will show that out of forty-three species which I enumerate as British, thirty-five occur in Belgium, viz., *Spirifera striata*, *S. Mosquensis*, *S. humerosa*, *S. duplicicosta*, *S. crassa*, *S. bisulcata*, *S. grandicostata*, *S. trigonalis*, *S. convoluta*, *S. triangularis*, *S. mesogonia*, *S. laminosa*, *S. distans*, *S. cuspidata*, *S. pinguis*, *S. ovalis*, *S. planata*, *S. integricosta*, *S. triradialis*, *S. rhomboidea*, *S. lineata*, *S. Urii*, *S. glabra*, *S. octoplicata*, *S. insculpta*; *Cyrtina septosa*; *Athyris planosulcata*, *A. lamellosa*, *A. Roysii*, *A. squamosa*, *A. globularis*, *A. ambigua*, *A. subtilita*; *Retzia radialis*, *R. ulotrix*; and that Belgium possesses ten or eleven species which do not occur or have not hitherto been discovered in our British isles, namely, *Spirifera pectinoidea*, de Kon.; *Sp. ornata*, de Kon.; *Sp. Fischeriana*, de Kon.; *Sp. acuticostata*, de Kon.; *Sp. Roemeriana*, de Kon.; *Sp. Schnuriana*, de Kon.; *Sp. ventricosa*, de Kon.; *Sp. glaberrima*, de Kon.; *Sp. cheiropteryx*, de Verneuil; *Sp. Bronniana*, de Kon.; and *Retzia serpentina*, de Kon. Many new and original ideas regarding the stratigraphical distribution of the species by that distinguished Belgian *savant* are also there introduced, to which I would recommend the attention of those who may feel interested in the subject.

In an illustrated catalogue of all the Scottish species of carboniferous Brachiopoda at present known, now preparing for The Geologist, I shall have occasion to revert to the two contemporaneous (?) carboniferous faunas discovered in Belgium by Prof. de Koninck, which he has designated as the *Fauna of Visé*, and the *Fauna of Tournay*, and which he believes to have recognized also in Great Britain.

THE SPIRIT OF GOOD BOOKS.

ON LAVAS OF MOUNT ETNA FORMED ON STEEP SLOPES AND ON CRATERS OF ELEVATION.

By Sir Charles Lyell, F.R.S., D.C.L.: London, 1859.

(*A Paper read before the Royal Society*, 10*th June*, 1858.)

For some years past it has been a commonly received doctrine among continental geologists that lava-streams could not consolidate on slopes or declivities of more than five degrees. When, then, solid lavas were found in various volcanic mountains at high angles, other sources of origin than the mere outflow from their respective craters had to be sought; and thus arose the theoretical idea of the formation of the cone or crater at a late period of the volcano's existence—after for ages numerous lava-streams had issued from it and had become consolidated one over the other into stony beds on successive flat plains—by the uprise and bursting of a vast dome or bubble; and such was called a "crater of elevation".

So commonly in England have we been accustomed to regard the great mountain-mass of every volcano as successively and continuously built up by the lavas and scoriæ rejected from its orifice, that we observe with astonishment the prevalence to which the "crater of elevation" doctrine, by being favoured by Humboldt and Von Buch, and some other great authorities, has attained.

Sir Charles Lyell early observed the danger of allowing this erroneous doctrine to hold its way, or to spread, and from the first edition to the ninth of his "Principles of Geology," he opposed its tenets; and, especially after his return from Madeira, in 1852, he controverted its essential point by some well-selected instances of stony lavas consolidated at steep angles.

Apparently feeling, however, the necessity of grappling with and thoroughly exploding this patronized falacy, Sir Charles, in 1857, visited Etna, and obtained conclusive examples of the capability of lavas forming stony masses on slopes of not less than from 40 to 47 degrees, an account of which he laid before the Royal Society. In October, 1858, Sir Charles again visited Etna, and obtained further confirmatory proofs, which have been engrafted on his original memoir, and appear in the last part, recently issued, of the Philosophical Transactions.

As the "crater of elevation" theory is built entirely upon the assumption that lavas will not consolidate on steep slopes, it is evident that, by attacking and demolishing the foundation, the superstructure must fall, and thus the chief object of Sir Charles Lyell's two visits to Etna was to collect evidence of the consolidation of lavas which flowed down declivities at high angles into tabular stony masses.

