inliers one where it will be delayed (of course on the supposition that no great physical change takes place), when the part between them and the present escarpment will be cut off as outliers. Each of these lines is in great part, I believe, through points where a slight change of dip takes place, which may have in some measure enabled the beds better to withstand denudation in the case of the outliers, or may have made them fall an easier prey to it in the case of the inliers, there being an inward dip in the former and an outward dip in the latter. Further out in the Chalk district there are traces of another line of outliers, better marked westward, along a line through Lane End (near Wycombe), Turville Common, Nettlebed, and Woodcot Common (east of Goring). The inner line merges into that of the escarpment near Reading, and further westward the outer line does so too. I have noticed like arrangements in line in Kent, but none so marked as the above, perhaps because the dip is generally less on

the northern side of the London basin than on the southern, so that the beds have a greater chance of spreading over a wider tract.

Of course delays in denudation may be owing also to change of condition, climatal or otherwise.

6.—*Chalk and Tertiary Cliffs.*

It is usual to talk of cliffs as the work of the sea alone; and those who say that subaërial actions are too weak to do the work of denudation in forming hills and valleys are wont to point to what is now going on along our shores as evidence that the sea and the sea only is nature's great tool for making ridges. I am willing however to meet them on their own ground, thinking that if it can be shown that the sea *alone* does not make the cliffs, but is very largely helped by those atmospheric actions which they despise, their statements as to the powerlessness of those actions will have all foundation destroyed, and will therefore fall to the ground, carrying with them the theories which they support.

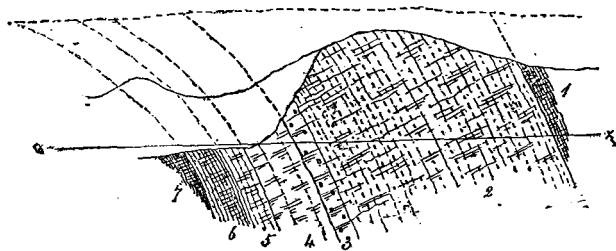
Let us examine the Chalk-coast of Kent. The cliffs are for the most part nearly vertical; indeed I can call to mind but one place where this is not the case, the well-known Shakspeare's Cliff, the higher part of which is a sharp slope, whilst near the bottom it is slightly overhanging (on account of a hard bed which stands out). Sometimes they are quite vertical; hardly ever are they undermined. Now if made by the sea alone, which can act only at their base, surely they should mostly overhang; but, in fact, they often project slightly at the bottom by a series of small steps. It is clear therefore that the upper part wears away as quickly as the lower, and as the sea can hardly attack the top of the cliff, one hundred feet or more high, one must look about for some other wearing power that can.

For that purpose let us go to the cliff-top and see what is going on there. We shall find that the action of the weather is nearly everywhere separating masses of Chalk, some of which, from the slow dissolving away of the surrounding rock, stand out for many years as pinnacles or needles, whilst others are soon hurled to the bottom. Where the Chalk is most jointed there of course the power of frost has most chance of showing itself: where too there are large pipes of sand and clay in the Chalk small needles are common along the top of the cliff, as in parts of the coast of Normandy.

When the softer and more yielding beds below the Chalk crop out near the base for some distance, the fall of the cliff sometimes takes place on a very large scale, and "undercliffs" are formed. Thus at Folkestone the porous yielding Upper Greensand has given way to the influence of springs and to the pressure of the great overlying mass of rock, which has in consequence slid down over the moist slippery surface of the Gault. The undercliff of the Isle of Wight is far longer and broader, and the nearly vertical cliff of hard Upper Greensand, which has resulted from its formation, is at a great height above the sea and often a third of a mile distant therefrom, so that no one can well call it a sea-cliff.

In Kent the Chalk escarpment and the Chalk cliff cut one another obliquely, whilst at the western end of the Isle of Wight the two are for a wonder parallel; but alas for the advocates of the marine formation of escarpments! this latter case in no way helps their theory, for putting aside the consideration of the fact that the cliff leaves the Chalk and turns southwards to cut through lower beds, one can see at a glance that the formation of the cliff has in great part destroyed the feature of the escarpment, of which only the curved top remains, as shown in the section below. Moreover

FIG. 3.—Section showing the relation of the Chalk cliff and the Chalk escarpment in the Isle of Wight. s. n.



