THE

GEOLOGY OF PORTLAND:

TWO LECTURES

DELIVERED IN PORTLAND,

Feb. 10*th and* 13*th* 1865,

BY

REV. J. E. TENISON WOODS, F.R.G.S.,F.L.S.,F.G.S., &c.

Primus ego aspiciam notum de littore pinum. *Ovid.*

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DEDICATION.

To W. H. ARCHER, Esq.,
REGISTRAR-GENERAL OF VICTORIA AND HON. CORRESP.
MEMBER OF THE STATISTICAL SOCIETY OF VICTORIA.

MY DEAR SIR,

I hope I am not making too much of a trifle by dedicating these Lectures to you. If you will accept them as a tribute to your profound learning and scientific ability, you will add one more to the many kindnesses already conferred on

Yours very respectfully,

Penola, April 7, 1865. JULIAN E. TENISON WOODS.

ADVERTISEMENT.

I have often thought that if amateurs would only give to the public what they knew of the geology of particular localities in their neighbourhood, we should soon have a complete geological history of the colony. Having spent many pleasant days in the investigation of the curious rocks about Portland, I have published the two following lectures as a part of the result of my labours, and as an instance of what I should like to see done throughout the colony. I have revised and added somewhat to the original M.S. in order to give greater prominence to the most important features, and I hope the simplicity of the details here given may incline others to follow my example in publishing what they know of our rocks and stones.

THE VOLCANIC ROCKS OF PORTLAND.

THE first notice history gives us of Portland, is in recording the events of the year 1801. Capt. Grant, who commanded the *Lady Nelson*, a small vessel of 60 tons burden, was directed to sail from London to Sydney by way of the newly discovered straits between Australia and Tasmania. The vessel was the first of such small tonnage, which ever attempted the voyage, and she was also the first to try the eastern passage thro' the straits. The earliest land sighted was Cape Northumberland, near which Mounts Gambier and Schank loomed further on shore. When Capes Bridgewater, Nelson and Grant, had been seen and named, and the ship had rounded the Lawrence Rocks (which, by the way, were named after one of the masters of the Trinity House), Capt. Grant came, as he tells us, in sight of a bold headland, from which the shore receded from low white cliffs into a sandy beach. The interior seemed a dense forest, amid which the natives signalled their strange visitors by sending up many a curling column of smoke. Capt. Grant tried to land, but was unsuccessful in his attempt,—unfortunately it was one of those unpleasant and thoroughly Australian days, when the sea has a surface like glass or oil, and yet is heaving up and down with a tremendous swell; when the sky is dark with leaden sluggish clouds, threatening a storm which never comes; when the air, unmoved by a breath of wind, is sultry and as clammy as a vapour bath. The heaving swell made the sails of the *Lady Nelson* flap idly to and fro, and to swing so much hither and thither, that Capt. Grant was glad to keep off the shore. So the land remained unvisited. Meanwhile, it lay untrodden by any but the savage, as he stealthily broke thro' the tangled forest in pursuit of his prey. But this part of the continent had a story of its own. With some portions of it, I feel myself quite incompetent to deal. Who, for instance, shall unravel the mysterious processes of nature, which converted the reddish soil into the green grass, or the many coloured flowers which were plentifully scattered around? Who shall describe the forces which brought out the varied colours of red, purple and violet, or the beautiful forms of the shadowy fern, the graceful creeper or the spreading tree? Chemists will tell you that in the soil there is iron, alumina, silica, potash, soda and a little lime, but how these became detached from the soil and combined with the non metallic elements, so as to form green leaves, feathery ferns and handsome flowers, is more than chemistry or geology can tell. The difference between the flora of the surface and the soil in which it grows, is the difference between life and death. With life, strictly speaking, geology does not deal. It can only treat of the relics of life, which become memorials of what has passed upon the earth's surface. If, after Capt. Grant had passed along these shores, theyhad subsided under the ocean, and a bed of sand had covered the plants, we should at least be able to say, if they were subsequently upheaved and exposed in hardened strata, that Portland had been dry land once before, and had been carpeted with flowers. More than this, the shape of the leaves would enable us to speak positively as to the character of the plants, and, in some respects, to make a near guess at the shape of the flowers and their seeds. Thus it is with the remains of life that science has principally to deal, and wherever there have been animals and plants, science steps in and holds

inquest on the remains, pronouncing subsequently its judgment as to what they were and how they came there. And when all signs of life are absent, at least, there is the mark of action of some kind—either the energy of fire, or the wearing of water. This supplies the clue we want for a history, and as none other is forthcoming in the case of Portland, it is fortunate that it does so. No sooner do we leave the surface, and plunge beneath the roots of the trees, than we lose sight of life in an instant. As dark as the depths we try to fathom, are the records we now meet with. A region of darkness, but also of death, because there are no signs of life in what is displayed for our examination. What is it that we see?

