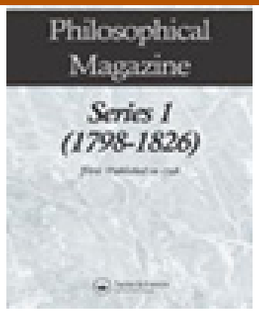

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XL. New observations on volcanoes and their lava

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pious evolution of gas through the whole length of the tube. The wires used in this were iron, and the red and black oxides were formed in considerable quantity.

Seeing the quantity of gas evolved with a given power is in proportion to the quantity of surface of the wires opposed, many contrivances might be used to increase the effect to a considerable degree. If thin plates of metal were used instead of wires, a greater surface would be opposed, and in all probability the effect would be increased. Several wires or plates might be arranged in the same tube, and alternately connected with the ends of the trough; or, if wire cloth was used instead of plates, probably the effect would be still further increased.

I am, sir, your obedient humble servant,

WILLIAM WILSON.

XL. *New Observations on Volcanoes and their Lava.* By G. A. DELUC*.

VOLCANOES have been so numerous on the surface of our continents, when they were under the waters of the antient sea; and as this class of mountains, raised by subterranean fires, manifest themselves still on the shores of the present sea, and in the middle of its waters, it is of importance to geology and the philosophy of the earth to obtain as just ideas of them as possible.

I have attended a great deal to this subject from my own observations; and I have shown, at different times, the errors into which several geologists and naturalists, in treating of it, have fallen.

This class of mountains, in particular, requires that we should see them, that we should behold them during their eruptions, that we should have traced the progress of their lava, and have observed closely their explosions; that we should have made a numerous collection of the matters which they throw up under their different circumstances, that we might afterwards be able to study them in the cabinet, and to judge of their composition according to the phænomena which have been observed on the spot.

This study is highly necessary when we apply to geology and the philosophy of the earth, in order that we may avoid falling into those mistakes which make us ascribe to subterranean fires what does not belong to them, or which leads us to refuse them what really belongs to them.

* From *Journal de Mines*, Thermidor, An. xii. No. 95.

We

We read in the *Journal de Physique* for January, 1804, under the title, *On the cause of Volcanoes,* the following assertions:

"What is the nature of the matters which maintain these subterranean fires? We have seen that Chimboraço, all these enormous volcanoes of Peru, and the Peak of Teneriffe, are composed of porphyry.

"The Puy-de-Dôme is also composed of porphyry, as well as the Mont-d'Or and the Cantal.

"Ætna, Solfatara, and Vesuvius, are also of the porphyry kind.

"These facts prove that the most considerable volcanoes with which we are acquainted are of porphyry."

This opinion, that the fires of volcanoes have their centres in such or such a rock, and that their lavas are produced from these rocks, has always appeared to me not to be founded on any certain data. Opinions also on this subject have varied; some having placed the origin of lava in horn rock, others in granite or schist, and at present it is assigned to porphyry.

I have always been of opinion that nothing certain could be determined in regard to this point. It ever remains uncertain whether the seat of the matters of which lava is formed be in compact rocks, or in strata in the state of softness, pulverulent, and muddy.

Those who see lava issue from a volcano in its state of fusion and incandescence, and in its cooling, are convinced that the nature of every thing is changed, that it exhibits a paste in which nothing can be known, except the substances which the volcanic fires have not reduced to fusion.

But these substances contained in the paste of lava, and those which are the most numerous, show us, that the strata from which they proceed cannot be similar to those exposed to the view, nor even to the most profound strata to which we can penetrate.

The schorl of volcanoes, which was named *augite,* and then *pyroxene,* an octaëdral prism with two biëdral pyramids, is not found in the strata with which we are acquainted; and the case is the same with the leucite or white garnet, a crystallization of a round form, with twenty-four trapezoidal faces. And these crystals, which are observed perfectly insulated in lava, are found there also, united in groups, which are likewise insulated, having no marks of former adhesion.

Here then we have two species of crystals exceedingly numerous in several kinds of lava. Those of Ætna are

filled with schorl; and those of Vesuvius, particularly the antient, contain schorl and leucites in great numbers*.

