THE GEOLOGICAL MAGAZINE.

No. LVIII.—APRIL, 1869.

ORIGINAL ARTICLES.

I.—ON THE SUPPOSED INTERNAL FLUIDITY OF THE EARTH.

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[Second Notice].

IN his recent volume on "Vesuvius," Professor Phillips has added the weight of his great authority to the popular opinion as to the complete internal fluidity of the globe. It may not, therefore, be out of place to examine very shortly the chief argument which appears to have led him to adopt this view, and to discredit that advocated in my paper in your December number, namely, that "pressure, by raising the temperature of fusion" in the matter immediately beneath the exterior crust, probably prevents its liquefaction; in other words, maintains it in a solid state, except where some upheaval of the surface rocks, or the production of some deeply penetrating fissure, has by a sudden reduction of pressure admitted of its local liquefaction.

The Professor opposes to this view the consideration that, "according to all analogy, pressure must rise (downwards) in a higher ratio than temperature in order to prevent solidification; and as both temperature and pressure must rise in arithmetical progression (at such depths as we are now considering) it is most probable that liquefaction can only be prevented in a slight degree by pressure; very possibly it is not prevented at all." (Vesuvius, p. 329.) Now it is evident that this argument rests on the assumption that the pressure to which any interior liquid mass is subjected, consists of the force of gravity alone, and (as I urged in my last paper) ignores the increased pressure arising necessarily "from the tendency to expansion of every part caused by its extreme heat, whether in a solid, liquid, or gaseous state—more particularly if, as there is reason to believe, the subterranean matter is intimately permeated with water, itself occasionally solidified by pressure, but yet retaining its intense expansibility." Surely this vast elastic force, resisted in its action by the weight, cohesion, and perhaps increasing contraction of the solid crust above, may well be supposed to augment the pressure on every part so far as to turn the balance in favour of solidification.

The ideas of those who advocate the fluidity of the interior of the

globe, seem to be very vague as to the meaning they attach to the word 'fluidity.' Some, like Mr. Hopkins, have used the phrase in its strict mathematical sense, excluding all consideration of internal friction—a sense utterly inconsistent with any conceivable condition of fused rock. Others seem to have had in their minds a degree of fluidity which would allow the matter always to find its own level, and yield to pressure by moving in the direction of least resistance with the facility of water in a siphon. A reviewer of Professor Phillips's work in the *Pall Mall Gazette* of March 10th, even asserts unhesitatingly that Palmieri's novel and recent observations on the seemingly *tidal* influence of the sun and moon upon the activity of a volcano in eruption, prove that "the lava ocean under Vesuvius must be enormous and comparable in size to the Atlantic or Pacific," because "tidal influence only produces appreciable effect on the largest sheets of water." Surely there is no need of such an assumption. If Professor Palmieri's idea of the tidal influence of the attraction of the sun and moon on volcanic activity—in itself extremely probable—be shown by further observations to be correct, it will only amount to a corroboration of that which many years since I put forward (and which Sir C. Lyell has adopted) as to the similar influence of varying barometric pressure on the action of Stromboli and other volcanos, whose lava ducts are at the time in open communication with the atmosphere. The elasticity of the steam and other gases contained within or beneath the lava, seizes the opportunity for expansion afforded by diminished atmospheric weight in this case, just as the tidal wave rises through the lateral pressure of the surrounding oceanic waters, when its own gravity is reduced by the moon's attraction. In the case of the volcano, there is evidently no need to imagine any lateral movement of highly liquid lava towards the vent, to account for slightly increased flows of lava, or steam explosions at the tidal periods. Nothing, therefore, in M. Palmieri's observations tends to support the hypothesis of the existence of vast oceans, still less of a continuous belt, of fluid matter, beneath the earth's crust—in itself, as I have shown, an improbable supposition.

Many facts tend to show that "lava," the only fused rocky matter in nature with which we are acquainted, is, when it issues from the interior of the earth during volcanic eruptions, extremely viscous; and though some currents are seen to flow down an incline so low as 6° or 8° with a velocity of three or four miles an hour, others are so sluggish as to accumulate in bulky masses beside or over the orifice whence they are expelled. If it be suggested that in the depths of the volcano the fluidity of the lava is probably very much greater, owing to its higher temperature, this idea is, I think, inconsistent with many well-known facts, such, for example, as the occasional efflux of liquid lava from the summit of Mauna Loa in Hawaii, while that in the crater of Kilauea at a level of 10,000 feet lower, and only 16 miles distant, remains unaffected. So, also, M. Deville saw on the summit of Vesuvius, in 1856, two closely adjoining minor craters, in one of which a pool of incandescent lava bubbled up, while the bottom of the other, at a lower level by 300

feet, remained empty (see Volcanos, p. 261). Such facts as these have brought me to the conviction that though there may be occasionally lateral flows of lava beneath the surface of a volcano, from an interior pool, through fissures opening outwards at a lower level—as in the *tappings* of the lake of Kilauea, so frequently witnessed—yet, in general, lava solidifies so rapidly and readily from increase of pressure or diminution of temperature, that no very extensive accumulations of such matter in a fluid state are likely to exist even beneath an active volcano, still less below vaster areas of the earth's crust, and that the apparent connection of one volcanic vent with others in its neighbourhood, or belonging to the same chain, is rather due to the lateral transmission or escape of heat than to the actual transference of liquid matter between one and the other. This is the leading idea which I have ventured to enounce in the work on volcanos so often referred to; and it is, I believe, perfectly consistent with all that we know of the phenomena of occasional local excitement and intermittence in the volcanic subterranean forces. It is an attractive sensational idea—that of a molten interior to the globe underlying a thin superficial crust, its surface agitated by tidal waves and flowing freely towards any issue that may be here and there opened for its escape; but I do not think it can be supported by any sound argument based on ascertained facts or phenomena, and I prefer the supposition that the interior of the globe, like its surface, is solid, except where local and temporary increase of heat or reduction of pressure have given occasion to the local liquefaction and partial outward discharge of the expanded matter—changes which may be attributed to the unequal escape of heat from the interior into outer space, both by radiation from a surface of ever-varying conductivity, and by direct expulsion through hot springs and volcanic vents.

FAIRLAWN, COBHAM,
March 13th, 1869.

II.—THE BRAZILIAN COAL FIELDS.

By NATHANIEL PLANT, F.R.G.S., F.G.S., etc.

With a Description of the Plant-Remains, etc., by W. CAREUTHERS, F.L.S., F.G.S., of the British Museum.

THE presence of Coal-beds in South America has been known for several years, but the only localities on this side between the Amazon and the River Plate where their existence has been actually determined, are in the two extreme southern provinces of Brazil, Rio Grande do Sul, and in the adjoining one of Santa Catharina, and in the neighbouring Republic of Banda Oriental or Uruguay.

Lignite, brown-coal, and bituminous schists occur in thin beds along the coast and in the interior of Maranham and Minas Geraes; but it is only in these three southern provinces that true Carboniferous rocks containing palæozoic fossils have hitherto been discovered; nor should I think it likely, from the observations I have