At first we meet with a light red gravelly or stony soil, and where the rain has washed and sorted the material, we find pebbles of ironstone, that is to say round glassy brown stones, something like burnt coffee beans. This is what is termed pea iron ore, a mixture principally of water, clay and iron rust, tho' the iron is by no means in so large a quantity as the appearance of the stone would lead you to expect. All soils are derived, more or less, from the decomposition of the rocks on which they lie, and the gravel we meet in Portland is no more than portions of soil which have resisted decomposition better than the others. Underneath the soil you find the rock itself, and if you look at any portion of it more closely, you find that it is a hard and blueish grey substance, full of egg-shaped cavaties, just like bubbles. And bubbles in fact they are. The stone has once been in a melting state, and the gases, with which it was filled, have become hardened into cavities as it cooled. It is called *Dolerite* or *Augitic Lava*, and consists of about 60 per cent. of silica, 20 of oxide of iron, 10 alumina, and the rest of the 100 parts made up of lime, magnesia, water, &c. Hornblende is the mineral which enters most largely into the composition of most volcanic rocks, and differs from augite only in the form of its crystals. When lavas cool slowly, they form crystals of hornblende: when rapidly they take a different shape and become augitic.

Thus we come to two facts, in the past history of Portland. The first is, that the ground is covered with a stone, which has come there in a state of molten heat, and next, that it has cooled with comparative rapidity. Observe, however, that the cooling may depend more upon the quantity of matter ejected, than upon the force which ejected it; or it might depend more upon circumstances attendant upon the eruption, than upon its causes. We shall look into these facts subsequently, but I now direct your attention to the mere fact, that we have evidence that Portland was formerly, very near the scene of former volcanic disturbance. Naturally we ask, where was the volcano? It is clear that nothing like a burning mountain exists anywhere in the neighbourhood now, and, in fact, there is no mountain at all from which these lavas could have flowed. If we travel inland to any of the hills which diversify the interior, we find that tracts of sandy soil, or at any rate non-volcanic country, intervene between the rocks we have here and the distant mountains. Mounts Clay and Eccles are both volcanic, and from the latter a lava stream almost reaches the sea. Mounts Kincaid and Richmond have lava on their summits, and Mt. Rouse and Mt. Napier are, beyond all question, extinct craters. But from none of them does any lava stream come to Portland. Whence then have our volcanic rocks been derived? We must look out to sea for the source, because the rocks are thicker in the direction of the sea and thin out as they are followed inland, and because in some places we find the same rocks actually covered by a marine deposit. There is also evidence from the rocks themselves, that they have been poured forth upon the bottom of the ocean and this would account for their being augitic or having cooled so much more rapidly than they would have done upon the land. The evidence is that wherever we can get a glimpse of the ash deposit which accompanied the eruption, we find that it is stratified as if by marine action, and sometimes is converted into a fine mud. Again, lava streams which flow under the air are very uneven on their surface, are more like cinders than stone, and flow generally in a long stream, while submarine lavas are solid

and compact because they were poured forth under the immense pressure of several hundred feet of water, and for the same reason are spread equally around and not in a long stream. The pressure of the water acted as a weight which made the rock develop itself equally on all sides like a flat table. But how could melted stone flow under water you will say? The answer to this will inform you why submarine lavas are not scoriaceous, and cindery on the surface. The first contact of the molten stream with the water, would of course lead to violent explosions of steam, disturbing the water and pulverizing the surface of the lava. Very soon it would be covered with a coating of pasty fragments or lava mud which would restore comparative tranquillity, because finely powdered trap rock is a powerful nonconductor of heat. Half an inch of such a paste would enable you to place your hand with safety on a cauldron of melted iron, hours after the vessel had been filled.