I shall make no mention of other substances, such as chrysolites and olivins, because their form is not sufficiently determined to enable us to decide whether they are found or not in the exterior strata.

It is not the lava of Vesuvius and Ætna alone which contains one or other of these crystals, or both of them together. Most of the lavas of the antient volcanoes in the neighbourhood of Rome are filled with myriads of leucites. Several of the lavas of the Brisgau contain schorls in great quantity. The gravel of the volcanic lake of Andernach is filled with them. They are found in the basaltes of the circle of Lewtomeritz in Bohemia, and in the scoriæ of the crater of Puy-de-la-Vache in Auvergne. I mention only the lavas of which I possess specimens, most of them collected by myself on the spot, or which were sent to me by my brother, who collected them in his excursions to the old volcanoes of Germany.

Are these two crystals so numerous in lava, the schorls of volcanoes, and leucites, found in any porphyry, granite, or horn rock? They are not found there: the question then is decided; lavas do not derive their origin from porphyry, nor from the two other rocks.

What, in all probability, has led to the contrary opinion, is the appearance of several kinds of lava, which, by the insulated substances they contain, have a porphyroid appearance, though they are not porphyritic.

Leucite is said to have been found:—Is this crystal, of a round form, with twenty-four trapezoidal faces, really that substance? If it is, in what kind of rock was it found? Is it found there by myriads, as in lava? Were this the case, must it not have been long since known? And if it be found only rarely, it is only an exception of very little consequence, compared with the grand fact presented by lava.

I have said that it is uncertain whether lava proceeds from solid rocks, or strata still in the state of softness, pulveru-

* The biëdral pyramids of schorl are subject to several varieties, but never to that of the prism, which has always eight faces: these faces vary in their size like those of rock crystal. Some are frequently seen which have two opposite faces broader than the rest; a variety which is observed also in the prisms of rock crystal. These perhaps are modifications which have made these prisms be considered by Dolomieu and Spallanzani as hexaëdra: they are certainly as much octaëdral as rock crystal is hexaëdral, and the rose feld-spar of Baveno tetraëdral.

I have in my possession a leucite which exhibits a very singular accident. It is united to a schorl, one part of the length of which it embraces. This union has produced an elongation of the leucite to embrace the schorl.

lent, and muddy. When we reflect, indeed, that these crystals, the schorls of volcanoes, and leucites, are found in such great number in their paste, all insulated, and without bearing any marks of adhesion to any rock; when we consider also, that these schorls are found insulated one by one in myriads, mixed with the small scoriæ, thrown up by the mouths which vomited forth the enormous lava of Ætna in 1669; that this lava itself is filled with it,—it is not easy to conceive how they could all be contained in a solid rock. It is still more difficult to conceive that fires capable of fusing granite, horn rock, and porphyry, should spare schorls, leucites, and some other substances, which are fused and reduced to glass in our furnaces.

The volcanic mountain of Viterbo exhibits lavas where the leucites are so near each other that they occupy between them more space than the paste of the lava which contains them.

The lava of Ætna contains, besides schorls and some olivins, a multitude of crystalline laminæ, whitish, and semi-transparent. They are named without hesitation *feld-spar*, which appears to me not so certain as is supposed.

These laminæ are two or three lines in breadth, and about half a line in thickness. They are found also separated from each other, mixed with the schorls and the small scoriæ of Mount Rosso, or the crater of 1669. In the bed of a rivulet which runs down from Mount Ætna I found rolled fragments of old very black lava, which contained some of these laminæ in as great quantity as any marble can contain fragments of shells. It would be very extraordinary if these laminæ proceeded from feld-spars, such as those with which we are acquainted, and that they should not be found mixed with any fragment larger or better determined, which might indicate in a certain manner that origin.

Admitting the hypothesis, that the strata from which the lavas proceed are in a pulverulent and muddy state, containing elements of all these small crystals, one may conceive how they are formed there, insulated, grouped, or solitary, and are found then in the lava in that state of insulation.

