

CHAPTER XX.

Dimensions and structure of the cone of Vesuvius—Dikes in the recent cone, how formed—Section through Vesuvius and Somma—Vesuvian lavas and minerals—Effects on decomposition of lava—Alluvions called “aqueous lavas”—Origin and composition on the matter enveloping Herculaneum and Pompeii—Controversies on the subject—Condition and contents of the buried cities—Proofs of their having suffered by an earthquake—Small number of skeletons—State of preservation of animal and vegetable substances—Rolls of Papyrus—Probability of future discoveries of MSS—Stabiae—Torre del Greco—Concluding remarks on the destroying and renovating agency of the Campanian volcanos.

Structure of the cone of Vesuvius.—BETWEEN the end of the eighteenth century and the year 1822, the great crater of Vesuvius had been gradually filled by lava boiling up from below, and by scoriæ falling from the explosions of minor mouths which were formed at intervals on its bottom and sides. In place of a regular cavity, therefore, there was a rough and rocky plain, covered with blocks of lava and scoriæ, and cut by numerous fissures, from which clouds of vapour were evolved. But this state of things was totally changed by the eruption of October, 1822, when violent explosions, during the space of more than twenty days, broke up and threw out all this accumulated mass, so as to leave an immense gulf or chasm, of an irregular, but somewhat elliptical shape, about three miles in circumference when measured along the very sinuous and irregular line of its extreme margin, but somewhat less than three quarters of a mile in its longest diameter, which was directed from N.E. to S.W.* The depth of this tremendous abyss has been variously estimated, for from the hour of its formation it decreased daily, by the dilapidation of its sides. It measured at first, according to the accounts of some authors, two thousand feet in depth from the extreme part of

* Account of the Eruption of Vesuvius in October, 1822, by G. P. Scrope, Esq., Journ. of Sci., &c., vol. xv., p. 175.

the existing summit* ; but Mr. Scrope, when he saw it, soon after the eruption, estimated its depth at less than half that quantity. More than eight hundred feet of the cone was carried away by the explosions, so that the mountain was reduced in height from about four thousand two hundred to three thousand four hundred feet †.

As we ascend the sloping sides, the volcano appears a mass of loose materials—a mere heap of rubbish, thrown together without the slightest order ; but on arriving at the brim of the crater, and obtaining a view of the interior, we are agreeably surprised to discover that the conformation of the whole displays in every part the most perfect symmetry and arrangement. The materials are disposed in regular strata slightly undulating, appearing, when viewed in front, to be disposed in horizontal planes. But as we make the circuit of the edge of the crater, and observe the cliffs by which it is encircled projecting or receding in salient or retiring angles, we behold transverse sections of the currents of lava and beds of sand and scoriæ, and recognise their true dip. We then discover that they incline outwards from the axis of the cone, at angles varying from 30° to 45° . The whole cone, in fact, is composed of a number of concentric coatings of alternating lavas, sand, and scoriæ. Every shower of ashes which has fallen from above, and every stream of lava descending from the lips of the crater, have conformed to the outward surface of the hill, so that one conical envelope may be said to have been successively folded round another, until the aggregation of the whole mountain was completed. The marked separation into distinct beds results from the different colours and degrees of coarseness in the sands, scoriæ, and lava, and the alternation of these with each other. The greatest difficulty, on the first view, is to conceive how so much regularity can be produced, notwithstanding the unequal distribution of sand and scoriæ, driven by prevailing winds in particular eruptions, and the small breadth of each sheet of lava as it first flows out from the crater. But on a closer examination we find that the appearance of extreme uniformity is delusive, for when a number of beds thin out gradually, and at different points, the eye does not without diffi-

* Mr. Forbes, Account of Mount Vesuvius, Edin. Journ. of Sci., No. xviii., p. 195, Oct., 1828.

† Ibid., p. 194.

culty recognise the termination of any one stratum, but usually supposes it continuous with some other, which at a short distance may lie precisely in the same plane. The slight undulations, moreover, produced by inequalities on the sides of the hill on which the successive layers were moulded, assists the deception. As countless beds of sand and scoriæ constitute the greater part of the whole mass, these may sometimes mantle continuously round the whole cone; and even lava-streams may be of considerable breadth when first they overflow, since in some eruptions a considerable part of the upper portion of the cone breaks down at once, and may form a sheet extending as far as the space which the eye usually takes in in a single section. The high inclination of some of the beds, and the firm union of the particles even where there is evidently no cement, is another striking feature in the volcanic tuffs and breccias, which seems at first not very easy of explanation. But the last great eruption afforded ample illustration of the manner in which these strata are formed. Fragments of lava, scoriæ, pumice, and sand, when they fall at slight distances from the summit, are only half cooled down from a state of fusion, and are afterwards acted upon by the heat from within, and by fumeroles or small crevices in the cone through which hot vapours are disengaged. Thus heated, the ejected fragments cohere together strongly; and the whole mass acquires such consistency in a few days, that fragments cannot be detached without a smart blow of the hammer. At the same time sand and scoriæ, ejected to a greater distance, remain incoherent*.