Scale about six inches to a mile.

- | | | |
|--------------------------|--------------------------------------|---------------------------|
| 1. Lower Tertiary beds. | 2. Chalk with many layers of flints. | 3. Chalk with few flints. |
| 4. Chalk without flints. | 5. Chalk Marl. | |
| 6. Upper Greensand. | 7. Gault. | x x. Sea-level. |

The broken lines show the form of the ground and the continuation of the beds, which must have existed before the sea-cliff was worn back into the escarpment, and which correspond to the same as they now exist in those parts away from the sea.

The dotted lines show the further extension of the beds until cut off by the "plain of marine denudation" made before the exposure of the land to subaërial actions.

the sea has utterly destroyed the Chalk ridge between the Needles and Handfast Point in Dorsetshire. Along all Chalk-coasts, indeed, the antagonism of the two denuding powers is well shown, the sharp cliffs cutting across the gently curved outlines of hill and valley that have been caused by long continued subaërial actions, the sea levelling what these have furrowed.

Let us now turn to the Tertiary coast of Kent. The foreshore of the Isle of Sheppey (and also of the greater part of the mainland from Whitstable to beyond Herne Bay) consists of a plain of London Clay sloping gently seawards. The cliffs are mostly sharp irregular broken slopes, not altogether cut out by the sea, but formed by the slipping downwards of masses of London Clay and of the overlying Bagshot Sand and Drift gravel, which last two form a more vertical ridge at the top of the slope.

Now it is clear that the waves do not rush up to the top of the cliff and bring down the clay sand etc., but that the fallen masses owe their fall to frost, rain, and heat: the heat of summer to dry up the beds, and by shrinkage to form fissures down which the rain may soak; rain to soften and make slippery; frost to divide mass

from mass by its irresistible expansive power. That the slips take place from the top is indeed well known, and good figures of one of them have been given by Mr. Redman.¹ I have myself seen a large and fresh one, and noted the occurrence of a crop of wheat some way down the slope.

The coast from the Reculvers westward for about two miles is of a somewhat different character, by reason of the rise of the sandy beds below the London Clay; but still the waste of the cliff is from the top, masses of the clay being constantly thrown down to the foot. The shape of the cliff is often different, the clay forming a slope at the top and the sands a more or less vertical wall below. Another agent too comes into play here—the wind, which when strong blows away much of the fine loose sand (Oldhaven Beds²) next below the London Clay. At Oldhaven Gap there is a well-marked cliff running inward from the shore at right angles, and with a broken slope on the other (eastern) side. This “chine,” which is about 300 yards long, and the bottom of which is but little above high-water-mark, has clearly been formed by land-water, although for the greater part of the year the insignificant watercourse along it is quite dry, for the sea has never touched its base, and I believe that it has been cut farther inland within the memory of man.

The sea, therefore, does not *by itself* destroy the land, but is largely helped by atmospheric actions. The former carries away what the latter bring within its reach. Without the help of rain, frost, etc., the sea would spend its force on compact and therefore on comparatively unyielding rocks: without the help of the sea these subaërial forces would soon mask solid cliffs with slopes of débris, and thus vastly decrease their own destructive power. The two destroying powers working together in different ways, the sea horizontally from below, the other set of agents vertically from above,³ cause tenfold the destruction of coast that either could do alone.

Most observers indeed are more or less agreed as to the waste of some cliffs from above, though so far as I know, this knowledge of the power of surface-actions on the coast has not been applied to the question of denudation. Sir C. Lyell indeed has said in his last work, that “the waste of the cliffs by marine currents constitutes on the whole a very insignificant portion of the denudation annually effected by aqueous causes . . . the action of the waves and currents on sea-cliffs, or their power to remove matter from above to below the sea-level, is insignificant in comparison with the power of rivers to perform the same task.”⁴

7.—Comparison between Cliffs and Escarpments.

