

IX. *Some account of the Eruption of Vesuvius, which occurred in the month of August 1834, extracted from the Manuscript Notes of the Cavaliere MONTICELLI, Foreign Member of the Geological Society, and from other sources; together with a Statement of the Products of the Eruption, and of the condition of the Volcano subsequently to it.* By CHARLES DAUBENY, M.D. F.R.S. F.G.S. &c., Professor of Chemistry and Botany in the University of Oxford.

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THE eruption of Vesuvius which occurred in the month of August of last year, excited on the spot an unusual share of interest, from the largeness of the volume of lava at the time discharged, and the extent of the damage it occasioned in its progress down the mountain; whilst in a scientific point of view it attracted the greater attention, since it was regarded by many as the concluding link in a series of volcanic operations, which had been going on up to that period with only occasional intermissions from the year 1831.

It was therefore natural, that on my arrival at Naples shortly after the mountain had subsided into a state of comparative repose, I should seize upon the opportunity which appeared to offer of increasing my acquaintance with volcanic phenomena; first, by collecting on the spot such information as could be best relied on, with respect to the leading features of the past eruption; and secondly, by ascertaining from personal examination the actual condition of the volcano, and the products resulting either from its late operations, or from those in actual progress.

With a view to the former object, I solicited and obtained from the Cavaliere MONTICELLI (one of the Foreign Members of the Geological Society) a written account of the eruption, from which he has permitted me to extract such particulars as I might deem likely to interest the Members of the Royal Society; whilst in the hope of accomplishing the latter object, a considerable portion of the time I spent at Naples was taken up in visiting the several parts of Vesuvius, and in collecting the solid as well as aeriform substances, ejected from its crater, and from the recently erupted lava.

In the former part, therefore, of the present communication, I can claim no further share, than as the compiler of facts observed and reported to me by others; and all that I conceive myself personally responsible for is the latter portion, in which I have stated the several products and actual condition of the volcano at the time I visited it.

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It would appear that for a considerable time previous to the eruption in question, the crater of the volcano had continued to throw up stones and scoriæ, which falling down for the most part almost perpendicularly round the point of their emission, had by degrees accumulated into two conical masses, which rose up in the midst of the great crater. The largest of these cones is calculated to have been more than 200 feet in height, and possessed at one time a regular pyramidal form, with an appearance of stability.

It is stated, however, by MONTICELLI, that in May last, from the 20th of which month up to the 20th of July, the volcano had continued to throw up stones and ashes, and even to emit lava, both these conical hillocks were observed to be broken away, and to sink towards the south; whence, in a memoir read by him to the Academy of Sciences at Naples on the 5th of August, he predicted their speedy disappearance.

These anticipations were realized at no long period subsequently. On the 22nd of August, after the volcano had continued for a month in a state of apparent repose, volumes of black smoke began to show themselves on the summit of the more recent of the two hillocks above noticed; and after a smart shock of an earthquake, this was succeeded by ejections of red-hot stones and scoriæ, which continued to be shot forth all the night with fresh quakings and rumblings of the soil.

Early on the 23rd, a current of lava was seen to issue from the foot of the great cone which encompasses the crater on its western side, and this bending in the direction of the point called Crocelle, reached the flanks of the rising ground denominated Contaroni, whence, moving continually forwards at the rate of about six feet per minute, and reinforced by a second stream of lava which had burst forth from an adjacent point, it reached about nightfall the path generally taken from the Hermitage to the summit of the mountain, which it completely blocked up.

During the 24th, lava continued to flow from the same points, and to advance down the western declivity of the mountain; and during the night a violent shaking of the volcano, which agitated the whole adjacent country, was apparently coincident with the falling in of both the conical hillocks described as existing in the interior of the crater, no traces of which were visible in the morning. Thus we have here a decided instance of two considerable pyramidal masses of volcanic materials, not blown into the air, as some might suppose to be the case, but actually swallowed up within the cavities of the mountain in the course of a single night.

Up to this time the western side of the volcano had been the point that yielded to the internal pressure, and the inhabitants of Portici and Resina had imagined themselves to be chiefly menaced. But on the evening of the 24th a fresh vent was established on the eastern side of the mountain near the *Grotta del Mauro*, whence the lava of 1817 had issued; and after this had taken place, no more lava was observed to flow from the western side of the cone. On the other hand, the current from the eastern side was reinforced on the morning of the 25th by a second stream,

which issuing forth from the foot of the great cone on the spot called Coutrel, flowed over the preceding one.