The inclined strata before mentioned, which dip outwards in all directions from the axis of the cone of Vesuvius, are intersected by veins or dikes of compact lava, for the most part in vertical position. In 1828, these were seen to be about seven in number, some of them not less than four or five hundred feet in height, and thinning out before they reached the uppermost part of the cone. Being harder than the beds through which they pass, they have resisted decomposition, and stand out in relief †.

* Monticelli and Covelli, *Storia di Fenon. del Vesuv.*, en 1821-2-3.

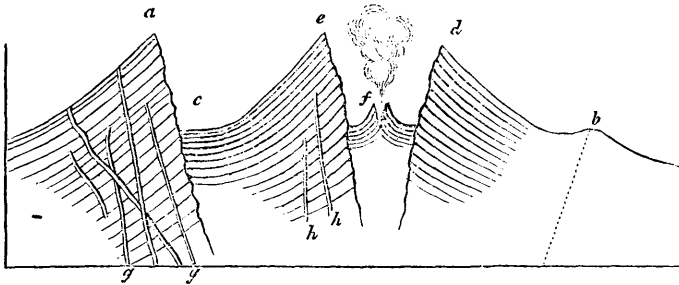
† When I visited Vesuvius in November, 1828, I was prevented from descending into the crater by the constant ejections then thrown out. I only got sight of three of the dikes, but Signor Monticelli had previously had drawings made of

There can be no doubt that these dikes have been produced by the filling up of open fissures with liquid lava; but of the date of their formation we know nothing farther than that they are all subsequent to the year 79, and, relatively speaking, that they are more modern than all the lavas and scoriæ which they intersect. A considerable number of the upper strata, not traversed by them, must have been due to later eruptions if the dikes were filled from below. That the earthquakes which almost invariably precede eruptions occasion rents in the mass is well known; and, in 1822, three months before the lava flowed out, open fissures, evolving hot vapours, were numerous. It is clear that such rents must be injected with melted matter when the column of lava rises, so that the origin of the dikes is easily explained, as also the great solidity and crystalline nature of the rock composing them, which has been formed by lava cooling down slowly under great pressure.

In the annexed diagram (No. 13.) it will be seen that, on the side of Vesuvius opposite to that where a portion of the ancient cone of Somma (*a*) still remains, is a projection (*b*) called the Pedamentina, which some have supposed to be part of the circumference of the ancient crater broken down towards the sea, and over the edge of which the lavas of the modern Vesuvius have poured; the axis of the present cone of Vesuvius being, according to Visconti, precisely equidistant from the escarpment of Somma and the Pedamentina. But it has been objected (and not without reason) to this hypothesis, that if the Pedamentina and the escarpment of Somma were the remains of the original *crater*, that crater must have been many miles in diameter, and more enormous than almost any one known on the globe. It is, therefore, more probable that the ancient mountain was higher than Vesuvius (which, comparatively

the whole, which he showed me. The veins which I saw were on that side of the cone which is encircled by Somma. In the March of the year before mentioned, an eruption began at the bottom of the deep gulf formed in 1822. The ejected matter had filled up nearly one-third of the original abyss in November, and the same operation was slowly continuing, a single black cone being seen at the bottom in almost continual activity. It is clear that these ejections may continue till the throat of Vesuvius is filled up in the same manner as before 1822; and Mr. Scrope has referred the frequent occurrence of volcanic cones without craters to this cause. I found, in 1828, the lava of 1822 not yet cool on the north side of the cone, and evolving much heat and vapour from crevices.

No. 13.



Supposed section of Vesuvius and Somma.

- a.* Monte Somma, or the remains of the ancient cone of Vesuvius.
b. The Pedamentina, a terrace-like projection, encircling the base of the recent cone of Vesuvius, on the south side.
c. Atrio del Cavallo*.
d. e. Crater left by eruption of 1822.
f. Small cone thrown up in 1828, at the bottom of the great crater.
g. g. Dikes intersecting Somma.
h. h. Dikes intersecting the recent cone of Vesuvius.

speaking, is a volcano of no great height); and that the explosions of the year 79 caused it not merely to disgorge the contents of its crater, which had long been choked up, but blew up a great part of the cone itself: so that the wall of Somma, and the ridge or terrace of the Pedamentina, were never the margin of a crater of eruption, but are the relics of a ruined and truncated cone. It will be seen in the diagram that the slanting beds of the cone of Vesuvius become horizontal in the Atrio del Cavallo (at *c*), where the base of the new cone meets the precipitous escarpment of Somma; for when the lava flows down to this point, as happened in 1822, its descending course is arrested, and it then runs in another direction along this small valley, circling round the base of the cone. Sand and scorixæ, also, blown by the winds, collect at the base of the cone, and are then swept away by torrents; so that there is always here a flattish plain, as represented. In the same manner the small interior cone (*f*) must be composed of sloping beds, terminating in a horizontal plain; for while this

* So called from travellers leaving their horses and mules there when they prepare to ascend the cone on foot.

monticule was gradually gaining height by successive ejections of lava and scoriæ, in 1828, it was always surrounded by a flat pool of semi-fluid lava, into which scoriæ and sand were thrown.