The first example given is the highly-inclined stony lava of Aci Reale.

The town of Aci Reale stands on the top of a cliff in which a platform, elevated at some points more than 650 feet above the sea, ends abruptly. The slope of this platform is usually about three or four degrees, and is prolonged two or three miles inland, while the cliff between the town and the sea consists of irregular precipitous terraces, and exposes on its face the truncated edges of several lava-currents, which were noticed by the Canon Recupero in his "Storia Naturale dell' Etna," to which the traveller Brydone called attention in England in his "Letter on the Two Sicilies."

In the face of this steep escarpment, facing the sea, an indentation, near the Bastione del Tocco, affords a longitudinal section of one of these lava-currents dipping east at from 23 to 27 degrees, and presenting all the usual characters of an upper and under scoriæ with a central stony mass.

This case is supported by another still more remarkable and decisive instance, in a branch of the great stream of 1689 which cascaded into the Cava Grande. The lava there consolidated into a central stony mass on an inclination of 35 degrees.

During the eruption of 1852, the lava cascaded more than once over the steep precipice of the Salto della Giumenta, more than 400 feet high, which intervenes between the hills of Calanna and Zoccolaro, and at this spot measurements of inclined stony lava, at angles varying from 35 to 45 degrees, were taken with the clinometer, and in one case even 50 degrees were ascertained.

The next remarkable instance given by Sir Charles is that of a steeply inclined continuous sheet of lava, 5,000 feet higher than the last mentioned, near the top of the great precipice of the Val del Bove, not far below the Cisterna. Thirty, thirty-five, and even thirty-eight degrees are there attained.

Other similar instances are given, and quite enough is done even in this first part of the paper to prove the essential point, that lavas can be consolidated on slopes of considerable steepness.

The second part of the paper enters into the subject of the structure and position of the older volcanic rocks of Mount Etna, as seen in the Val del Bove, as also on the proofs of a double axis of elevation; and by these means the "crater of elevation-hypothesis" is again refuted, and the opinions of M. Elie de Beaumont, both as to theory and many important matters of fact, are controverted.

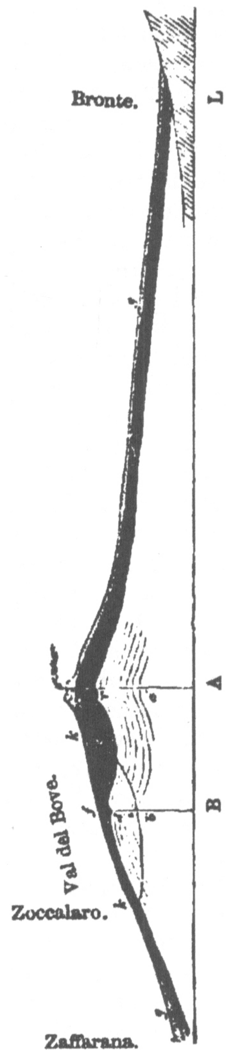
From a point in the Val del Bove called the Piano di Trifoglietto, midway between the Serra Giannicola and the hill of Zoccolaro, the beds of lava radiate in all directions (shown by the arrows in the map of the region of Etna and the Val del Bove at page 321); and from this quaquaversal dip Sir Charles assumes this point (T in the map referred to) to have been an ancient centre of eruption distinct from the present cone of Etna, and that Etna had therefore at one period a double axis, or two points of permanent eruption, with an intermediate valley, or intercolline space, between the two cones, which became gradually filled up by lavas and fragmentary matter. For the sake of distinguishing these, the extinct axis is termed the axis of Trifoglietto, and the present centre of activity the axis of Mongibello,—the modern Sicilian appellation of Mount Etna.

The former existence of an old centre of eruption in the Piano del Trifoglietto had been inferred independently by S. Von Waltershausen from the convergence towards a middle point in that area of thirteen or more dikes of greenstone, one of them of enormous dimensions, visible in the surrounding escarpments. The same geologist also observed in the gigantic buttresses of the cliffs, 2,000 and 3,000 feet high, between the Giannicola and the Rocca del Corvo, that while in the lower part of the precipices the lava-beds dip at high angles inward towards the escarpment, or away from the Val del Bove, those in the middle portion become horizontal, and those nearer the summit dip towards the Val del Bove, as if they were sloping away from some other point near the present great centre of Mongibello.

