LUIGI PALMIERI

# THE ERUPTION OF VESUVIUS IN 1872


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# INTRODUCTORY SKETCH, &c.

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The publishers of this little volume, in requesting me to undertake a translation of the "Incendio Vesuviano," of Professor Palmieri, and to accompany it with some introductory remarks, have felt justified by the facts that Signor Palmieri's position as a physicist, the great advantages which his long residence in Naples as a Professor of the University, and for many years past Director of the Meteorological Observatory—established upon Vesuvius itself, prior to the expulsion of the late dynasty—have naturally caused much weight to attach to anything emanating from his pen in reference to that volcano.

Nearly forty memoirs on various branches of physics—chiefly electricity, magnetism and meteorology—produced since 1842, are to be found under Palmieri's name in the "Universal Catalogue of Scientific Papers of the Royal Society," and of these nine refer to Vesuvius, the earliest being entitled "Primi Studii Meteorologici fatti sul R. Osservatorio Vesuviano," published in 1853. He was also author, in conjunction with Professor A. Scacchi, of an elaborate report upon the Volcanic Region of Monte Vulture, and on the Earthquake (commonly called of Melfi) of 1851. These, however, by no means exhaust the stock of Palmieri's labours.

The following Memoir of Signor Palmieri on the eruption of Vesuvius in April of this year (1872), brief as it is, embraces two distinct subjects, viz., his narrative as an eye-witness of the actual events of the eruption as they occurred upon the cone and slopes of the mountain, and his observations as to pulses emanating from its interior, as indicated by his Seismograph, and as to the electric conditions of the overhanging cloud of smoke (so called) and ashes, as indicated by his bifilar electrometer, both established at the Observatory. The two last have but an indirect bearing upon Vulcanology. The narrative of the events of the eruption is characterised by exactness of observation and a sobriety of language—so widely different from the exaggerated style of sensational writing that is found in almost all such accounts—that I do the author no more than justice in thus expressing my view of its merits.

Nor should a special narration, such as this, become less important or suffer even in popular estimation by the fact that so recently my friend, Professor J. Phillips, has given to the world the best general account of Vesuvius, in its historical and some of its scientific aspects, which has yet appeared. That monograph—with its sparkling style, and scholarly digressions, as well as for its more direct merits—will, no doubt, become the manual for many a future visitor to the volcanic region of Naples; but it, like the following Memoir of Palmieri, and in common with almost every work that has appeared on the subject of Volcanoes, contains a good deal which, however interesting, and remotely related to Vulcanology, does not properly belong to the body of that branch of cosmical science, as I understand its nature and limits.

It tends but little, for example, to clear our views, or enlarge our knowledge of the vast mechanism in which the Volcano originates, and that by which its visible mass is formed, that we should ascertain the electric condition of the atmosphere above its eruptive cone, or into what crystallographic classes the mineral species found about it may be divided: it will help us but little to know Pliny's notions of how Pompeii was overwhelmed, or to re-engrave pictures, assumed to give the exact shape of the Vesuvian or other cone at different periods, or its precise altitude, which are ever varying, above the sea. Even much more time and labour may be spent upon analysing the vapours and gases of fumaroles and salfatares than the results can now justify.

Nothing, perhaps, tends more to the effective progress of any branch of observational and inductive science, than that we should endeavour to discern clearly the scope and boundary of our subject.

To do so is but to accord with Bacon's maxim, "*Prudens questio dimidium scientiæ*." That once shaped, the roads or methods of approach become clearer; and every foothold attained upon these direct paths enables us to look back upon such collateral or subordinate questions as at first perplexed us, and find them so illuminated that they are already probably solved, and, by solution, again prove to us that we *are* in the right paths.

I believe, therefore, that I shall not do disservice to the grand portion of cosmical physics to which volcanic phenomena belong, by devoting the few pages accorded to me for this Introduction to sketching what seems to me to be the present position of terrestrial *Vulcanicity*, and tracing the outlines and relations of the two branches of scientific investigation—*Vulcanology* and *Seismology*—by which its true nature and part in the Cosmos are chiefly to be ascertained.

The general term, *Vulcanicity*, properly comprehends all that we see or know of actions taking place upon and modifying the surface of our globe, which are referable not to forces of origin above the surface, and acting superficially, but to causes that have been or are in operation beneath it. It embraces all that Humboldt has somewhat vaguely called "the reactions of the interior of a planet upon its exterior."

These reactions show themselves principally and mainly in the marking out and configuration of the great continents and ocean beds, in the forcing up of mountain chains, and in the varied phenomena consequent thereon, as seen in more or less adjacent formations.