The fragments of natural rocks thrown up by Vesuvius are not of the same kind as the matters of which the lava is composed. Most of these fragments are micaceous rocks, with laminæ of greater or less size, and of a kind of granite called *sienite*. I have found some composed of white

white quartzy rock; it is found sometimes of calcareous rock.

The most probable idea that can be formed in regard to the origin of these fragments is, that they have been carried from the borders of the strata through which the lava, that comes from great depths, has opened for itself a passage. These fragments are carried to the surface of the lava as far as the bottom of the chimney of the crater, whence they have been thrown out by explosions, mixed with fragments separated, or rather torn, from the lava; for it is not by the lava that they have been brought forth to view, but by explosions.

Some of these fragments of natural rocks have not been attacked by the fire; others have more or less; which depends, no doubt, on the place which they occupied in the volcano, and on the time which they remained in it. The most of the latter have retained at their surface a crust of lava, and this crust contains substances which are not the same as that of the fragment it covers.

On Vesuvius the strata pierced by eruptions are lower than the surface of the soil; in Auvergne and several places of Germany they are above; for this reason there are seen there in their place schists or granites, which the eruptions have broken to form for themselves a passage.

No volcano rests on natural strata; they sometimes show themselves on the exterior; but they have been opened by eruptions, and their edges have remained in their place.

The focus of no volcano exists or has existed in the cone which appears above the surface of the ground. They have been raised by eruptions, which, proceeding from great depths, have thrown them up through the upper strata. When it is said, therefore, that the volcanic mountains of Auvergne rest on granite, this is a mistake, and an incorrect expression has been used by those who have not formed a just idea of the phænomenon. Lava may have flowed upon granite or any other rock, and rested upon it; but this is never the case with the volcano itself: its bases are below all the rocks visible.

It is from the bosom even of the lava, when in a state of fusion in the interior of the volcano, that all the explosions proceed. In that state of fusion they contain all the matters which produce fermentations, and the disengagement of expansible fluids.

I have been enabled to ascertain this on Vesuvius as far as was possible. The continual noise which was heard through the two interior mouths of the crater which I had before

before my eyes, was that of an ebullition, accompanied with inflammable vapours, and the gerbes of burning matters which they threw up at intervals were separated pieces of the lava in its state of fusion. I saw several of them in the air change their form, and sometimes become flat on the bodies which they struck or embraced in falling. And among the most apparent of these fragments there are always a multitude of small ones of the size of peas and nuts, and still smaller ones, which show at their surface, by their asperities, all the characters of laceration.

The name of *scoriæ* has been given to these fragments to distinguish them from compact lava, though their composition be the same as that of the hardest lava; and it is for want of reflecting properly on this point that it has been said that it is the compact part only that we must observe, in order to judge of their nature. The pieces which I took from the flowing lava with an iron hook, have at their surface the same lacerations and the same asperities as the fragments thrown up by explosions, and both contain the same substances.

This separation, by tearing off the parcels of the lava effected by fermentations and explosions which proceed from their bosom, serves to explain those columns, sometimes prodigious, of volcanic sand which rise from the principal crater. When seen with a magnifying glass, this sand exhibits nothing but lava reduced very small, the particles of which, rough with inequalities, have the bright black colour and the varnish of recent lava.

Parcels of substances which exist in our strata, such as fragments of quartz, scales of mica, and crystals of feldspar, are found sometimes in lava. Similar matters must no doubt be disseminated in the composition of our globe, without there being reason to conclude that the strata from which they proceed are the same as the exterior strata. It is neither in the granites, the porphyries, nor the horn rock, and still less in the schists and calcareous rocks that the schorls of volcanoes, the leucites, and perhaps olivins, will be found. These small crystals are brought to view by the lava, otherwise they would be unknown to us.

These lavas contain a great deal of iron, which they acquire neither from the granite nor porphyries. Might not one see in the ferruginous sand which is found in abundance on the borders of the sea near Naples, and in the environs of Rome, specimens of that kind of pulverulent strata from which lava proceeds?