The change of dip in the inferior, medial, and uppermost beds of the Giannicola, and the convergence of the greenstone-dikes towards the Trifoglietto centre are inexplicable by the "crater of elevation theory," but become plainly intelligible on the principle of a double axis of eruption. Then, in the lower beds we perceive the lava streams flowing away from the old cone of eruption, and mingling in the intercolline space with the currents ejected from the Mongibello crater, until, in the levelling process thus being effected, the horizontality of the succeeding lavas of the middle portion occurs, and after this the streams from the existing cone, flowing down in greater force than those from Trifoglietto, gradually overflowed and extinguished it—the lavas which thus flowed down presenting, of course, the opposite dip to those below, or towards the centre of Trifoglietto.

The points of argument next brought forward are the want of continuity in the older and modern parts of Etna, and the truncation of its summit: these are followed by a discussion on the hypothesis of upheaval by injection. Geologists who assume that lava cannot congeal into continuous stony layers on slopes exceeding five or six degrees, must unavoidably embrace the conclusion that nine-tenths of the lava-beds which constitute the nucleus of Etna, and not a few also which overlie that nucleus unconformably, were brought into their present position by mechanical forces, after the materials of the mountain had accumulated on nearly level ground.

LIGN. 1.—IDEAL SECTION OF MOUNT ETNA TO ILLUSTRATE THE THEORY OF A DOUBLE AXIS OF ERUPTION.



A, axis of *Mongibello*; B, axis of *Trifoglietto*; *a*, *c*, and *b*, *i*, *d*, older lavas, chiefly trachytic; *c*, *c*, and *d*, *f*, lavas chiefly doleritic poured out from A after the axis or focus B was spent, and before the origin of the Val del Bove; *g*, *g*, scoriæ and lavas of later date than the Val del Bove; *k*, *i*, *k*, Val del Bove (the faint lines represent the missing rocks); at *i* the beds dip away from the Val del Bove; in the middle (*c*) they are horizontal, and at the top (*k*) they dip towards the Val del Bove; L, older tertiary and secondary rocks.

M. Elie de Beaumont has suggested that when new fissures are produced during an eruption, radiating from the centre, and traversing the nucleus of the mountain, the lava rising simultaneously to the rim of the highest crater would fill such fissures, causing a tumefaction and distension of the whole mass, and that thus a greater or less upheaval of the cone might result. There is no actual data, however, for deciding that the dyke-making process thus appealed to is usually attended by upheaval. On some occasions, as proved by the observations of Scacchi, Schmidt, and others, it indicates a collapse, or partial subsidence of the flank of the cone. That an uplifting of the incumbent mass must accompany the injection of liquid matter through fissures which are not perpendicular (Sir Charles notices some such fissures inclined at an angle of 75 degrees to the horizon), no one can deny; and therefore, while rejecting the theory of a single terminal catastrophe, or any paroxysmal development of the elevating force, we may fairly ascribe no small influence to those disturbing operations, by which such innumerable dikes have been formed near the principal centres of eruption. But the great points to be kept in view are whether the quaquaversal arrangement of the beds in cones like Etna, and the high inclination of the lavas and scoriæ are not mainly, and in many cases exclusively, due to eruption; and whether the upheaving power, granting its intervention, does not play a very subordinate part. Whether, in fact, it is more probable that, following the proposition of M. de Beaumont, a large portion of the lava-beds now dipping at an angle of 28 degrees had an original slope of only 5 or 6 degrees, the remaining 20 degrees being due to upheaval; or whether the converse may not be more truly assumed, that the 23 degrees may have been the original average inclination, and that the additional 5 or 6 degrees may have been gained by subsequent elevatory movements—in other words, that a fifth part alone of the whole dip may be ascribable to elevation.

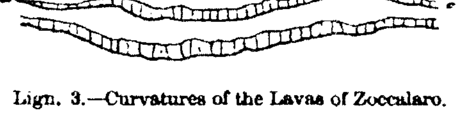
The supposed frequent injection of lava in beds conformable to tufaceous strata, and to which Waltershausen attributes much of the upheaval of the mass of Etna, is then subjected to a similar scrutiny and carefully considered.