These constitute the mechanism which has moulded and fashioned the surface of our globe from the period when it first became superficially solid, and prepared it as the theatre for the action of all those superficial actions—such as those of tides, waves, rain, rivers, solar heat, frost, vitality, vegetable and animal (passing by many others less obvious)—which perpetually modify, alter or renew the surface of our world, and maintain the existing regimen of the great machine, and of its inhabitants. These last are the domain of Geology, properly so called. No geological system can be well founded, or can completely explain the working of the world's system as we now see it, that does not start from Vulcanicity as thus defined; and this is equally true, whether, as do most geologists, we include within the term Geology everything we can know about our world as a whole, exclusive of what Astronomy teaches as to it, dividing Geology in general into Physical Geology—the boundaries of which are very indistinct—and Stratigraphical Geology, whose limits are equally so.

It has been often said that Geology in this widest sense begins where Astronomy or Cosmogony ends its information as to our globe, but this is scarcely true.

Vulcanicity—or Geology, if we choose to make it comprehend that—must commence its survey of our world as a nebula upon which, for unknown ages, thermic, gravitant and chemical forces were operative, and to the final play of which, the form, density and volume, as well as order of deposition of the different elements in the order of their chemical combination and deposition was due, when first our globe became a liquid or partly liquid spheroid, and which have equally determined the chemical nature of the materials of the outward rind of the earth that now is, and with these some of the primary conditions that have fixed the characters, nature and interdependence of the vegetables and animals that inhabit it. Physical Astronomy and Physical Geology, through Vulcanicity, thus overlap each other; the first does not end where the second begins; and in every sure attempt to bring Geology to that pinnacle which is the proper ideal of its completed design—namely, the interpretation of our world's machine, as part of the universal Cosmos (so far as that can ever become known to our limited observation and intelligence)—we must carry with us astronomic considerations, we must keep in view events anterior to the "*status consistentior*" of Leibnitz, nor lose sight of the fact that the chain of causation is one endless and unbroken; that forces first set moving, we know not when or how, the dim remoteness of which imagination tries to sound in shadowy thought, like those of the grand old Eastern poem, "When the morning stars first sang together," are, however changed in form, operative still. The light and fragile butterfly, whose glorious garb irradiates the summer zephyr in which it floats, has had its power of flight—which is its power to live—determined by results of that same chain of causes that lifted from the depths the mountain on whose sunny side he floats, that has determined the seasons and the colour of the flower whose nectar he sucks, and that discharges or dissipates the storm above, that may crush the insect and the blossom in which it basked. And thus, as has been said, it was not all a myth, that in older days affirmed that in some mysterious way the actions and the lives of men were linked to the stars in their courses.

Whatever may have been the manifestations of Vulcanicity at former and far remoter epochs of our planet, and to which I shall return, in the existing state of regimen of and upon our globe it shows itself chiefly in the phenomena of Volcanoes and of Earthquakes, which are the subjects of Vulcanology and of Seismology respectively, and in principal part, also, of this Introduction.

The phenomena of hot springs, geysers, etc., which might be included under the title of Thermopægology, have certain relations to both, but more immediately to Vulcanology.

Let us now glance at the history and progress of knowledge in these two chief domains of Vulcanicity, preparatory to a sketch of its existing stage as to both, and, by the way, attempt to extract a lesson as to the methods by which such success as has attended our labours has been achieved.

It will be most convenient to treat of Seismology first in order.

Aristotle—who devotes a larger space of his Fourth Book, Περὶ Κοσμου, to Earthquakes—Seneca, Pliny, Strabo, in the so-called classic days, and thence no end of writers down to about the end of the seventeenth century—amongst whom Fromondi (1527) and Travagini (1679) are, perhaps, the most important now—have filled volumes with records of facts, or what they took to be such, of Earthquakes, as handed down to or observed by themselves, and with plenty of hypotheses as to their nature and origin, but sterile of much real knowledge.

Hooke's "Discourses of Earthquakes," read before the Royal Society about 1690, afford a curious example of how abuse of words once given by authority clings as a hindrance to progress. He had formed no distinct idea of what he meant by an Earthquake, and so confusedly mixes up all elevations or depressions of a permanent character with "subversions, conversions and transpositions of parts of the earth," however sudden or transitory, under the name of Earthquakes.

A like confusion is far from uncommon amongst geological writers, even at the present day, and examples might be quoted from very late writings of even some of the great leaders of English Geology.

From the seventeenth to the middle of the eighteenth century one finds floods of hypotheses from Flamsteed, Höttinger, Amontons, Stukeley, Beccaria, Percival, Priestly, and a crowd of others, in which electricity, then attracting so much attention, is often called upon to supply causation for a something of which no clear idea had been formed. Count Bylandt's singular work, published in 1835, though showing a curious *partial* insight in point of advancement, might be put back into that preceding period.