The escarpment of Somma exhibits a structure precisely similar to that of the cone of Vesuvius, but the beds are intersected by a much greater number of dikes. The formation of this older cone does not belong to the historical era, and we must not, therefore, enlarge upon it in this place; but we shall have occasion presently to revert to the subject, when we speak of a favorite doctrine of some modern geologists, concerning "craters of elevation" (Erhebung's Cratere), whereby, in defiance of analogy, the origin of the identical disposition of the strata and dikes in Vesuvius and Somma has been referred to a mode of operation totally dissimilar.

Vesuvian Lavas.—The modern lavas of Vesuvius are characterized by a large proportion of augite (or pyroxene). When they are composed of this mineral and felspar, they may be said to differ in no way in composition from many of the ancient volcanic rocks of Scotland. They are often porphyritic, containing disseminated crystals of augite, leucite, or some other mineral, imbedded in a more earthy base. These porphyritic lavas are often extremely compact, especially in the dikes both of Vesuvius and Somma, which, in hardness and specific gravity, are by no means inferior to ordinary veins of trap, and, like them, often preserve a remarkable parallelism in their two opposite faces for considerable distances. In regard to the structure of the Vesuvian lavas on a great scale, there are no sections of sufficient depth to enable us to draw fair comparisons between them and the products of extinct volcanos. At the fortress near Torre del Greco a section is exposed, fifteen feet in height, of a current which ran into the sea; and it evinces, especially in the lower part, a decided tendency to divide into rude columns. A still more striking example may be seen to the West of Torre del Annunziata, near Forte Scassato, where the mass is laid open by the sea to the depth of twenty feet. In both these cases, however, the rock may rather be said to be divided into numerous perpendicular fissures, than to be prismatic, although the same

picturesque effect is produced. In the lava-currents of Central France (those of the Vivarais, in particular), the uppermost portion, often forty feet or more in thickness, is an amorphous mass passing downwards into lava, irregularly prismatic; and, under this, there is a foundation of regular and vertical columns, in that part of the current which must have cooled most slowly. But the lavas last mentioned are often one hundred feet or more in thickness; and we cannot expect to discover the same phenomenon in the shallow currents of Vesuvius, although it may be looked for in modern streams in Iceland, which exceed even those of ancient France in volume. Mr. Scrope* mentions, that, in the cliffs encircling the great crater of the modern cone, he saw many currents offering a columnar division, and some almost as regularly prismatic as any ranges of the older basalts; and he adds, that in some the spheroidal concretionary structure, on a large scale, was equally conspicuous. Brieslak† also informs us, that in the siliceous lava of 1737, which contains augite, leucite, and crystals of felspar, he found very regular prisms in a quarry near Torre del Greco; which observation is confirmed by modern authorities‡. The decomposition of some of the felspathic lavas, either by simple weathering, or by gaseous emanations, converts them from a hard to a soft clayey state, so that they no longer retain the smallest resemblance to rocks cooled down from a state of fusion. The exhalations of sulphuretted hydrogen and muriatic acid which are disengaged continually from the Solfatara, also produce curious changes on the trachyte of that extinct volcano: the rock is whitened and becomes porous, fissile, and honeycombed, till at length it crumbles into a white siliceous powder§. Numerous globular concretions, composed of concentric laminæ, are also formed by the same vapours in this decomposed rock||.

They who have visited the Phlegræan Fields and the volcanic region of Sicily, and who are aware of the many problematical appearances which igneous rocks of the most modern origin assume, especially after decomposition, cannot but be

* Journ. of Sci., vol. xv., p. 177. † Voy. dans la Campanie, tome. i, p. 201.

‡ Mr. Forbes, on Mount Vesuvius, Edin. Journ. of Sci., No. xviii., Oct. 1828.

§ Daubeny on Volcanos, p. 169.

|| Scrope, Geol. Trans., second series, vol. ii., p. 346.

astonished at the confidence with which the contending Neptunists and Vulcanists in the last century dogmatized on the igneous or aqueous origin of certain rocks of the remotest antiquity. Instead of having laboured to acquire an accurate acquaintance with the aspect of known volcanic rocks, and the transmutations which they undergo subsequently to their first consolidation, the adherents of both parties seem either to have considered themselves born with an intuitive knowledge of the effects of volcanic operations, or to have assumed that they required no other analogies than those which a laboratory and furnace might supply.

Vesuvian Minerals.—A great variety of minerals are found in the lavas of Vesuvius and Somma; for there are so many common to both, that it is unnecessary to separate them. Augite, leucite, felspar, mica, olivine, and sulphur, are most abundant. It is an extraordinary fact, that, in an area of three square miles round Vesuvius, a greater number of simple minerals have been found than in any spot of the same dimensions on the surface of the globe. Häuy only enumerated three hundred and eighty species of simple minerals as known to him, and no less than eighty-two had been found on Vesuvius before the end of the year 1828*. Many of these are peculiar to that locality. Some mineralogists have conjectured that the greater part of these were not of Vesuvian origin, but thrown up in fragments from some older formation, through which the gaseous explosions burst. But none of the older rocks in Italy, or elsewhere, contain such an assemblage of mineral products; and the hypothesis seems to have been prompted by a disinclination to admit that, in times so recent in the earth's history, the laboratory of Nature could have been so prolific in the creation of new and rare compounds. Had Vesuvius been a volcano of high antiquity, formed when Nature

Wanton'd as in her prime, and play'd at will
Her virgin fancies,

it would have been readily admitted that these, or a much greater variety of substances, had been sublimed in the crevices of lava, just as several new earthy and metallic compounds are known to have been produced by fumeroles, since the

* Monticelli and Covelli, *Prodrom. della Mineral. Vesuv.*

eruption of 1822. But some violent hypothesis must always be resorted to, in order to explain away facts which imply the unimpaired energy of reproductive causes, in our own times.