But if the lava of Portland has flowed under the sea, the levels must have been very different from what they are now. A large quantity of the basaltic rocks, as you are aware, lie upon the summit of the cliffs, and at such different levels, that we must suppose the sea bottom to have been very uneven at the time. For if you remark, the cliff on which the lighthouse stands is composed of volcanic earth from top to bottom, while Whaler's Bluff has only a thin covering or cap of the same material, and yet the bluff is obviously the higher of the two. Every one is familiar with the peculiar white coralline limestone, which fringes the bay at certain places and how unequally the basaltic rocks lie upon it. Yet the unequality is more apparent than real, because the rains have caused landslips which have seared and cut down the cliffs until they look more uneven than they are. But still the limestone underneath is uneven. On the south side of the bay only a few pinnacles or points are perceptible, while to the north it rises into fine escarpments. At any rate, if we even suppose the sea bottom to have been uneven, it must have become more so subsequently. The trap rock lies at all sorts of levels. At what is called Grant Bay, it has not risen much above the surface, and at the Bluff, as before remarked, its lowest part is very much above the sea level. We don't know much about the forces of upheaval; we can only see the manner in which they have been exercised, but we can affirm positively, that they have been more energetic in the middle of the bay, than upon the north and south sides of it. I think I may add too that the force was somewhat sudden in its effects, for in no other way can I account for the break in the strata, which terminate so abruptly at the edge of the cliffs. Anything like slow upheaval would, I am sure, have left a gradual slope from the land to the sea, with no sudden disappearance of the volcanic rocks.

So now we have two conclusions to form from the inanimate looking, blueish-grey rock of the Bay, and the reddish soil which covers it. Very long ago, so long, in fact, that years seem portions of time too completely insignificant, and small, to act as its measure, the place where we are now assembled lay under the deep rolling waves of the ocean Of the varied kind of life belonging to that time; of the fishes which glided over what are now your houses; or the shell-fish which browsed on the marine weeds, whose place is now occupied by the grass; of the microscopic animalculæ, and other strange inhabitants of that mysterious deep, I shall have occasion to speak hereafter. It is sufficient to say now, that there was an ocean here sometimes broken into tumultuous heavings, or at times lying peacefully under a glaring sun, which scarcely penetrated the deep blue water. How long it remained so, we can but speculate. A change came at last. First there were earthquakes and then sounds, which set the noise of the waves at defiance; the ocean seethed and steamed under the increasing heat; violent explosions became more rapid and gradually incessant, while the water grew more muddy and troubled. In the midst of these strange novelties, for so quiet, so usually unruffled a place as Portland; in the midst of such turmoil and

strife the floor of the ocean opened with a terrible convulsion, such as only a struggle between fire and water would cause, and molten lava poured forth spreading masses of rock on every side.

I am afraid I should tax the faith of my hearers, too much, were I to speculate further on the volcanic disturbance of Portland, before giving them some instances to show that such things as sub-marine volcanoes, really do occur. In 1831, the quiet sea bottom of the Mediteranean was disturbed by such a phenomenon. At about 33 miles south west of Sicily, and in a place where 100 fathoms of water had been found some short time previously, shocks of earthquakes were repeatedly reported by ships. About July 10, a Sicilian vessel passed the place, and the captain reported that he saw a column of water, about 60 feet high and 800 yards in circumference, rising from the sea, and soon afterwards a dense steam ascended to a height of 1,800 feet. The same captain on his return, found a small island, 12 feet high, with a crater in its centre ejecting volcanic matter and immense columns of vapour. The sea around was covered with floating cinders of a red colour, and dead fish. The eruption continued with great violence until the end of the month, at which time the island was visited by several geologists, who found it to be about 90 feet high, and $\frac{3}{4}$ of a mile in circumference. When it reached the height of 200 feet and was three miles in circumference, it began rapidly to diminish in size. During the month of August there occurred, on the south west side of the island, a violent ebullition with much white steam, showing that a second vent was found; but towards the close of the year, not a vestige of the island could be seen, and all that remains is a dangerous shoal with two distinct outcroppings of black lava, showing where the vents were placed.

Nor is this instance the only one we have of submarine volcanoes. Space alone prevents me bringing forward many other illustrations, such as the elevation of the island of Sabrina, off the Azores in 1811, which island though 300 feet high was very soon washed away by the waves: such also as the uprising of the island of Nyöe, off Iceland in 1783, and another island in the Atlantic in 1720. The crews of many vessels have also reported from various places in the ocean, such phenomena as jets of flame and sulphurous smoke, immense columns of steam, and bubbling discoloured water. New shoals have also been encountered, or reef rocks just emerging above the surface where previously there had always been deep water. Altogether therefore we may say that submarine volcanoes are rather common, and certainly not such impossibilities as the opposite characters of fire and water would lead us to expect, nor perhaps so rare as subaerial volcanoes are at the present day.