In 1760 appeared the very remarkable Paper, in the fifty-first volume of the "Philosophical Transactions," of the Rev. John Mitchell, of Cambridge, in which he views an Earthquake as a sudden lifting up, by a rapid evolution of steam or gas beneath, of a portion of the earth's crust, and the lateral transfer of this gaseous bubble beneath the earth's crust, bent to follow its shape and motion, or that of a wave of liquid rock beneath, like a carpet shaken on air. Great as are certain collateral merits of Mitchell's Paper, showing observation of various sorts much in advance of his time, this notion of an Earthquake is such as, had he applied to it even the imperfect knowledge of mechanics and physics then possessed in a definite manner, he could scarcely have failed to see its untenable nature. That the same notion, and in a far more extravagant form, should have been reproduced in 1843 by Messrs. Rogers, by whom the gigantic parallel anticlinals, flanks and valleys of the whole Appalachian chain of mountains are taken for nothing more than the indurated foldings and wrinkles of Mitchell's carpet, is one of the most salient examples of the abuse of hypothesis untested by exact science.

Neither Humboldt nor Darwin, great as were the opportunities of observation enjoyed by both, can be supposed to have formed any definite idea of *what* an Earthquake is; and the latter, who had observed well the effects of great sea-waves rolling in-shore after the shock, did not establish any clear relation between the two.[A]

Hitherto no one appears to have formed any clear notion as to what an Earthquake is—that is to say, any clear idea of what is the nature of the movement constituting the shock, no matter what may be the nature or origin of the movement itself. The first glimmering of such an idea, so far as my reading has enabled me to ascertain, is due to the penetrating genius of Dr. Thomas Young, who, in his "Lectures on Natural Philosophy," published in 1807, casually suggests the probability that earthquake motions are vibratory, and are analogous to those of sound.[B] This was rendered somewhat more definite by Gay Lussac, who, in an able paper "On the Chemical Theories of Volcanoes," in the twenty-second volume of the "Annales de Chémie," in 1823, says: "En un mot, les tremblements de terre ne sont que la propagation d'une commotion à travers la masse de la terre, tellement indépendante des cavités souterraines qu'elle s'entendrait, d'autant plus loin que la terre serait plus homogène."

These suggestions of Young and of Gay Lussac, as may be seen, only refer to the movement in the more or less solid crust of the earth. But two, if not three, other great movements were long known to frequently accompany earthquake shocks—the recession of the sea from the shore just about the moment of shock—the terrible sounds or subterraneous growlings which sometimes preceded, sometimes accompanied, and sometimes followed the shock—and the great sea-wave which rolls in-shore more or less long after it, remained still unknown as to their nature. They had been recognised only as concomitant but unconnected phenomena—the more inexplicable, because sometimes present, sometimes absent, and wholly without any known mutual bearing or community of cause.

On the 9th February, 1846, I communicated to the Royal Irish Academy my Paper, "On the Dynamics of Earthquakes," printed in Vol. XXI., Part I., of the Transactions of that Academy, and published the same year in which it was my good fortune to have been able to colligate the observed facts, and bringing them together under the light of the known laws of production and propagation of vibratory waves in elastic, solid, liquid and gaseous bodies, and of the production and propagation of liquid waves of translation in water varying in depth, to prove that all the phenomena of earthquake shocks could be accounted for by a single impulse given at a single centre. The definition given by me in that Paper is that an earthquake is "*The transit of a wave or waves of elastic compression in any direction, from vertically upwards to horizontally, in any azimuth, through the crust and surface of the earth, from any centre of impulse or from more than one, and which may be attended with sound and tidal waves dependent upon the impulse and upon circumstances of position as to sea and land*."

Thus, for example, if the impulse (whatever may be its cause) be delivered somewhere beneath the bed of the sea, all four classes of earthquake waves may reach an observer on shore in succession. The elastic wave of shock passing through the earth *generally* reaches him first: its velocity of propagation depending upon the specific elasticity and the degree of continuity of the rocky or the incoherent formations or materials through which it passes.

Under conditions pointed out by me, this elastic wave may cause an aqueous wave, producing recession of the sea, just as it reaches the margin of sea and land.

If the impulse be attended by fractures of the earth's crust, or other sufficient causes for the impulse to be communicated to the air directly or through the intervening sea, ordinary sound-waves will reach the observer through the air, propagated at the rate of 1,140 feet per second, or thereabouts; and may also reach him before or with or soon after the shock itself, through the solid material of the earth; and lastly, if the impulse be sufficient to disturb the sea-bottom above the centre of impulse, or otherwise to generate an aqueous wave of translation, that reaches the observer last, rolling in-shore as the terrible "great sea-wave," which has ended so many of the great earthquakes, its dimensions and its rate of propagation depending upon the magnitude of the originating impulse and upon the variable depth of the water. It is not my purpose, nor would it be possible within my limits here, to give any complete account of the matter contained in that Paper, which, in the words of the President of the Academy upon a later occasion, "fixed upon an immutable basis the true theory of Earthquakes."[C] I should state, however, that in it I proved the fallacy of the notion of vorticose shocks, which had been held from the days of Aristotle, and showed that the effects