We have hitherto described the structure of the cone; but a small part only of the ejected matter remains so near to the volcanic orifice. A large portion of sand and scorix is borne by the winds and scattered over the surrounding plains, or falls into the sea; and much more is swept down by torrents into the deep, during the intervals, often protracted for many centuries, between eruptions. There, horizontal deposits of tuffaceous matter become intermixed with sediment of other kinds, and with shells and corals, and, when afterwards raised, form rocks of a mixed character, such as tuffs, peperinos, and volcanic conglomerates. Some of the lavas, also, of Vesuvius, reach the sea, as do those of almost all volcanos; since they are generally in islands, or bordering the coast. Here they find a bottom already rendered nearly level, for reasons before explained by us, when speaking of deltas. Instead, therefore, of being highly inclined, as around the cone, or in narrow bands as in a valley, they spread out in broad horizontal sheets so long as they retain their fluidity; and this process may probably continue for a considerable time, since, as upon the land, the upper coating of hardened lava protects the liquid and moving mass below from contact with the air, so beneath the sea the same superficial crust may prevent the great body of lava from cooling, and, being pressed upon by the weight of an increasing column of water as the current descends, it is probably squeezed down: thus the subjacent matter, still in a state of fusion, may be made to flow rapidly towards all points of the compass. This would take place the more readily if the Huttonian assumption be true, that lava cools down more slowly under the pressure of a deep sea than in the open air, which was supposed to be a corollary from Sir James Hall's experiments respecting compression, whence it was inferred that vast pressure prevented water from expanding into steam. But even if such be the case, it by no means follows that the heat of the lava could be carried off more slowly than in the air, and in seas of ordinary depth there can be no doubt that the melted matter would cool far more rapidly under water.

Besides the ejections which fall on the cone, and that

much greater mass which finds its way gradually to the neighbouring sea, there is a third portion often of no inconsiderable thickness, composed of alluvions, spread over the valleys and plains at small distances from the volcano. Immense volumes of aqueous vapour are evolved from a crater during eruptions, and often for a long time subsequently to the discharge of scorïæ and lava. These vapours are condensed in the cold atmosphere surrounding the high volcanic peak, and heavy rains are caused sometimes even in countries where, under other circumstances, such a phenomenon is entirely unknown. The floods thus occasioned sweep along the impalpable dust and light scorïæ, till a current of mud is produced, which is called, in Campania, "lava d'acqua," and is often more dreaded than an igneous stream (lava di fuoco), from the greater velocity with which it moves. So late as the 27th of October, 1822, one of these alluvions descended the cône of Vésuvius. After overspreading much cultivated soil, it flowed suddenly into the villages of St. Sebastian and Massa, and, filling the streets and interior of some of the houses, suffocated seven persons. It will therefore happen very frequently, that, towards the base of a volcanic cone, alternations will be found of lava, alluvions, and showers of ashes. To which of these two latter divisions the mass enveloping Herculaneum and Pompeii should be referred, has been a question of the keenest controversy; but the discussion might have been shortened, if the combatants had reflected that, whether volcanic sand and ashes were conveyed to the towns by running water, or through the air, during an eruption, the interior of buildings, so long as the roofs remained entire, and all underground vaults and cellars, could only be filled by an *alluvion*. We learn from history, that a heavy shower of sand, pumice, and lapilli, sufficiently great to render Pompeii and Herculaneum uninhabitable, fell for eight successive days and nights, in the year 79, accompanied by violent rains. We ought, therefore, to find a very close resemblance between the strata covering these towns, and those composing the minor cones of the Phlegræan Fields, accumulated rapidly, like Monte Nuovo, during a continued shower of ejected matter; with this difference, that the strata incumbent on the cities would be horizontal, whereas those in the cones are highly inclined, and that

large angular fragments of rock, which are thrown out near the vent, would be wanting at a distance, where small lapilli only would be found. Accordingly, with these exceptions, no identity can be more perfect than the form and distribution of the matter at the base of Monte Nuovo, as laid open by the encroaching sea, and the appearance of the beds superimposed on Pompeii. That city is covered with numerous alternations of different horizontal beds of tuff and lapilli, for the most part thin, and subdivided into very fine layers. I observed the following section near the Amphitheatre, in November, 1828,—(descending series).