I have here offered enough to prove that it cannot be determined

determined that lava proceeds from strata similar to those with which we are acquainted. The operations of volcanoes, those vast laboratories of nature, will always remain unknown to us, and on this subject our conjectures will always be very uncertain.

What is the nature of that mixture which gives birth to these eruptions, that produce lava and throw up mountains? What we observe as *certain* is, that the introduction of the water of the sea is necessary to excite these fermentations, as containing marine acid and other salts, which, united to the sulphuric acid, the bases of which are contained in abundance in the subterranean strata, determine these fermentations, which produce the disengagement of fire and other fluids, and all the grand effects that are the consequence.

Several naturalists have believed, and still believe, that fresh or rain water is sufficient for this purpose; but they are mistaken: this opinion is contradicted by every fact known. To be convinced of this, nothing is necessary but to take a short view of them. I have done it several times, as it is necessary to consider them often. I shall here enumerate the principal ones:—No burning mountain exists in the interior part of the earth; and all those which still burn are, without exception, in the neighbourhood of the sea, or surrounded by its waters. Among the deliquescent salts deposited by the smoke of volcanoes, we distinguish chiefly the marine salt, united to different bases. Several of the volcanoes of Iceland, and Heckla itself, sometimes throw up eruptions of water, which deposit marine salt in abundance. No extent of fresh water, however vast, gives birth to a volcano. These facts are sufficient to prove that the concurrence of sea-water is absolutely necessary to excite those fermentations which produce volcanoes.

I shall here repeat the distinction I have already made between burnt out volcanoes and the antient volcanoes, that I may range them in two separate classes.

When we simply give the name of *burnt out* or *extinguished* volcanoes to volcanic mountains which are in the middle of the continents, it is to represent them as having burnt while the land was dry, and inhabited as it is at present; which is not a just idea. These volcanoes have burnt when the land on which they are raised was under the waters of the antient sea, and none of them have burnt since our continents became dry. It is even very apparent that most of them were extinct before the retreat of the sea, as we find by numerous examples in the present sea.

Those

Those which I denominate extinct volcanoes are such as no longer burn, though surrounded by the sea, or placed on the borders of it. They would still burn, were not the inflammable matters by which they were raised, really exhausted and consumed. Of this kind is the volcano of Agde, in Languedoc. Of this kind also are many of the volcanic islands which have not thrown up fire since time immemorial.

M. Humboldt, in his letters written from Peru, speaks of the volcanoes which he visited, but what he says is not sufficiently precise to enable us to form a just idea of them. He represents Chimboraço as being composed of porphyry from its bottom to its summit, and adds, that the porphyry is 1900 toises in thickness; afterwards, he remarks, that it is almost improbable that Chimboraço, as well as Picchincha and Antisana, should be of a volcanic nature: "The place by which we ascended," says he, "is composed of burnt and scorified rock, mixed with pumice-stone, which resembles all the currents of lava in this country."

Here are two characters very different. If Chimboraco be porphyry from the top to the bottom, it is not composed of burnt and scorified rocks, mixed with pumice-stone; and if it be composed of burnt rocks, it cannot be porphyry. This expression, *burnt and scorified rocks*, is not even exact, because it excites the idea of natural rocks, altered in their place by fire, and they are certainly lava which have been thrown up by the volcano. But the truth must be, that Chimboraço, and all the other volcanoes of Peru, are composed of volcanic matters, from their base at the level of the sea to the summit.

I have just read in the *Annales du Muséum d'Histoire Naturelle**, a letter of the same traveller, written from Mexico, on his return from Peru, where, speaking of the volcanoes of Popayan, Pasto, Quito, and the other parts of the Andes, he says, "Great masses of this fossil (*obsidian*) have issued from the craters; and the sides of these gulphs, which we closely examined, consist of porphyry, the base of which holds a mean between obsidian and pitch-stone (*pechstein*)." M. Humboldt therefore considers obsidian, or black compact glass, as a natural fossil or rock, and not as volcanic glass.