But to return to Portland. Whether submarine volcanic disturbance can be proved to have taken place elsewhere or not, I am quite certain that it occurred here. Where was the crater we may therefore ask, or rather the orifice through which all this immense mass of lava was thrown out? Two reasons incline me to think that it must have been very near the present site of Portland. The first is that the lava we find could not have flowed very far in such a comparatively small quantity. Secondly, a crater on a very large scale would have left very different remains from those which we now find. But if near Portland where are we to look for it? Not on the land side for as I have already said the stream has evidently come from the sea. On the side of the ocean I can find no place which would at all correspond with a crater, except the Lawrence Rock, which as I said Capt. Grant named after one of the masters of the Trinity House, and who I dare say little dreamt in what fiery records his name was to be perpetuated. I have not visited the Lawrence Rocks, nor seen any more of them than the view to be obtained from the nearest point on the land side, so that I can hardly pronounce that they are the remains of a crater, but I have seen specimens of the rocks brought from the place and they consist entirely of an ash deposit,

very like what we should expect to find around a submarine crater, and very different from the lava at any other part of the bay.

How far from the nearest land was Portland then. A good long distance I should say, in fact the Australian continent, as a continent, was not known in those days. This is why I think so. The volcanic emanations did not cause the upheaval, on the contrary we have evidence as I shall show you in another lecture, that lava continued to be poured forth a very long time after a portion of the present floor of the ocean had been raised to dry land. Neither did the portion of the sea, with which we are dealing now, become raised directly the trap rocks appeared upon the scene. In fact these rocks are covered with a deposit, which I regard as much more recent and which at the same time covers Australia very extensively. They are the Post Pliocene rocks, and it is no exaggeration to say that the Post Pliocene beds are the most extensively distributed of any formation in Australia, and that very little of the Australian land was above water when they were laid down. So then there was no shore near our submarine crater. There may have been islands here and there, or a chain of them where our mountains are seen now, but there was no continent certainly.

But the fiery outbursts of Portland, were by no means alone. There is abundant evidence to show that most of our marine trap rocks belong to the same geologic age. The outburst formed the commencement of that volcanic disturbance, which lasted nearly without interruption until the continent had assumed almost its present form, and until the gold of the slowly wearing quartz reefs had been washed out deep into the soil below, and the watercourses which took them from their matrices had been covered by many a fathom of basaltic lava. At the time that Portland was so disturbed, the sea bed now called the colony of Victoria, felt in many places the throes of what was the commencement of a change in its destiny. Other parts of the same sea were much disturbed at the same time, but I should say that the disturbance commenced or nearly commenced about Portland. Knowing as yet so little of the geology of other parts of the colony, we cannot say what rocks follow next in antiquity, but we may be sure that the extinct craters such as Mount Gambier, Mount Schank, Mount Rouse, Mount Napier, and Mount Eccles, are the most modern and formed the final efforts of the volcanic movement, before it sunk to rest among the mysteries of the past. The volcanic tract comprised in the district to which I am referring, is very nearly coincident with the whole of Western Victoria. Running north from Port Phillip, so as to include the greater part of the gold fields, and west so as to cut off from the colony of South Australia the country around Penola and Mount Gambier, we should thus include a tract which is all more or less volcanic. The lake country round Geelong, the beautiful hills and soils about Port Fairy and Warrnambool, Mounts Chadwell and Camperdown and Buninyong, all would belong to the same fiery province. And a very disturbed province it must have been. We may talk of the volcanoes of Iceland, or refer to the troubled neighbourhood of Etna and Vesuvius, but Western Victoria, must have been about as hot a corner on the earth's surface as it could then boast of. There must have been always a burning mountain at one period or another, and often as many as two or three together. One year it would be an eruption at Mount Gambier; then Mount Rouse and Mount Schank would break out; scarcely would that be over when Mount Napier whose volcanic fires were on so large a scale as to surpass the others easily, would burst forth with a terrific display and make the solitudes resound with its explosions. Then Mount Gambier would break out again, and after that the hills would rest quietly smoking for a time: then Mount Eccles, near Portland, would have its turn and a terrible turn it would be too if we may judge from what is left, and while it piled its mountainous streams of lava, the other hills applauded with hideous roarings. By day the scene must have been diversified by many a curling column of smoke rolling over the blackened and desolate

looking scoriæ with which the ground was so thickly strewn. The sombre sooty appearance of the peaked hills was dark and heavy with more the aspect of a colliery or a smelting furnace, than the flowery meadows we see around us now. By night the scene must have been awful and grand. The wild landscape was then lit up by lurid flames or glowing lava streams, throwing the dark cones out into relief and tinging the volumes of smoke with fiery outlines. A dreadful spot upon the earth's surface realizing the ghastly visions of the ancients about Tartarus. And yet in drawing the picture, I can assure my hearers that I am in no way heightening the effect by any appeal to the imagination which is not grounded on facts. There is irrefragable evidence that all these things have really taken place, that not only have the most of the hills round Portland been volcanoes, but they have been in activity not once but many different times. At the same time the place where we are assembled was emerging from the sea with evidence upon its surface, that volcanic fire had given it a visit as well as its neighbours.