	Feet.	Inches.
1. Black sparkling sand from the eruption of 1822, containing minute regularly-formed crystals of augite and tourmaline from		2 to 3*
2. Vegetable mould	3	0
3. Brown incoherent tuff full of <i>pisolitic globules</i> in layers, from half an inch to 3 inches in thickness	1	6
4. Small scorïæ and white lapilli	0	3
5. Brown earthy tuff with numerous pisolitic globules	0	9
6. Brown earthy tuff with lapilli divided into layers	4	0
7. Layer of whitish lapilli	0	1
8. Grey solid tuff	0	3
9. Pumice and white lapilli	0	3
	10	4

Many of the ashes in these beds are vitrified and harsh to the touch. Crystals of leucite, both fresh and farinaceous, have been found intermixed †. The depth of the bed of ashes above the houses is variable, but seldom exceeds twelve or fourteen feet, and it is said, that the higher part of the Amphitheatre always projected above the surface; though, if this were the case, it seems to be inexplicable that the city should never have been discovered till the year 1750. It will be observed, in the above section, that two of the brown half-consoli-

* The last great eruption, in 1822, only caused a covering of a few inches thick on Pompeii. Several feet are mentioned by Mr. Forbes—Ed. Journ. of Science, No. xix., p. 131, Jan. 1829; but he must have measured in spots where it had drifted. The dust and ashes were five feet thick at the top of the crater, and decreased gradually to ten inches at Torre del Annunziata. The size and weight of the ejected fragments diminished very regularly in the same continuous stratum as the distance from the centre of projection was greater.

† Forbes, Ed. Journ. of Sci., No. xix., p. 130, Jan. 1829.

dated tuffs are filled with small pisolitic globules. It is surprising that this circumstance is not alluded to in the animated controversy which the Royal Academy of Naples maintained with one of their members, Signor Lippi, as to the origin of the strata incumbent on Pompeii. The mode of aggregation of these globules has been fully explained by Mr. Scrope, who saw them formed in great numbers, in 1822, by rain falling during the eruption on fine volcanic sand, and sometimes, also, beheld them produced like hail in the air, by the mutual attraction of the minutest particles of fine damp sand. Their occurrence, therefore, agrees remarkably well with the account of heavy rain, and showers of sand and ashes, recorded in history, and is opposed to the theory of an alluvion brought from a distance by a flood of water.

Lippi entitled his work "Fu il fuoco o l'acqua che sotterrò Pompei ed Ercolano?"* and he contended that neither were the two cities destroyed in the year 79, nor by a volcanic eruption, but purely by the agency of water charged with transported matter. His Letters, wherein he endeavoured to dispense, as far as possible, with igneous agency, even at the foot of the volcano, were dedicated with great propriety to Werner, and afford an amusing illustration of the polemic style in which geological writers of that day indulged themselves. His arguments were partly of an historical nature, derived from the silence of contemporary historians, respecting the fate of the cities which, as we have already stated, is most remarkable; and were partly drawn from physical proofs. He pointed out with great clearness the resemblance of the tufaceous matter in the vaults and cellars at Herculaneum and Pompeii to aqueous alluvions, and its distinctness from ejections which had fallen through the air. Nothing, he observed, but moist, pasty matter could have received the impression of a woman's breast, which was found in a vault at Pompeii, or have given the cast of a statue discovered in the theatre at Herculaneum. It was objected to him, that the heat of the tuff in Herculaneum and Pompeii was proved by the carbonization of the timber, corn, papyrus-rolls, and other vegetable substances there discovered: but Lippi replied with truth, that the papyri would have been

* Napoli, 1816.

burnt up, if they had come in contact with fire, and that their being only carbonized, was a clear demonstration of their having been enveloped, like fossil wood, in a sediment deposited from water. The Academicians, in their report on his pamphlet, assert, that when the Amphitheatre was first cleared out, the matter was arranged, on the steps, in a succession of concave layers, accommodating themselves to the interior form of the building, just as snow would lie if it had fallen there. This observation is highly interesting, and points to the difference between the stratification of ashes in an open building, and in the interior of edifices and cellars. Nor ought we to call this allegation in question, because it could not be substantiated at the time of the controversy, when the matter was all removed; although Lippi took advantage of this removal, and met the argument of his antagonists by requiring them to prove the fact.

There is decisive evidence that no stream of lava has ever reached Pompeii since it was first built, although the foundations of the town stand upon the old leucitic lava of Somma; several of whose streams, with tuff interposed, have been cut through in excavations. At Herculaneum the case is different, although the substance which fills the interior of the houses and the vaults must have been introduced in a state of mud, like that found in similar situations in Pompeii: the superincumbent mass differs wholly in composition and thickness. Herculaneum was situated several miles nearer to the volcano, and has therefore been always more exposed to be covered, not only by showers of ashes, but by alluvions and streams of lava. Accordingly, masses of both have accumulated on each other above the city, to a depth of nowhere less than seventy, and in many places of one hundred and twelve feet*. The tuff which envelops the buildings consists of comminuted volcanic ashes, mixed with pumice. A mask imbedded in this matrix has left a cast, the sharpness of which was compared by Hamilton to those in Paris plaster; nor was the mask in the least degree scorched, as we might expect it to have been, if it had been imbedded in heated matter. This tuff is porous, and, when first excavated, is soft and easily worked, but acquires