On the morning of the 26th, an immense column of black and dense smoke served as the prelude to the bursting forth of a new current of lava from the same point as before, as well as from several others in the neighbourhood; and the whole of this molten mass poured down the mountain in a single narrow stream, circumscribed within the boundaries of a hollow way or water-course. Here, its progress being favoured by the rapid slope of the declivity, it very soon reached Mauro, and took possession of the road leading from Bosco-tre-case to Ottayano.

On the 27th it was augmented by two fresh currents emitted from points not far distant; but now, instead of flowing on in a single stream as before, it became divided into three. The largest of these currents, going straight in the direction of Mauro, spread over some lands belonging to the hamlet of Torcigno; the second covered the cultivated fields above Bosco-reale; and the third invaded the upper part of the village of Bosco-tre-case.

It was the first, however, of these currents which effected the greatest damage. Widening as it descended, it had acquired, by the time it reached the base of the mountain, a breadth of nearly half a mile, retaining even there a depth which averaged from fifteen to eighteen feet.

At Mauro, the Casino of the Prince of Ottayano formed its precise boundary to the north, and one wall of that mansion was swept away by it, whilst all the rest of the building stood uninjured. From this point the lava proceeded to the road which leads from Torre del Annunziata to Ottayano, which it completely blocked up, and moving still further to the eastward, swept away in its course several detached hamlets included in the Commune.

It is calculated, that 180 houses, the abode of about 800 persons, were destroyed by the current, and that 500 acres (moggie) of land were covered over and reduced to sterility by it.

Among the remains of the houses overthrown by the lava, which I was able to examine, no traces of fusion were visible, and the lava seemed to have acted merely as so much dead weight pressing upon them from without. These, however, it is to be remarked, were on the verge of the stream, where the lava was least hot; for in the interior of the current I was unable to discover any vestiges of the houses that had been destroyed.

At the time that the eruption occurred, the villages in the neighbourhood were covered, to the depth, it is said, of two inches, by a shower of capilli; and from one account which I have seen, it would appear that torrents of hot water were poured down from the crater on the 28th.

The flow of lava from the crater continued all the 29th; but subsequently to that date no further eruption was perceived, and the principal current already described, being no longer urged forwards or augmented by fresh streams from above, gradually

slackened in its progress, and stopped at a distance of about a quarter of a mile beyond the road from Torre to Ottayano.

The lava is said to have been accompanied throughout its progress by a cloud of black sand, which hovered over its path, and from this cloud emanated frequent flashings of very vivid lightning, sometimes, but not always, followed by thunder.

These flashings MONTICELLI refers to the particles of sand being in an opposite state of electricity to that of the air, and consequently, when diffused through it by the wind, producing a discharge of electrical light. The same phenomenon was remarked by him in the preceding month of May, at which time the volcano, as has been stated, emitted a cloud of light volcanic sand. This was diffused by the wind over the whole of the circumambient atmosphere, and from the edges of this cloud, where the lightest and finest particles only of the sand were present, frequent coruscations of lightning appeared to emanate, whilst in its denser and blacker portion none such were discernible.

Towards the close of this eruption there occurred a phenomenon, which may perhaps be attributable to the volcanic action going on under Vesuvius. In a pond belonging to a private individual at Puzzuoli, all the fish suddenly died. In the lake of Fusaro, at this time, from twelve to thirteen hundred weight of fish were calculated to have perished; and it was remarked, that the victims principally belonged to those species which congregated at the bottom of pools, such as eels. Thus, too, a vast number of oysters at the bottom of this lake were found dead, whereas those which had attached themselves to the stones or the reeds on its sides are said to have escaped. In the neighbouring lake of Licola, also, several of the same species of fish were found to have perished.

After the 29th of August no further signs of internal commotion were exhibited by the mountain during the past year, except that disengagement of aqueous and aëri-form vapours from the crater which is scarcely ever entirely absent.