"Had the lavas," writes Sir Charles, "which slope away from the ancient centres of Trifoglietto and Mongibello been in great part injected between the tuffs, we should have frequently seen them penetrating through the dikes. But though these last are of so many different ages, and are continually seen to traverse the alternating lavas and tuffs, I could discover no instance of such dikes being in their turn traversed by lavas. It may be asked, how in the escarpments of the Val del Bove can we distinguish a lava which has flowed originally at the surface from a tabular mass of rock which may have been forced, when in a melted state, into a fissure between two layers of tuff? I reply, that the lava has almost invariably its upper and lower scoriæ, and sometimes immediately beneath the latter a layer of burnt tuff, such as I saw in the Balzo di Trifoglietto, at various heights in Monte Zoccalaro, and in the valley of St. Giacomo, where I traced a red tuff for a great distance, underlying the most powerful of the older lavas. Such red layers are never in direct contact with the central and overlying crystalline stony layer, for there intervenes always a fundamental stratum of fragmentary and scoriaceous matter between the stony bed and the burnt tuff below. On the other hand, I looked in vain for an instance of some powerful sheet of lava which had one of these brick-red clays *above* as well as below it. Had the crystalline lavas, whether trachytic or doleritic, whether slightly or steeply inclined, been in great part intrusive, they would have altered the tuffs as much *above* as below them. Moreover, they must have given rise to innumerable faults; for while they vary in thickness from 3 to 60 feet, they are not persistent for indefinite distances, but often thin out rapidly in both directions. They ought therefore, had they been injected, to have lifted up the incumbent deposits partially, so as to give rise to many conspicuous faults. For these reasons, I can not adopt the conclusion that the upheaval of Etna has been largely due to the injection of lavas in sheets parallel or conformable to the tuffs and fragmentary materials."

M. Elie de Beaumont in his celebrated essay on Mount Etna insists on the uniformity in thickness and parallelism of the many hundreds of lava-beds which are presented on the escarpments of the Val del Bove, and on their continuity for great distances, as facts confirmatory of the doctrine of their original horizontality and subsequent upheaval into their present positions, referring their occasional steep inclinations to their liability to be bent together, like the regular sedimentary strata which have undergone flexures in mountain-chains. This assertion has not escaped the keen observation of Sir Charles Lyell, and consequently we have a portion of his paper devoted to the evidence of pseudo-parallelism and the want of uniform thickness of the beds forming the escarpments of the Val del Bove. A conspicuous selected case of want of uniformity in thickness of stony layers in the northern escarpment—one bed

Lign. 2.—Non-parallel Lavas. Want of Uniformity in Thickness of Stony Layers in Northern Escarpment of the Val del Bove.

attaining forty-feet in its thickest part—and instances of non-parallel strata to the south of Finocchio Inferiore, and at the Serradel Solfizio, with an example of curvatures in the lavas of Zoccolaro effectually



Lign. 3.—Curvatures of the Lavas of Zoccalaro.

