LETTERS TO THE EDITOR.

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Suggested Nature of the Phenomena of the Eruption of Mont Pelee on July 9. Observed by the Royal Society Commission.

ALTHOUGH Dr. Anderson and Dr. Flett were able, at the largely attended meeting of the Royal Society on November 20, to add little to what they had published in their preliminary report three months ago, beyond exhibiting the very full and excellent series of photographs of the affected regions of the Soufrière and Mont Pelée eruptions, they succeeded in exciting renewed interest in the problem of the nature of that eruption of Mont Pelée on the evening of July 9, which they had the exceptionally good fortune to witness under most favourable conditions. The photographs and perfect description of this particular outburst give it an unsurpassed value as a contribution to the scientific history of volcanoes, and the Royal Society has therefore the greatest reason to congratulate itself upon the success—a success almost beyond the most sanguine expectation—of its commission to Drs. Anderson and Flett to visit the scene of these eruptions.

We can now hardly hope that any fuller knowledge of the nature of an eruption of the kind witnessed by these geologists will be forthcoming through future observations. What is now to be done in order to clear up what remains obscure is experimental work in the laboratory. To me it seems that only one point requires investigation before we shall have a definite conception and understanding of the phenomenon at the base of such outbursts as those in the West Indies, as well as that of the Bandaisan eruption, or rather explosion, in Japan, closely similar to them in its essential features.

From the text of the published report, modified a little in the accounts given at the meeting, we know that, after spasmodic bursts of steam, dust, and stones, and discharges of torrents of water and mud, the climax of the eruption came as the welling-up in the crater and overflow, like that of a liquid, of red-hot dust, which descended the mountain side, at first relatively slowly, but with ever-increasing velocity, like an avalanche of snow. This avalanche of incandescent sand was accompanied by a dense cloud, black as night, which soon concealed it from view and swelled out in convolutions with terrible energy until it reached perhaps one mile high and two broad. After this, it ceased to enlarge and gradually lost its dense blackness through ash settling down and leaving nothing visible but white steam.

There was, therefore, (1) a flow of incandescent sand down to the sea, mainly by gravitation, but with a velocity apparently surpassing that of a torrent of water; and (2) the expanding motion of the superincumbent, black cloud, together with its rapid motion along the course of the stream of sand, *from which it never lifted.* Just after the overflow of sand from the crater, there must have been an enormous outrush of steam and, perhaps, other gases, and this will have had some effect in driving the cloud through the air; but the progressive formation and the appearance of the cloud forbid the belief that this effect could have been considerable. That the cloud enlarged upwards rather than laterally was due to its consisting of heated steam, for although the dust which it carried with it will have impeded the velocity of its expansion, it will not have lessened its extent.

There can be only one conclusion drawn as to the cause of the free motion and rapid rush of the torrent of sand and of the swelling, convoluting cloud, and that is the continuous evolution of water vapour from every particle of the moving hot sand. Possibly some other gas may also have escaped, but if so only in relatively small quantity, as otherwise the water vapour would not so easily have condensed and become visible. Violent friction between the issuing steam and the solid particles may sufficiently account for the extensive electric discharges. The continuous escape of this water from the particles of the hot sand, at such a high temperature, even though in small quantity, would surround every particle with a compressed atmosphere of steam sufficient to keep it apart from all others, and thus produce a quasi-liquid mass which, on account of the density of the sand, would gravitate strongly and at the same time would, by virtue of the interstitial compressed steam preventing all rubbing together of solid particles, give the mass its marvellous mobility. That this would be so is easily borne out by facts familiar to the chemist and physicist. One of these was, indeed, brought up by Sir William Ramsay in the discussion which followed upon the reading of the papers, namely, the behaviour of precipitated silica when heated, which, however, he attributed to a movement of particles in gases similar to that of Brownian movements of particles in liquids. When any fine dust or powder, which is non-coherent whether cold or hot, gives off sufficiently fast a gas or vapour when heated, it will, when smartly heated, swell up and become mobile, sometimes almost as mobile as liquid ether, keep a horizontal surface when its containing-vessel is tilted, and admit of being poured like a liquid into another vessel. Because of its frequent presence in the work of inorganic chemical analysis, precipitated silica is, perhaps, the most widely known example of this behaviour. In ordinary circumstances, the silica acts in this way almost wholly in consequence of its continuing to liberate up to even a blowpipe heat the water always present in some form of combination with it. Probably, too, it and all such light powders owe for a moment part of the movement of their particles from each other merely to the rapid expansion of the air in the interstices of the powder when the containing vessel is quickly heated, but the escape of hygroscopic or other moisture is obviously the principal cause. When the silica is kept steadily heated, it loses most of its mobility. Other hygroscopic or vapour-condensing powders behave similarly; very finely divided charcoal powder is generally a good example; magnesia alba is another, which gives out both carbonic acid and water.

Light bodies are naturally best fitted for the observance of this phenomenon, but manganese binoxide when evolving oxygen shows it, and even platinum black will throw up dust and enlarge. Indeed, it is a common phenomenon for a slightly coherent powder suddenly heated in a platinum crucible to float in motion as a moulded mass in an atmosphere of gas generated from itself by the hot walls of the crucible. Not inapposite instances of the power of escaping vapour to hold up bodies is that familiar phenomenon of liquid water or alcohol assuming the spheroidal state, that is, rolling about on a hot plate without touching it, being couched on a bed of its own continuously evolved vapour. Where experiment is now wanted is to find out what andesitic minerals will, under great pressure, combine chemically or physically, but intimately, with water at a red out heat and then retain it sufficiently when the pressure is released for an appreciable though short time to elapse before the regeneration of the steam is ended.

A modification of the explanation here given suggests itself which would do away with the necessity for the existence of such combinations of water with rock materials. It is that as the incandescent sand flowed over the soil, it generated the steam from the damp earth or hydrated rocks beneath it in such quantity as to buoy up the sand from the soil and separate its particles. In accordance with this view would be the observation that the hot sand visibly (that is, without obscuring cloud) poured over the lip of the crater and then as it flowed down obscured itself in cloud. On the other hand, the escape of gas or vapour caused by cooling is not an unknown phenomenon, while against this view is the difficulty to explain when holding it the production of the sand within the crater. Drs. Anderson and Flett speak of the dust as lava blown to pieces by the expansion of the gases it contains. I would suggest that the production of the sand just in that way is inconceivable; for if the lava had been molten, it would have been scattered in drops and vesicles in all directions, and only if solid would it have become dust, while in either case it would not have remained as a mass of sand, but have been scattered to the winds. The production of sand or dust, if it really was produced in the crater, will have been a disintegration of rock masses by the pressure diffused through them of the condensed water, with which they were impregnated and perhaps combined, a disintegration leading up to the falling to dust of the masses while they were still under sufficient pressure to prevent scattering.

The strong escape of steam from the sand would, of course, carry up much of the dust with it and thus constitute the black cloud, while its cauliflower-like expansions were apparently only an exaggerated form of what is to be seen over a seething cauldron or a stream of boiling water. EDWARD DIVERS.

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