SPECIAL ARTICLES.

THE MECHANISM OF THE MONT PELÉE SPINE.

THE growth of the Mont Pelée spine is essentially an eruption of solid rock. Geologists are familiar with the eruption of solid material in the form of lapilli and dust, but the escape of lava in a continuous solid mass is a novel phenomenon. Naturally much interest is felt in its explanation, and the subject has been discussed by several geologists. So far as the literature has come to my attention, it has failed to include a factor which appears to me to be of prime importance, and I take the liberty, therefore, of contributing to the discussion, even though my knowledge of the Pelée eruptions is altogether at second-hand.

The phenomenon to be explained is the gradual issue of a column of rock several hundred feet in diameter and having the full cross-section of the throat of the volcano. This rock is so hot as to be incandescent, except the immediate exterior, which may be supposed to be cooled by contact with the air; but it clearly is not molten, for the mass as a whole is so rigid as to support its own weight with a height of more than 1,000 feet. While it grows by rising, its height is also reduced by the breaking away of fragments above. Allowing for this reduction, the total length of the extruded column has been estimated at 3,000 feet.

It seems to me quite clear that this process of extrusion is, properly speaking, volcanic eruption; that molten magma rising from some deep source undergoes a change of physical condition in the conduit, and is thereby enabled to issue in solid form. The process is so rapid as to preclude the hypothesis that solidification results from loss of heat by conduction. Even if surface water finds its way to the walls of the conduit, and is able there to cool the exterior part of the rising column, there can be no appreciable effect on the interior part of the column within the short time indicated by the history of the eruption. The suggestion that surface water is absorbed (as steam) by the lava and the lava is thereby cooled, encounters a double objection: (1) That rising lavas, undergoing relief from pressure, are in condition for discharging, instead of absorbing, gases; and (2) that the diffusion through the rising magma of water absorbed in the periphery of the conduit would require as much time as the cooling of the magma by conduction.

I ascribe the solidification, instead, to the escape of gases originally contained in the magma, that is, of gases contained before the magma rose in the conduit. Steam is assumed to be the principal gas; but the nature of the gas is not important to the mechanical theory. As the gas passes from the condition of absorption into the free condition, forming bubbles in the magma, it is greatly expanded, and this expansion consumes energy. The case is analogous to that of a body of air rising through the atmosphere and becoming cooler by reason of expansion. In that case the energy expended in the expansion is furnished by the heat of the air itself, and the result is a lowering of temperature. In the expansion of gas within the magma the energy is furnished by the heat of the magma, with the result that the magma is converted from a liquid to a solid condition. There may be other results from the withdrawal of heat from the magma. If its temperature was originally above the temperature of liquefaction then it may be cooled as well as solidified. Or the process may, perhaps, go somewhat beyond the accomplishment of solidification, and give to the solid a temperature slightly below the melting point. But all that is necessary to the hypothesis is that the withdrawal of heat from the lava suffices to change it from the liquid to the solid condition.

If this view is correct, then the remarkable feature of the process involved in the production of the Pelée spine is the arrest of the exclusion and expansion of the gas at the precise stage necessary for the solidification of the magma. Usually it either falls short or passes beyond; in the one case producing a liquid magma charged with bubbles; in the other bursting the solid vesicles and blowing their fragments into the air. The rarity with which the process is arrested at the completion of solidification is probably to be ascribed to the fact that it interacts on itself. The amount of gas which can be held in solution by a particular magma depends chiefly on the pressure to which it is subject. (The influence of temperature is not important in the present connection.) As pressure is gradually relieved during eruption, more and more of the contained gas is discharged. When explosion of vesicles is once initiated at the top of the column it reduces the pressure on lower parts by carrying away some of the lava, and this loss of pressure in turn promotes the exclusion of the gas. If this view of the process is correct, the paroxysmal character of explosive volcanic eruption is strictly analogous to that of geyser eruption.

These theoretic considerations lead to the prediction that when the Pelée spine shall have become so cool as to permit of close inspection, its lava will be found to be porous. Porosity may, perhaps, not be accounted a verification of the theory, but the absence of vesicles would prove it untenable.

G. K. GILBERT.

WASHINGTON,
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A SUGGESTIVE RELATION BETWEEN THE GRAVITATIONAL CONSTANT AND THE CONSTANTS OF THE ETHER.

THE phenomena of radio-activity and the ionization of gases point so strongly toward the electrical constitution of matter, that the writer has made an attempt to connect the fundamental constant of gravitation with the electrical constants of the ether.

The result obtained is published with the hope that it may suggest to other physicists a more valuable extension.

The gravitational equation as ordinarily written is

$$F = k\frac{M, M^1}{r^2},$$

where k is the gravitational constant and M, M^1 are the gravitating masses. The unit of mass is the gram. This is a purely arbitrary unit, so I have chosen a new unit of mass, which may be defined as follows: The unit of mass shall be that mass which is associated with one electromagnetic unit each of positive and negative electricity. This mass is considered to be made up of electrons, each of which has a definite mass associated with a definite amount of electricity.

The adoption of this unit of mass involves a change in the numerical value of the gravitational constant. The object of this paper is to investigate the value of this constant.

The ratio of the charge to the mass of an electron as well as the charge itself has been determined by direct experiment. The most probable value of the charge e on an electron is 10^{-20} electromagnetic units, as measured by Mr. H. A. Wilson. The ratio e/m has been measured by a number of physicists. The following are some of the best values found by experiment:

Kaufmann (1898)...........	1.86×10^7
Simon (1899)..............	1.865×10^7
Lenard (1899)..............	1.15×10^7
Kaufmann (1901)...........	1.31×10^7
Wiechert (1899)............	1.42×10^7

The mean of the above values is $e/m = 1.52 \times 10^7$ electromagnetic units. This quantity as well as the charge e is probably correct to one significant figure.

The charge e as stated above is 10^{-20}; hence the mass of an electron is $m = .65 \times 10^{-27}$ grams.

The number of electrons carrying one electro-magnetic unit of electricity is 10^{20}; consequently the mass associated with one unit of negative electricity is $.65 \times 10^{-7}$ grams. Gravitating matter as we know it is neutral as regards charge. There must be present then an equal amount of positive electricity. The mass associated with this positive electricity will also be $.65 \times 10^{-7}$ grams; hence the total mass that is associated in the combination of one unit each of both electricities is 1.3×10^{-7} grams.

This is the new unit of mass. The new gravitational constant may be found by substituting in the equation

$$F = k\frac{M, M^1}{r^2}.$$

The value of k for gram unit of mass is $6{,}673 \times 10^{-11}$, from which

$$F = \frac{1}{9 \times 10^{20} r^2} = \frac{1}{(3 \times 10^{10})^2 r^2} = \frac{1}{h^2 r^2}.$$