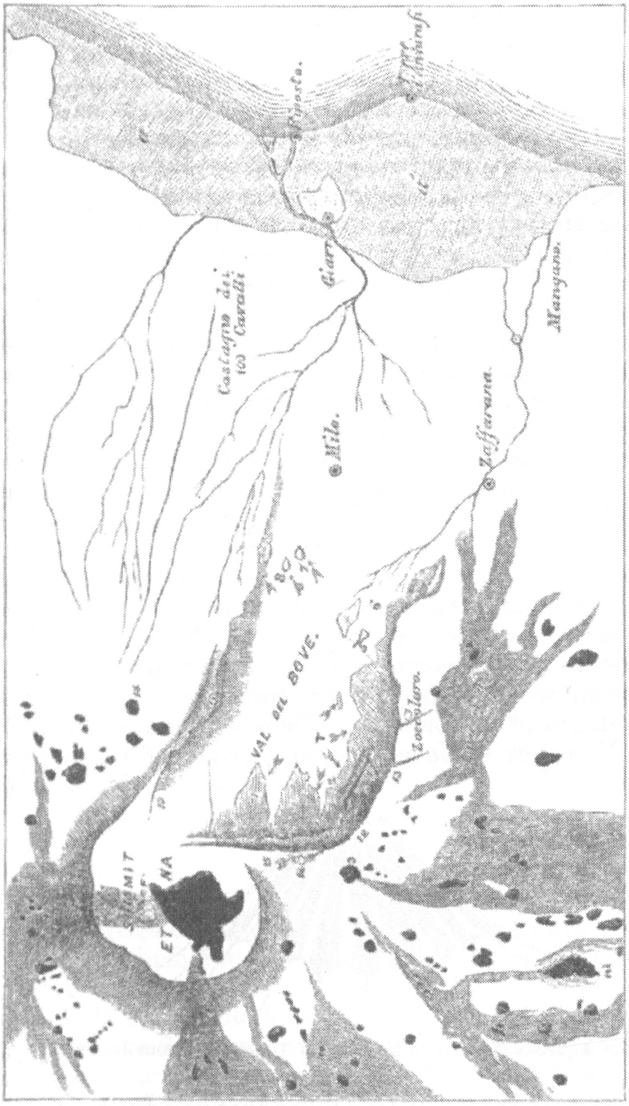
dispose of this point, and leave remaining only the easy task of proving the analagous form and arrangement of the ancient and modern lavas.

The third part of Sir Charles's paper is devoted to the relation of the volcanic rocks of Mount Etna to the associated alluvial and modern tertiary deposits of Giarre.

This part first enters into the origin of the Val del Bove, and how it is due to aqueous erosion.

The origin of that large crateriform valley has been sometimes attributed to a sudden catastrophe connected with those movements

MAP OF ETNA, THE VAL DEL BOVE, AND THE COAST OF RIPESTO AND TORRE D' ARCHIRAFI.



1. Giannicola.
2. Rocco del Corvo.
3. Montagnuola.
4. Hill of Calanna.
5. Salto.
6. Valle di Calanna.
7. Finocchio.
8. Musara.
9. R. Capra.
10. Valle del Leone.
11. Serra del Concazze.
12. Schiena dell' Asino.
13. Serra del Solfizzio.
14. Cisterna.
15. Piano del Lago.
T Axis of Trifoglietto.
a, a, Alluvial deposits.

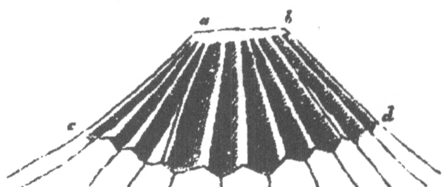
The darker shaded portions represent certain lava-currents, and the black spots indicate the sites of cones of eruption.

which are supposed to have given rise to the mountain itself; but if the doctrine of a double axis be admitted, and the reasoning advanced in this paper be conceded, it is certain we must come "to the conclusion that the mountain, with its lavas and tuffs sloping away from more than one centre, and pierced by a succession of dikes, was already complete before the Val del Bove began to be formed."

The alluvial formation on which Giarre and some other towns on the coast are built, attests the removal, at some unknown period, of a vast quantity of stony fragments from that part of Etna which lies immediately in the direction of the Val del Bove; and if it could be shown that this transported matter came down from that great valley, it would go far to prove that the abstraction of the missing rocks was for the most part effected by aqueous agency. On examination it actually appears that the portion of this deposit,—which consists of coarsely stratified materials, with rounded and angular blocks some nine feet in diameter, but without striations or scratches like the "glacial drift"—opposite to the Val del Bove is conspicuous beyond the rest for its volume, and by being exclusively composed of the wreck of the volcano itself, the blocks being of trachyte, basalt, dolerite, grey-stone, and indeed of every variety of rock met with in the Val del Bove; some being evidently derived from dikes.

As usual, Sir Charles provides against attack by combatting the probable objections likely to be made to his notions. "It may," he says, "perhaps be suggested that the deposit at Giarre and Mangeno might have been swept down by rivers from the old cone when it was still entire, and before the caldera originated, in favour of which theory it might be urged that in the Val del Bove at present we discover no action of running water capable of causing extensive denudation; also that we may well imagine, during some former suspension of eruption on the eastern flank of the volcano, that ravines like the Cava Grande may have been gradually excavated in the wide space separating the two hills of Calanna and of Caliato."