So tranquil a condition of the volcano, although to a general observer it might appear deficient in that lively interest which belonged to the state of things that had preceded it, was at least favourable to a detailed examination of the several parts of the mountain, and allowed of my descending twice into the interior of the crater, which, owing to the falling in of the two conical hillocks alluded to, presented at that time a comparatively level surface. There were, indeed, three depressions or pits of considerable depth in the midst of it, which, though without any visible communication with the interior, were so charged with the noxious vapours evolved from an infinity of minute and scarcely visible spiracles, that it was judged unsafe to venture down into them. The rest of the crater, however, was a concavity of no great depth, which was traversed by my guide and myself with comparative facility, after we had remained within its precincts time enough, to collect the various sublimations that lined its walls, and to condense some of the vapours still copiously exhaled from its crevices. The sides of the crater consisted of strata which might be traced for a considerable

way round its brim in a direction nearly horizontal, except in one part, where, from some shock or fracture, they had sunk abruptly downwards. These strata consisted of loose volcanic sand and rapilli, coated with saline incrustations of common salt, coloured red and yellow by peroxide of iron, and presenting a beautiful and brilliant appearance. I could perceive no dykes intersecting these strata, as at the Monte Somma.

In order to collect the vapours, I caused to be constructed an apparatus, consisting of the head of a large alembic, fitted on to a cylindrical vessel of tinned iron with riveted joints, which, being open at bottom, and introduced a little way into the ground, served to conduct the exhalations into the receiver connected with it above. By this contrivance I succeeded in the course of an hour or two in condensing a sufficient quantity of the vapour for chemical examination at Naples. In the liquid collected I could detect no saline ingredient, and there appeared only a slight trace of sulphurous or sulphuric acids. The principal body condensed along with the steam was muriatic acid, which was uncombined with any base.

Whether carbonic acid might be disengaged from the crater I could devise no unexceptionable method of determining; yet by comparing the quantity of carbonate of barytes precipitated, by exposing a given quantity of barytic water for five minutes in the vapour of one of the Fumaroles, with what was obtained from the same quantity in equal times exposed to the open air out of the Fumaroles, I am led to conclude that this gas was exhaled.

Of nitrogen, the air of the Fumarole appeared to contain the same proportion, as atmospheric air does in general.

No sulphuretted hydrogen was emitted from the crater, neither could I discover, either in the condensed vapour or in the sublimations lining its walls, any trace of muriate of ammonia.

Muriatic salts principally were detected among the latter, but sulphates of lime, alumina, and iron were likewise present.

The next point in the volcano which arrested my attention was the vent on the eastern side of the great cone, from which issued one of the principal streams of lava that burst from the mountain in August last.

The vapours here collected appeared to agree in composition entirely with those from the interior of the crater; and the sublimations were of the same nature, with the addition of much specular iron ore and some muriate of copper.

The lava, which had been emitted in August, continued, when I visited it in November, to give out throughout the whole of its course white vapours; and even after the copious rains which fell subsequently, many of the spiracles, so late as the end of December, continued to emit the same. The interior of the current appeared also at both these periods to retain a considerable proportion of its original temperature. After removing about six feet of loose scorïæ, I at length reached the upper surface of the bed of lava itself, into which it would have been impossible to penetrate without the

assistance of mining implements. The surface temperature of the lava was indeed not high enough to melt lead, but one of DANIELL'S pyrometers, with an iron rod, left in contact with it for a few minutes, rose more than one degree. It is probable, however, that I had failed in this instance in obtaining the full temperature of the superficies; for nearly a month afterwards, that is, late in December, after much rain had fallen, I removed the scoriæ from another contiguous portion of the bed, and found that a thermometer placed upon it, and merely covered over with a little sand, rose to 390° of FAHRENHEIT. From the cracks and cavities of this lava much aqueous vapour was still exhaling, and this I succeeded in condensing by means of the same apparatus which I had employed within the crater.