* Hamilton's Observations on Mount Vesuvius, p. 94. London, 1774.

a considerable degree of induration on exposure to the air. Above this lowest stratum is placed, according to Hamilton, "the matter of six eruptions," each separated from the other by veins of good soil. In these soils Lippi informs us, that he collected a considerable number of land shells—an observation which is no doubt correct, for we know that in Italy several species burrow annually, in certain seasons, to the depth of five feet and more from the surface. Della Torre also informs us, that there is in one part of this superimposed mass a bed of true siliceous lava (*lava di pietra dura*); and, as no such current is believed to have flowed till near one thousand years after the destruction of Herculaneum, we must conclude, that the origin of a large part of the covering of Herculaneum was long subsequent to the first inhumation of the place. That city, as well as Pompeii, was a sea-port. Herculaneum is still very near the shore, but a tract of land, a mile in length, intervenes between the borders of the Bay of Naples and Pompeii. In both cases the gain of land is due to the filling up of the bed of the sea with volcanic matter, and not to elevation by earthquakes, for there has been no change in the relative level of land and sea. Pompeii stood on a slight eminence composed of the lavas of the ancient Vesuvius, and flights of steps led down to the water's edge. The lowermost of these steps are said to be still on an exact level with the sea.

After these observations on the nature of the strata enveloping and surrounding the cities, we may proceed to consider their internal condition and contents, so far at least as they offer facts of geological interest. Notwithstanding the much greater depth at which Herculaneum was buried, it was discovered before Pompeii, by the accidental circumstance of a well being sunk, in 1713, which came right down upon the theatre, where the statues of Hercules and Cleopatra were soon found. Whether this city or Pompeii, both of them founded by Greek colonies, was the most considerable, is not yet determined; but both are mentioned by ancient authors as among the seven most flourishing cities in Campania. The walls of Pompeii were three miles in circumference; but we have, as yet, no certain knowledge of the dimensions of Herculaneum. In the latter place the theatre alone is open for inspection; the Forum, Temple of Jupiter, and other buildings, having been

filled up with rubbish as the workmen proceeded, owing to the difficulty of removing it from so great a depth below ground. Even the theatre is only seen by torch-light, and the most interesting information, perhaps, which the geologist obtains there, is the continual formation of stalactite in the galleries cut through the tuff; for there is a constant percolation of water charged with carbonate of lime mixed with a small portion of magnesia. Such mineral waters must, in the course of time, create great changes in many rocks: and we cannot but perceive the unreasonableness of the expectations of some geologists, that volcanic rocks of remote eras should accord precisely with those of modern date; since it is obvious that many of those produced in our own time will not long retain the same aspect and composition.

Both at Herculaneum and Pompeii, temples have been found with inscriptions commemorating their having been rebuilt after they were thrown down by an earthquake*. This earthquake happened in the reign of Nero, sixteen years before the inhumation of the cities. In Pompeii, one-fourth of which is now laid open to the day, both the public and private buildings bear testimony to the catastrophe. The walls are rent, and in many places traversed by fissures still open. Columns are lying on the ground only half hewn from huge blocks of travertin, and the temple for which they were designed is seen half repaired. In some few places the pavement had sunk in, but in general it was undisturbed, consisting of great flags of lava, in which two immense ruts have been worn by the constant passage of carriages through the narrow street. When the hardness of the stone is considered, the continuity of these ruts from one end of the town to the other is not a little remarkable, for there is nothing of the kind in the oldest pavements of modern cities.

A very small number of skeletons have been discovered in either city; and it is clear that the great mass of inhabitants not only found time to escape, but also to carry with them the principal part of their valuable effects. In the barracks at Pompeii were the skeletons of two soldiers chained to the stocks, and in the vaults of a country-house

* Swinburne and Lalande—Paderni, *Phil. Trans.*, 1758, vol. 50, p. 619.

in the suburbs, were the skeletons of seventeen persons who appear to have fled there to escape from the shower of ashes. They were found inclosed in an indurated tuff, and in this matrix was preserved a perfect cast of a woman, perhaps the mistress of the house, with an infant in her arms. Although her form was imprinted on the rock, nothing but the bones remained. To these a chain of gold was suspended, and rings with jewels were on the fingers of the skeleton. Against the sides of the same vault was ranged a long line of earthen amphoræ.

The writings scribbled by the soldiers on the walls of their barracks, and the names of the owners of each house written over the doors, are still perfectly legible. The colours of fresco paintings on the stuccoed walls in the interior of buildings are almost as vivid as if they were just finished. If these artificial colours, therefore, have stood, it is not wonderful that those of shells should have remained unfaded. There are public fountains decorated with shells laid out in patterns in the same fashion as those now seen in the town of Naples; and in the room of a painter who was perhaps a naturalist, a large collection of shells was found, comprising a great variety of Mediterranean species, in as good a state of preservation as if they had remained for the same number of years in a museum. A comparison of these remains with those found so generally in a fossil state would not assist us in obtaining the least insight into the time required to produce a certain degree of decomposition or mineralization; for although, under favourable circumstances, much greater alteration might doubtless have been brought about in a shorter period, yet the example before us shows that an inhumation of seventeen centuries may sometimes effect nothing towards the reduction of shells and several other bodies to the state in which fossils are usually found.