Nor are the many hills about the town, the only evidence left that volcanic disturbance happened on a large scale in this country. Most of you have seen, and I am sure all have heard, of that beautiful tract of land which lies around the valleys of the Glenelg, the Wannon, and the Wando. To those who have not seen it, I fear any description of mine will fail to give an adequate idea. After travelling along the table land, which rises from the sea in a series of terraces for about 50 miles north of Portland, one comes suddenly to a break in the even surface of open forest. So sudden and abrupt is it that such a change would never be looked for even at the distance of a mile, unless a close observer were to remark the thin blue haze like smoke which shows between the openings of the trees. All at once the traveller finds himself on the edge of a valley, which dips away from his feet like a precipice, and lies in rolling hills of grass only very scantily dotted with tress. The vale is just like a crack in the surface, for the indentations in one side correspond with promontories on the other. What is still more curious is that both sides of the valley are at an equal level, and are even continuations of the same tableland just as if no valley intervened. But it is not one valley that is seen here. As soon as one is crossed, the hills on the opposite side lead to the edge of another, and so on amid gullies and swelling downs, nearly destitute of timber for many miles. All the flattopped summits of the sides are at the same level or nearly so, and all the mounds which lie like islands in the midst of the gorges are evidently outliers of the same broken plain. In each valley a slender processional line of timber marks the course of a stream, which runs some 300 or 400 ft. at least, below the level of the country. It can be seen at a glance that such small rivers never could have hollowed out such immense gullies and ravines. It is evident from the course of the drainage that it has followed creeks on the surface already in existence, and in doing so has taken a very round about course to reach the sea. In fact one sees after a little consideration that the country owes its peculiar configuration to the somewhat sudden upheaval of a great plain or tableland, which has become cracked and fissured as it rose. And what caused the upheaval? The stones tell their own tale here as elsewhere. The bottom of every valley contains either granite or mica schist, or else the sides are covered with large boulders of basaltic rock. Some of the ravines are actually filled half their length with a lava stream, which thus causes the occupying stream to leap down in beautiful cascades. The lower falls of the Wannon and a tributary are thus caused, while the upper falls are the consequence of a dyke of porphyry running across the stream bed. Besides lava streams and porphyry dykes, there are intrusion of other rocks which stand up in peaks here and there, and very much diversity the scenery. Almost every kind of volcanic stone is represented. There are dykes of *Diorite* and *Felspar Porphyry*, hills of *Serpentine*, *Phonolite* and *Basalt*, with *Olivine;* but what is the strangest thing of all, there is not one single extinct crater in the vallies from which they proceeded. How have they come there

then? We can't exactly tell you. Every volcanic district has evidence of similar intrusions and upheavals, but amid all our experience of volcanic phenomenon, nothing of the kind has been witnessed in actual operation. We can tell how the forces have been exerted, but the cause of it all is hidden.

Before I leave the subject of volcanoes, I must refer to two enquiries, which are of special importance. Are such large volcanic districts common on the earth's surface? They are unquestionably, and more than that, volcanic disturbance is seldom manifested in any other way. I had an opportunity of visiting one of the most interesting tracts of the kind, that of Central France, and though the phenomena there exhibited, are not nearly so extensive as those we meet with here, the appearance of both places is very much the same. But if the volcanoes of Central France, bear no proportion in point of size to those of Western Victoria, neither will ours bear any proportion to many other tracts upon the earth's surface, such as those of Central America, the Indian Archipelago, &c. There is at present, in the northern part of South America, an area in full activity, which has produced results in comparison to which ours are positively insignificant. Large mountains there are still burning, and, sad to say, large cities leave most disastrous records of what mischief a burning mountain can do.