In order to test the value of the hypothesis, Sir Charles explored from their lower to their upper terminations the two principal valleys of aqueous erosion, which slope upwards from the foot of the cone to the southern margin of the Caldera. Those who are conversant with Junghuhn's "Volcanos of Java" are well aware of the nature and



Lign. 3.—Furrows of Aqueous Erosion on the Cone of Tongger. From Junghung's "Java."

value of this test; for they will remember that the flanks of volcanic cones which are in full activity are free from furrows eaten out by running water; whereas, such as have been long extinct, or are in a state of moderate activity, exhibit a great number of ravines from 300 to 600 feet deep, excavated by torrents, and parted from each other by ribs or ridges of volcanic rocks, compared by Junghuhn to the spokes of an umbrella. All these furrows grow narrower and shallower when traced upwards, and come to an end before they reach the rim of the crater; whereas, in such volcanic cones as have been truncated by explosions and subsidences, after considerable aqueous erosion, the rim is invariably indented. On applying this rule it was found that the crest of the southern escarpment of the Val del Bove, between Montagnuola and Zoccolaro, was very entire and unbroken; "but that there were notches, or deep depressions, several hundred feet deep, precisely at the two points where the upper ends of the valleys, called the Val dei Zappini and the Valle del Tripodo, joined the crest. Hence, it is natural to conclude that the valleys in question are of older date than the Val del Bove, and that their higher extremities were once prolonged towards the upper region of the cone, and were cut off when the Caldera was formed. Such an explanation of the facts would, however, be fatal to any theory which refers to a single catastrophe, or to any one mode of operation, whether slow or sudden, the upheaval of Etna, the tilting of the inclined beds, and the opening of the great cavity called the Val del Bove."

The erosion of the Valle del Tripodo is stated to be still going on, and a small inclined delta at its mouth furnishes the means of learning how much matter has been brought down in a given time, or during the sixty-six years which have elapsed since 1722, when a powerful flow of lava crossed the lower extremity of a narrow valley, and suddenly put a stop to the transportation of alluvium to lower levels. "The waters of the torrent, even when most swollen, no sooner arrive at the margin of the lava, than they are absorbed by its spongy, scoriaceous crust, and by the superficial rents and grottos in which it abounds. The engulfed waters continue their course underground; but the mud, sand, and boulders are all left behind and form a deposit, already several hundred feet long and thirty or forty deep, which "proves, on the one hand, how much erosion has gone on in little more than half a century; and, on the other, how entirely all aqueous erosion ceases in areas once covered with fresh lava, and where a superficial drainage is turned into a subterranean one."

It is not, however, attempted to attribute the origin of the Val del Bove exclusively to the action of running water; and it is presumed local catastrophes of paroxysmal intensity may have given rise to the first breaches which ended in the production of this enormous cavity.

The Cisterna, an elliptical hollow, now about 120 feet deep, was produced in 1792 on the platform of the Piano del Lago by the sinking of the ground, and deepened again by subsidence in 1832. On a still higher level near the Philosopher's Tower, is a fosse-like depression known to have originated during the same eruption of 1832. The great rent of Mascalucia, a mile in length and 30 feet deep, formed in 1381, is still open; and another fissure, 6 feet broad and of unknown depth, was formed in the plain of San Lio in 1669, and is said to have been twelve miles long, reaching to near the summit of Etna.

"Such openings on the steep parts of a cone might easily become water-courses, and give passage to floods during the winter's rain and the melting of the snow, and these might gradually deepen and widen such fissures." Paroxysmal explosions like that of Vesuvius in the year 79 might also be powerful agents; and, "if a great explosion happened to be lateral instead of central, the new chasm being commanded by higher ground, or by the region of snow, floods of water would at certain seasons sweep down into it, and might increase its dimensions. "To account for the position of so great a cavity on one side only of a cone, we may, in the case of Etna, imagine a connection between the Val del Bove and the old axis of Trifoglietto. The ancient habitual duct or chimney may, like that of the ancient Vesuvius, after being plugged up for ages, have again given passage to vast volumes of pent-up gases or steam, blowing up the incumbent lavas of Mongibello, which had filled the crater and overtopped the secondary cone. Moreover, the accumulated snow and ice, and consequently the action of running water, may at some earlier period have been greater in the higher region, when the cone of Mongibello was larger and loftier, before its truncation, especially if the first excavation of the Val del Bove dates as far back as the close of the glacial period, or when the Alpine glaciers reached the plains of the Po; for at that time the climate of a Sicilian winter could hardly fail to be colder than now."