The wooden beams in the houses at Herculaneum are black on the exterior, but when cleft open they appear to be almost in the state of ordinary wood, and the progress made by the whole mass towards the state of lignite is scarcely appreciable. Some animal and vegetable substances of more perishable kinds have of course suffered much change and decay, yet the state of conservation of these is truly remarkable. Fishing-nets are very abundant in both cities, often quite entire; and their

number at Pompeii is the more interesting from the sea being now, as we stated, a mile distant. Linen has been found at Herculaneum, with the texture well defined; and in a fruiterer's shop in that city were discovered vessels full of almonds, chestnuts, walnuts, and fruit of the "carubiere," all distinctly recognizable from their shape. A loaf, also, still retaining its form, was found in a baker's shop, with his name stamped upon it thus: "Eleris Q. Crani Riser." On the counter of an apothecary was a box of pills converted into a fine earthy substance; and by the side of it a small cylindrical roll, evidently prepared to be cut into pills. By the side of these was a jar containing medicinal herbs. In 1827, moist olives were found in a square glass case, and "caviare," or roe of a fish, in a state of wonderful preservation. An examination of these curious condiments has been published by Covelli, of Naples, and they are preserved hermetically sealed in the museum there*.

There is a marked difference in the condition and appearance of the animal and vegetable substances found in Pompeii and Herculaneum; those of Pompeii being penetrated by a grey pulverulent tuff, those in Herculaneum seeming to have been first enveloped by a paste which consolidated round them, and then allowed them to become slowly carbonized. Some of the rolls of papyrus at Pompeii still retain their form; but the writing, and indeed almost all the vegetable matter, appear to have vanished and to have been replaced by volcanic tufa somewhat pulverulent. At Herculaneum the earthy matter has scarcely ever penetrated; and the vegetable substance of the papyrus has become a thin friable black matter, almost resembling in appearance the tinder which remains when stiff paper has been burnt, in which the letters may still be sometimes traced. The small bundles, composed of five or six rolls tied up together, had sometimes lain horizontally, and were pressed in that direction, but sometimes they had been placed in a vertical position. Small tickets were attached to each bundle, on which the title of the work was inscribed. In one case only have the sheets been found with writing on both sides of the pages. So numerous are the obliterations and corrections, that many must have been

* Mr. Forbes, *Edin. Journ. of Sci.*, No. xix., p. 130, Jan., 1829.

original manuscripts. The variety of hand-writings is quite extraordinary : almost all are written in Greek, but there are a few in Latin. They were all found in the library of one private individual ; and the titles of four hundred of those least injured, which have been read, are found to be unimportant works, but all entirely new, chiefly relating to music, rhetoric, and cookery. There are two volumes of Epicurus "On Nature," and the others are mostly by writers of the same school, only one fragment having been discovered, by an opponent of the Epicurean system, Crisippus *. In the opinion of some antiquaries, not one-hundredth part of the city has yet been explored ; and the quarters hitherto cleared out, at great expense, are those where there was the least probability of discovering manuscripts.

As Italy could already boast splendid Roman amphitheatres and Greek temples, it was a matter of secondary interest to add to their number those in the dark and dripping galleries of Herculaneum ; and having so many of the masterpieces of ancient art, we could have dispensed with the inferior busts and statues which could alone have been expected to reward our researches in the ruins of a provincial town. But from the moment that it was ascertained that rolls of papyrus preserved in this city could still be decyphered, every exertion ought to have been steadily and exclusively directed towards the discovery of other libraries. *Private dwellings* should have been searched, and no labour and expense should have been consumed in examining public edifices. A small portion of that zeal and enlightened spirit which prompted the late French and Tuscan expedition to Egypt, might, long ere this, in a country nearer home, have snatched from oblivion some of the lost works of the Augustan age, or of the most eminent Greek historians and philosophers. A single roll of papyrus might have disclosed more matter of intense interest than all that was ever written in hieroglyphics †.

* In one of the manuscripts which was in the hands of the interpreters when I visited the museum, the author indulges in the speculation that all the Homeric personages were allegorical—that Agamemnon was the ether, Achilles the sun, Helen the earth, Paris the air, Hector the moon, &c.

† During my stay at Naples, in 1828, the Neapolitan Government, after having discontinued operations for many years, cleared out a small portion of Herculaneum, near the sea, where the covering was least thick. After this expense

Besides the cities already mentioned, *Stabiæ*, a small town about six miles from *Vesuvius*, and near the site of the modern *Castel-a-Mare* (see map, plate 3), was overwhelmed during the eruption of 79. *Pliny* mentions that, when his uncle was there, he was obliged to make his escape, so great was the quantity of falling stones and ashes. In the ruins of this place, a few skeletons have been found buried in volcanic ejections, together with some antiquities of no great value, and rolls of papyrus, which, like those of *Pompeii*, were illegible.