Father de la Torre, who resided at Naples, and has written on Vesuvius, believed also that the interior of its mouth was composed of natural rocks and strata like every other

* No. 17.

mountain:

mountain: he calls them *strati naturali, sassi naturali,* though every thing there be the work of fire.

If M. Humboldt had been a witness to the birth and formation of the craters of which he speaks, he would soon have given them up entirely to the volcanic empire. The violence of the fire; the explosions and burning lava with which that empire would have reclaimed them, would soon have silenced all Neptunian pretension, and confirmed that these masses, which he calls *porphyry*, and their bases, holding a medium between obsidian and pitch-stone, are lava and vitrifications belonging to Vulcan. M. Humboldt derives his objection against the opinion that obsidian is volcanic glass, from its swelling up and becoming spongy and fibrous by the least degree of heat of a furnace, whence he concludes that it cannot be the production of fire.

An attentive examination of volcanic productions shows that their state and appearance depend on the nature of the matters which have been subjected to the action of the fires, on the degree of heat, the time and place where it has been exercised. Therefore a degree of heat which has been able to reduce any substance to compact glass, would not be sufficient to put it into a state of ebullition, and at that moment could not be carried to a degree capable of producing that effect: to this the want of free air may contribute. But there are some circumstances, even pretty frequent, of volcanic fires giving fibrous and puffed-up glass. I possess a vitrification from Lipari, the centre of which is compact glass, and the inside in laminæ, bubbles, and threads, like pumice-stone. I have in my possession another, part of which is glass nearly compact, and part glass very much puffed up. I found on the sea-shore, near Messina, two pieces of four or five inches in diameter, formed merely of vitreous laminæ, elongated, undulated, and full of puffed up places. I have two fragments of obsidian, or black compact glass of Ischia, one of the entire faces of which evidently shows by the circular undulations of the one, and the rounded inequalities of the other, that they have been in a state of fusion. I saw at Vulcano a vitreous mass, from which I broke a large fragment, the glass of which is compact in some parts, and full of puffed up places, some of them large and others small. Of this kind is the black compact glass of the volcanoes of Iceland.

Another objection of M. Humboldt is, that obsidian is found in such large masses that it may be compared to a quarry. But why should this be an objection? Vitreous lava does not differ from any other lava, but by more perfect vitrification;

vitrification; and in regard to the size of the masses, it may be said that it has no bounds, since Ætna, a volcano much less considerable than those of Peru, throws up lava several leagues in extent, and of a very great thickness.

Obsidian, therefore, or the black glass of the volcanoes of Peru, is as certainly a production of their fires as the lava which is seen to issue from the bottom of every crater.

[To be continued.]

XLI. *Proceedings of Learned Societies.*

ROYAL SOCIETY OF LONDON.

In the sitting of 25th April last there was read an interesting paper on an artificial substance possessing the principal characteristic properties of tannin, by Charles Hatchett, Esq. a member of the society.

The author, after mentioning the labours of Mr. Deyeux and Mr. Seguin, the former of whom first separated this substance from galls, the characteristic property of which, to precipitate gelatin from water, was ascertained by the latter; and after mentioning the experiments of Mr. Biggin, Mr. Proust, and Mr. Davy, remarks that no one had hitherto supposed that it could be produced by art, unless the fact mentioned by Mr. Chenevix, that "a decoction of coffee berries did not precipitate gelatine, unless they had been previously roasted," might be considered as an indication of it. Recent experiments have, however, shown him that tannin may be formed by very simple means, not only from vegetable, but from mineral and animal substances.

In the course of his experiments on lac and resins, he observed the powerful effects of nitric acid on these substances, and has since observed that by long digestion almost every species of resin is dissolved, and so completely altered that water does not cause any precipitation, and that by evaporation a deep yellow viscid substance is obtained, equally soluble in water and in alcohol. In his experiments afterwards, on the bitumens, he observed a material difference between their solutions and those of resins. With bitumens, nitric acid, by long digestion, formed a dark brown solution; a deep yellow coloured mass was separated, which, by subsequent digestion in another portion of nitric acid, was completely dissolved, and, by evaporation,