Isolated outliers of ancient rock, such as Finochio and Musara, are striking monuments of waste, helping to prove the former continuity of the northern escarpment of the Val del Bove in a southerly direction; and the multitude of dikes projecting from ten to fifty feet above the general level of the ground in every part of the escarpments, shows clearly to what an extent the softer and more destructible beds have been wasted away by atmospheric aud torrential action. Such dikes are records of the former existence of masses of rocks now no more, though we can still trace the exact shape of the fissures by which they were at one period traversed. The lateral ravines also before mentioned bear testimony to the removing power of running water since the Val del Bove was bounded by lofty precipices."

The obliteration of the river Amenano by the lava of 1669 is given as an example of the antagonism of aqueous erosion and volcanic activity; and in like manner it is suggested that "at some former period there may have existed many rivers in the Val del Bove like those now draining the calderas of Palma and Tiraxana in the Canaries; and, like them, they may, after uniting, have issued by one principal gorge; yet they would inevitably be all effaced from the map, and the gorge filled up with stony matter whenever the time arrived, during a new phase of eruption, for fresh floods of lava to traverse the Caldera." Sir Charles then brings forward the great flood of 1755, the only authenticated instance of a great body of water having passed from the higher region of Etna through the Val del Bove to the sea. "An eruption had taken place at the summit of the volcano in the month of March, a season when the top was covered with snow. The Canon Recupero, a good observer and man of great sagacity, was commissioned by Charles of Bourbon, King of Naples, to report on the nature and cause of the catastrophe. He accordingly visited the Val del Bove in the month of June, three months after the event, and found that the channel of the recent flood, now less than two Sicilian miles broad, was still strewed over with sand and fragments of rock to the depth of forty palms*. The volume of water in a length of one mile he estimated at sixteen millions of cubic feet, and he says that it ran at the rate of a mile in a minute and a half for the first twelve miles. At the upper end of Val del Bove, all the pre-existing inequalities of the ground for a space of two miles in length and one in breadth were perfectly levelled up and made quite even, and the marks of the passage of the flood were traceable from thence up the great precipice, or Balzo di Trifogliotto, to the Piano del Lago, or highest platform.

Recupero, in his report, maintains that if all the snow on Etna, which he affirms is never more than four feet deep (some chasms we presume excepted), were melted in one instant, which no current of lava could accomplish, it would not have supplied such a volume of water. He came therefore to the startling conclusion that the water was vomited forth by the crater itself, and was driven out from some reservoir in the interior of Etna.

As it seems unlikely the Canon could have been mistaken as to the region of the mountain whence the waters came, Sir Charles submits as an explanation, that there might have been at the time of that eruption not only the winter's snow of that year, but many older layers of ice, alternating with volcanic sand and lava, at the foot or on the flanks of the cone which were suddenly melted by the permeation through them of hot vapours, and the injection into them of melted matter.

In the first edition of the "Principles of Geology" the existence of a glacier under the volcanic sand and lava near the Casa Inglese is noticed; and if glaciers may thus endure for long series of years, the store of water which Recupero speculated upon as contained in the interior of the mountain seems sufficiently accounted for.

The gradual rise of the sea-coast, and of the inland cliffs at the eastern base of Etna is attested by the existence of alluvial deposits in some places some hundred feet above the sea; while the fossils contained in them, and those contained in the fossiliferous strata cut into terraces at various heights, afford intelligible data for working out the general history of such upheaval. The proximity of land, for instance, is shown by the tusks and teeth of elephants at Palermo and Terra Forte; while the existence at other places, as near the church St. Andrea, below Taormina, of raised beaches containing shells of recent species shows a former coastal line. It seems probable also, from the leaf-bearing tuffs of Fasano, near Catania, that a portion of Etna is of sub-aërial origin, coeval with the upraised alluvial and

* A palm is a fraction more than 10 inches English.

estuarine formations, and evidence is not wanting to support the inference that a large portion of the mountain is even of posterior date.