Of the towns hitherto mentioned, *Herculaneum* alone has been overflowed by a stream of melted matter; but this did not, as we have seen, enter or injure the buildings which were previously enveloped and covered over with tuff. But burning torrents have often taken their course through the streets of *Torre del Greco*, and consumed or inclosed a large portion of the town in solid rock. It seems probable that the destruction of three thousand of its inhabitants, in 1631, which some accounts attribute to boiling water, was principally due to one of those alluvions which we before mentioned; but, in 1737, the lava itself flowed through the eastern side of the town, and afterwards reached the sea: and, in 1794, another current rolling over the western side, filled the street and houses, and killed more than four hundred persons. The main street is now quarried through this lava, which supplied building-stones for new houses erected where others had been annihilated. The church was half buried in a rocky mass, but the upper portion served as the foundation of a new edifice. The number of the population at present is estimated at fifteen thousand; and a satisfactory answer may readily be returned to those who inquire how the inhabitants can be so "inattentive to the voice of time and the warnings of Nature*," as to rebuild their dwellings on a spot so often devastated. No neighbouring site unoccupied by a town, or which would not be equally insecure, combines the same advantages of proximity to the

had been incurred, it was discovered that the whole of the ground had been previously examined, near a century before, by the French Prince d'Elbeuf, who had removed everything of value! The want of system with which operations have always been, and still are, carried on is such, that we may expect similar blunders to be made continually.

* *Sir H. Davy, Consolations in Travel*, p. 66.

capital, to the sea, and to the rich lands on the flanks of Vesuvius. If the present population were exiled, they would immediately be replaced by another, for the same reason that the Maremma of Tuscany and the Campagna di Roma will never be depopulated, although the malaria fever commits more havoc in a few years than the Vesuvian lavas in as many centuries. The district around Naples supplies one, amongst innumerable examples, that those regions where the surface is most frequently renewed, and where the renovation is accompanied, at different intervals of time, by partial destruction of animal and vegetable life, may nevertheless be amongst the most habitable and delightful on our globe. We have already made a similar remark when speaking of tracts where aqueous causes are now most active; and the observation applies as well to parts of the surface which are the abode of aquatic animals, as to those which support terrestrial species. The sloping sides of Vesuvius give nourishment to a vigorous and healthy population of about eighty thousand souls; and the surrounding hills and plains, together with several of the adjoining isles, owe the fertility of their soil to matter ejected by prior eruptions. Had the fundamental limestone of the Apennines remained uncovered throughout the whole area, the country could not have sustained a twentieth part of its present inhabitants. This will be apparent to every geologist who has marked the change in the agricultural character of the soil the moment he has passed the utmost boundary of the volcanic ejections, as when, for example, at the distance of about seven miles from Vesuvius, he leaves the plain and ascends the declivity of the Sorrentine Hills.

Yet favoured as this region has been by Nature from time immemorial, the signs of the changes imprinted on it during the period that it has served as the habitation of man, may appear in after-ages to indicate a series of unparalleled disasters. Let us suppose that at some future time the Mediterranean should form a gulf of the great ocean, and that the tidal current should encroach on the shores of Campania, as it now advances upon the eastern coast of England: the geologist will then behold the towns already buried, and many more which will inevitably be entombed hereafter, laid open in the steep cliffs, where he will discover streets superimposed above each

other, with thick intervening strata of tuff or lava—some nuscathed by fire, like those of Herculaneum and Pompeii, others half melted down like those of Torre del Greco, or shattered and thrown about in strange confusion like Tripergola. Among the ruins will be seen skeletons of men, and impressions of the human form stamped in solid rocks of tuff. Nor will the signs of earthquakes be wanting. The pavement of part of the Domitian Way, and the Temple of the Nymphs, submerged at high tide, will be uncovered at low water, the columns remaining erect and uninjured; while other temples which had once sunk down, like that of Serapis, will be found to have been upraised again by subsequent movements. If they who study these phenomena, and speculate on their causes, assume that there were periods when the laws of Nature differed from those established in their own time, they will scarcely hesitate to refer the wonderful monuments in question to those primeval ages. When they consider the numerous proofs of reiterated catastrophes to which the region was subject, they may, perhaps, commiserate the unhappy fate of beings condemned to inhabit a planet during its nascent and chaotic state, and feel grateful that their favoured race escaped such scenes of anarchy and misrule.

Yet what was the real condition of Campania during those years of dire convulsion? “A climate where heaven’s breath smells sweet and woingly—a vigorous and luxuriant nature unparalleled in its productions—a coast which was once the fairy land of poets, and the favourite retreat of great men. Even the tyrants of the creation loved this alluring region, spared it, adorned it, lived in it, died in it*.” The inhabitants, indeed, have enjoyed no immunity from the calamities which are the lot of mankind; but the principal evils which they have suffered must be attributed to moral, not to physical causes—to disastrous events over which man might have exercised a control, rather than to the inevitable catastrophes which result from subterranean agency. When Spartacus encamped his army of ten thousand gladiators in the old extinct crater of Vesuvius, the volcano was more justly a subject of terror to Campania, than it has ever been since the rekindling of its fires.

* Forsyth’s Italy, vol. ii.