My next question is, what is the cause of volcanoes? This is not so easily satisfied, and in answering it, I am sorry to leave the satisfactory region of fact and certainty, to dive into that of misty speculation and guess work. The first and easiest way to account for all the volcanoes on the earth's surface, is the theory which seems the most plausible, and of which you have all heard at one time or another. The centre of the earth is supposed to be a mass of liquid fire, and volcanoes are places where the crust has cracked and let a portion of the fluid contents run out. To many this theory appears so certain that they are surprised to hear it called in question, or asked for the proofs in its favour. These proofs are, that volcanoes, as proceeding from great depths in the earth, are pretty good evidence of what the character of those depths must be. Again, the deeper we dig into the earth's crust, the higher the temperature rises, and as the increase of heat has been ascertained to be one degree for every 64 feet of descent; we should arrive at less than 24 miles, at a heat which would keep the hardest rocks in a state of fusion. Last of all, the lowest rocks in the earth's crust are always igneous in character, and would seem to show that the globe is slowly cooling down from its intense original heat.

I am almost afraid to tell you, that such satisfactory reasoning is far from proving the case. In the first place, we don't know that volcanic products come from such immense depths, at least, if the whole diameter of the earth be considered. Secondly, the increase of heat as we descend proves too much. The cause is too enormous and unnecessary to produce the trifling effects we are considering. The highest volcanic mountain would scarcely be as much, with reference to the earth, as a grain of sand to a water melon, and the largest volcanic district is but an inconsiderable spot upon its surface. Again, the thickness of the earth's crust would be utterly inadequate to support 8,000 miles of liquid fire. Oh but the force of gravitation! Well, if the force of gravitation restrained it, then volcanoes ought not to occur at all. Besides, we can find a better reason to account for the increase of heat as we dig down. Pressure causes heat we are well aware, and it is the absence of it on high mountains, which makes them so cold and snowy. Pressure must have an enormous influence on the heat of the earth's crust, almost sufficient, indeed, to account for the increase of temperature. For remember, we are not dealing with the weight of the atmosphere alone. We have the pressure of millions and millions of tons of rocks, piled one above the other. But this you may say, would come to the same thing; be the cause what it may, you would have the effect gradually increasing until a state of fusion is reached. Not at all. The pressure increasing with the heat would prevent liquefaction, and in effect the granites we find in the

lowest strata, have not been fused, but seem to have been brought to a pasty mass by the combined efforts of water, heat and pressure. Last of all, the most convincing argument we have against a central nucleus of fluid fire, is that the actual specific gravity of the earth is more in accordance with the idea of a hollow shell, than a mass of molten rock.

Well then, if the centre of the earth is not a mass of fire, how are we to account for volcanoes. The very fact of their occurring in districts, is a proof that they are derived from local peculiarities in the rocks where they occur. It would be impossible for me to give even an outline of half the theories, which have been broached to account for these singular phenomena. As a specimen, I may give one. It has been remarked that volcanoes are rarely found except near the sea, and that, in consequence, they are in some way connected with the upheaval of the land. It has been argued that the introduction of sea water by cracks and fissures, would cause chemical combination to ensue among the metals, which, we know, are plentifully stored in the earth's interior; such, for instance, as *Calcium*, *Potassium*, *Aluminum*, &c. Now, the oxidation of such metals is a chemical process, which would evolve much heat and electricity, and this, aided of course by the elastic force of the discharged gases, would give rise to volcanoes. To support this view, it is alleged that volcanoes are not formed far away from the salt water basins of some kind; secondly, that the chemical constituents of lavas, correspond with such a view; and lastly, that only when the surface of the land is cracked and pressed by upheavals, do we ever see volcanic phenomena developed. The latter fact is certainly true, with regard to the volcanoes of Portland, because the sea bottom appears to have been subsiding when the Pliocene rocks were deposited. Directly we have evidence of upheaval, we find also that lavas and basalts begin to appear.

This is all I shall say about the theories. The one I have given, appears to me to be the most plausible; but who shall say it is the right one. I hold it as certain, however, that volcanic disturbance is local, and not connected with the centre of the earth; that it is due to chemical action, but of what kind I can hardly say. Surely, when the most scientific men are at issue on the subject, you and I must be contented with what is somewhat uncertain.

Thus you see I have sketched for you, the commencement of the history of Portland. I have not dealt with the earliest records we have, but it is certainly its most striking feature. More ancient periods will form the subject of the next lecture. In the meantime, I hope you have followed my attempt to describe the fiery cradle of this place, and that you will feel an extra interest in a town whose stones have been formed by fire, whose hills have been rolled up by earthquakes, and at the birth of whose foundations, a royal salvo of explosions proclaimed to the restless ocean, that another land had been raised from the waves.