The condensed steam on examination was found to be impregnated, not only with free muriatic acid, but also with muriate of ammonia; and as the vapours were collected at the very point of their escape from the lava, it can hardly be doubted, that the latter salt is actually present ready formed within the cavities of the stone, having been emitted from the volcano along with the lava itself. The scoriæ which cover the surface of the bed are in some places quite incrustated over with beautiful crystals of this sort, some of which are perfectly white, whilst others are of an orange-yellow colour. The latter appears to be owing to the presence of oxide of iron. The quantity of sal ammoniac was large enough to repay the trouble of collecting, and much of it was carried away by the peasants to Naples to be sold to the workers in brass and jewellery. Muriate of soda was also common amongst the substances incrusting the scoriæ, but none could be detected in the vapour emitted at the period of my examination.

The very same substances I found to be exhaled, during my stay at Naples, from the crater of the Solfatara of Puzzuoli, which differed however in one respect, namely, in that of emitting much sulphuretted hydrogen, from which the vapours of Vesuvius were entirely free. Hence the film of minute crystals of sulphur which forms on the surface of the rock of the Solfatara in the immediate neighbourhood in the Fumeroles; whilst from the Vesuvian lava no sulphur in any form was given out at the time of my visit, although amongst the sublimations produced at an earlier stage of the operations, crystals of this body were not uncommon.

The disengagement of such principles, as water, muriatic acid, and sal ammoniac from a semi-extinct volcano like the Solfatara, is much more intelligible, than its escape from the substance of a bed of lava which has already undergone consolidation.

In the latter instance, what is the condition in which we are to imagine such bodies to exist in the heart of the mass? Not certainly in a state of chemical union with its constituents, for we cannot conceive any affinity inherent in salts of ammonia or soda for the earthy ingredients of a bed of lava; neither, if in combination with them, would they be separated, as the latter parted with its heat.

It seems necessary to suppose, that these bodies, being thrown up at the time of the eruption from the interior of the volcano, became entangled within the interstices

of the lava at the same time disengaged ; that a portion of what was originally ejected still continues in a compressed state within the cavities of the rock, especially in its interior ; and that it is only by slow degrees that they find means of escape through chinks and crevices to the surface.

We know that many trap rocks contain a portion of water and of muriatic acid, and that the latter body has even been detected in the domite of Auvergne, a volcanic production, which, comparatively speaking, must be regarded as of extreme antiquity* ; so that we may more readily conceive, in what manner lavas of recent origin retain larger quantities of the same volatile principles, and even certain saline substances, diffused through their pores and fissures.

Perhaps indeed, although chemical attraction in these cases is out of the question, a certain degree of *adhesive affinity* may have been exerted, between the substances exhaled, and the walls of the cavities that had contained them. Dr. FARADAY, in the Sixth Series of his Researches on Electricity, published in our Transactions, has introduced some pertinent remarks on this kind of influence, referring to it, amongst other phenomena, the operation of platina in determining the union of oxygen and hydrogen in DÖBEREINER'S experiment. Nor indeed does it seem improbable, that, as heat exercises a repulsive power, not only between the particles of bodies, but likewise between masses of them †, so likewise a species of affinity may exist between masses of matter even where their particles are not mutually attractive ; and that this may retard the operation of heat upon bodies possessing intrinsically a considerable degree of volatility, and prevent their entire disengagement all at once from the cavities of the substance which entangled them.

Be that as it may, it seems certain from the above observations, that ammonia is one of the original products of volcanic action in the case of Vesuvius ; and it would be easy to extend the same inference to other volcanos,—a fact, I am aware, by no means new, but still one, the circumstances of which seem to deserve investigation, especially, as from the readiness with which nascent hydrogen enters into combination with azote, it might be imagined, that the ammonia was somehow or other generated in the open air, owing to a disengagement of hydrogen from the lava.

I trust, that the having traced it to the vapour directly issuing from the mass effectually dispels such a suspicion, and will serve as an additional argument in support of an opinion I have long entertained, that atmospheric air and water both find their way to the seat of volcanic operations, and are alike deprived of their oxygen by certain principles there existing ; whilst the residuary nitrogen and hydrogen are evolved, in in some cases separately, in others united, in the form of ammonia.

* I might likewise refer to the existence of carburetted hydrogen in a condensed state in cavities of rock-salt at Wielitzka, and that of sal ammoniac in that of the Tyrol, as facts of the same description. The latter might lead to some speculations with regard to the origin of sea-salt, to which I may perhaps on some future occasion recur.

† See Professor POWELL'S Paper in the Philosophical Transactions for 1834, Part II.