The marine tertiary strata of Cefali and Nizzeti are considered by Sir C. Lyell as slightly younger than the Norwich Crag, and "if so, the great mass of Etna, or all that is of sub-aërial origin, being newer than the Nizzetti clays, must be, geologically speaking, of extremely modern date. Its foundations were probably laid in the sea, and were in all likelihood contemporaneous with the basalts and other igneous products of the Cyclopean Isles and Aci Castello, which belong to the period of the fossil shells of Nezzeti and Cefali. When that fauna flourished, the area where Etna now rises was probably a bay of the sea, afterwards converted into land by the outpouring of lava and scoriæ, as well as by the slow and simultaneous upheaval of the whole territory. During that gradual rise the ancient river-plain of the Simeto, in which were embedded the remains of elephants and other quadrupeds, together with certain marine strata (those of Camuliu) formed near the mouth of that river, acquired their present comparatively elevated position. The local eruptions of La Motta and Paterno took place about the same time—*i. e.*, during, or immediately after the deposition of the older alluvium, when also the leaf-bearing tuffs of Fasano were formed. In the course of the same long period of elevation the cone of Trifoglietto, and probably the lower part of the cone of Mongibello, were built up. Still later, the cone last mentioned, becoming the sole centre of activity, overwhelmed the eastern cone and finally underwent in itself various transformations, including the truncation of its summit and the formation of the Val del Bove on its eastern flank. At length the phase of lateral eruptions, which is still in full vigour, closed this long succession of events—changes which may have required thousands of centuries for their devellopment, although in the same lapse of time the molluscous fauna of the Mediterranean has scarcely undergone a twentieth part of one entire revolution."

After a recapitulation of the principal arguments of the third part, the author concludes his admirably lucid and logical paper with the expressal of his conviction, that "upheaval has no where played such a dominant part in the cone- and crater-making process as to warrant the use of the term 'elevation-craters' instead of cones and craters of eruption—a conviction in which we think most reflecting geologists will concur, and which seems, through the medium of Sir Charles's paper, to have attained influence in the head-quarters of the supporters of the "elevation-theory" from the fact, that the Geological Society of Berlin, at which city that hypothesis was first propounded, has, by permission requested of its author, translated it into German.

No doubt the weight of such names as those of the late venerable Baron Humboldt and M. Elie de Beaumont caused the "elevation doctrine" to be received generally more from the credibility of such authorities, than from the merits of the doctrine itself. In the recent death of the first illustrious philosopher it has lost one of its most powerful supporters, and rumour even speaks of the second as a seceder, in having inclined to the opinion that the "crater of elevation theory" is now no longer tenable.

Since the reading of the above paper, Mr. Scrope has supported its arguments by a voluminous paper before the Geological Society. Sir Charles Lyell himself has also delivered a lecture on the subject at the Royal Institution, and has, in the last number of the Philosophical Magazine, published some remarks on Professor C. Piazzi Smyth's supposed proofs of the submarine origin of Teneriffe and other volcanic cones in the Canaries. This last brochure was drawn forth by a chapter on geology and volcanic theories, appended to a "Report on the Teneriffe astronomical experiment of 1856" by the Scottish astronomer, in which it was stated that fossil shells had been found upon the slopes of the crater there. As this statement involved points of high theoretical interest, and was made to stand in the report as expressly confirming the "elevation" of the great crater of Teneriffe, Sir Charles wrote to the Professor to know under what geological circumstances he, or his informants, had detected such shells. It appears, however, that this statement of the fossil shells was made entirely upon mere report, and that it is without any foundation. As this was published under the sanction of the Admiralty, Sir Charles has felt himself called upon to refute it, and has added correct details of observations made by himself and Mr. Hartung at Teneriffe and in the islands of Grand Canary and Palma, which, so far from corroborating the "crater of elevation-hypothesis," in this instance are directly opposed to it.

Future observation will now probably add additional testimony to the more reasonable view of the general formation of volcanic cones and craters by eruptions; and since attention is so thoroughly drawn to the subject there will doubtless be many other writers upon it: but, however numerous or excellent they may be, to Sir Charles Lyell will ever be due the double merit of first detecting the dangerous spread of a false doctrine, and of having had the boldness of making the first attack upon it in the face of the support it had received from some of the most eminent of the continental geologists.