From what has been remarked above therefore it is clear that

¹ Proc. Inst. Civ. Eng. vol. xxiii. p. 186, 1865, where, and in an earlier paper by the same author (ibid. vol. xi. p. 162, 1854), the destruction of the South-east coast of England is well treated of.

² Quart. Journ. Geol. Soc. vol. xxii. p. 412.

³ See Jukes, Brit. Assoc. Rep. for 1862, Trans. of Sections, p. 61.

⁴ Principles of Geology, Ed. 10, vol. i. pp. 565, 570 (1867).

rivers often run along the foot of Chalk and Tertiary escarpments, whilst, on the other hand, it is very rare for the sea to do so.

Again, an escarpment is remarkable for the comparatively uniform level of its top for long distances, any change therein being by a gentle slope; whilst the height of a range of cliffs is ever varying, and that suddenly and with sharp slopes. Escarpments, too, are nearly always the highest part of a district, the ground falling from them on both sides; cliffs, however, are very rarely so, but are often backed by higher ground; indeed those cases that I know of Chalk cliffs being through the highest ground are just where they cut through the escarpment, as on the north of Folkestone and at Beachy Head. The same kind of reasoning that has been used with reference to the features of the Chalk and the Tertiary beds may be applied to other formations; and how, therefore, an escarpment can be an old sea-cliff passes my understanding, for the two have nothing in common and much in opposition, as may be clearly seen from the following table:—

COMPARATIVE TABLE OF THE DISTINCTIVE FEATURES OF ESCARPMENTS AND CLIFFS.

ESCARPMENTS.	CLIFFS.
(a) Run along the strike, or in other words, keep to one formation throughout.	(a) Rarely run along the strike, but at all angles to it, and cut through many formations in succession.
(b) Tops more or less even and nearly flat.	(b) Tops mostly very uneven.
(c) Form the highest ground of a country, overlooking other parts.	(c) Rarely through the highest ground of a country, but mostly backed by higher ground.
(d) Very rarely have the sea at their foot, but often springs and watercourses.	(d) Sea at their foot.
(e) Often run in more or less winding lines.	(e) Run nearly straight, or in curves of very large radius, when through homogeneous rock, and when not broken through by valleys.
(f) No beach at their foot.	(f) Mostly a beach at their foot.
(g) Are now being destroyed by the sea in places where the sea touches them.	(g) Are now being made by the sea (aided by atmospheric actions).
(h) Bases rise towards the watershed and have nothing to do with the sea-level.	(h) Bases at the sea-level.
(i) Those of successive formations run in more or less parallel lines for long distances, with plains, vales, or valleys between.	(i) No such parallel arrangement known, long fringes of land divided by belts of sea not being common, except in such cases as Coral Islands, where the features have been caused by growth, not by decay.

What can be more different than these two? It is for those who say that escarpments are old sea-cliffs to answer the question, and until that has been done they have little reason on their side.

8.—Conclusion.

All geologists know that rivers have made great deposits, as for instance the Wealden Beds, and therefore I do not see how they can avoid allowing that rivers, etc., have been the agents in effecting a great amount of denudation. The solid matter of the Wealden Beds must have existed somewhere before, and must have been worn away by subaërial actions and carried off by streams (the sea being quite

out of the question): more too must have been worn away than was deposited afterwards by the rivers, for much would be carried out to sea to form a marine deposit. Of course freshwater beds are both less common and thinner than marine beds, but so also, as aforesaid, the comparatively trifling denudation that has formed our hills and valleys is of far less amount than that which has planed down vast tracts of country and carried off therefrom a great thickness of rock. Perhaps, indeed, the proportion that the effects of marine denudation bear to those of subaërial denudation is not far from the same as that which marine deposits bear to freshwater deposits.

To those who say that subaërial agents are too small and too weak for the work which has been put to their credit, it may be answered that unlimited time would get over that difficulty; and it should be borne in mind that good evidence has been brought forward that in late geological times our climate was far more severe than now, and that there may have been a far more rainy period before the present order of things was established; or in other words, that the agents in question were far more powerful than they now are in these islands. Great change indeed has taken place in historic times; the felling of forests, the draining of land, the embanking and canalization of rivers, the reclaiming of marshes, and the like human handiworks having had their effect in lessening rainfall and floods, and therefore also the wearing action of surface water.

As astronomy has proved the existence of almost boundless space, so geology needs almost boundless time. The former science gives us our liveliest picture of infinity, and the latter our best idea of eternity. When astronomers talk without any opposition of immeasurable space, surely geologists should be allowed immeasurable time. The last Wollaston Medallist has eloquently said, "The leading idea which is present in all our researches, and which accompanies every fresh observation, the sound which to the ear of the student of nature seems continually echoed from every part of her works is Time! Time! Time!"¹

Lastly, it seems to me that the discussion on the question of denudation has been argued on a wrong foundation. Surely, if we can explain the facts and appearances we see by actions and operations that can be seen going on at the spot now, we are bound to take such explanation until it can be disproved, or until a better one can be given, and we have no right to call in the aid of other and distant operations, without there is some good sign of their having been once present (thus for instance with regard to many rock-basins now far from glaciers, there are unmistakable signs of their once having contained ice). As a simple matter of reasoning therefore, apart from all scientific truth, we are bound to accept the theory of subaërial denudation until it can be put aside. Geologists should not call on those who hold it, and who show its agreement with things seen, to disprove other theories; but rather should expect its adversaries to disprove it, and to show firstly, that rain,

¹ Scrope, "The Geology, etc., of Central France," Ed. 2 (1858), p. 208.

rivers, ice, springs, damp, and frost are powerless to wear away rocks and to cut out escarpments valleys and rock-basins; and secondly, that the sea can do and does such work. This, no light task truly, must be done, if it can be done, not by mere assertions of individual opinion, or mere statements based on hasty and prejudiced observations, but by hard work and sound reasoning. Not with us, but with our opponents, lies the *onus probandi*.

ERRORS IN THE FIRST PART OF THIS PAPER.

Page 451, line 16 from bottom, for “action” read “actions.”

Page 451, line 11 from bottom, for “Portland Stone in part of the Isle of Purbeck” read “Purbeck and Portland Beds in Dorsetshire.”

Page 453, line 15 from bottom, after “follow” insert “us.”

III.—ON THE “LINGULA FLAGS,” OR “FESTINIOG GROUP” OF THE DOLGELLY DISTRICT.

By THOMAS BELT, F.G.S.

[PART I.]

THE strata lying above and below the *Lingula Flags* have already been well described and illustrated: the Menevian Group below, by Messrs. Salter and Hicks, and the Tremadoc Group above, by Messrs. Homfray, Ash, and Salter. The great mass of strata lying between has not fared so well, though several notices of it, to which I shall refer, have appeared. In the present paper I propose to describe these strata in detail; and the remarks I have to offer embody the results of three years' researches, during part of which I have had the advantage of the company and able co-operation of Messrs. Ezekiel Williamson and J. C. Barlow, whose discoveries I shall have to mention in my description of the rocks and their fossil contents. To facilitate the study of the district around Dolgelly, which is exceedingly faulted and complicated, I have carefully mapped out nearly the whole of the rock exposures. This may seem to have been unnecessary, seeing that we have already the Geological Survey maps of the district. But since the officers of the Survey examined and mapped out the rocks of Merionethshire, from fifteen to eighteen years have elapsed, and the maps which then added so much to our knowledge are now far behind our requirements. The whole of the strata lying between the Tarannon shale and the Cambrian grits are there coloured alike. Neither the Arenig nor the Tremadoc rocks are recognised; and we now know that the strata there named “*Lingula Flags*” include at least three distinct and diverse groups.

In 1847 Professor Sedgwick separated the Tremadoc rocks from the “*Lingula Flags*,” calling the latter the Festiniog Group. Since then Mr. Salter has been the pioneer in their investigation. His discovery in 1863 of *Paradoxides Davidis* in the slates of St. David's gave an impulse to the study of these old rocks, that has resulted in a rich harvest of Primordial trilobites, chiefly through the indefatigable