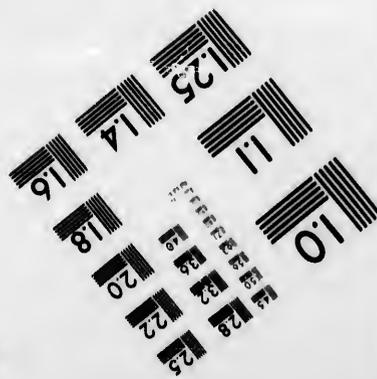
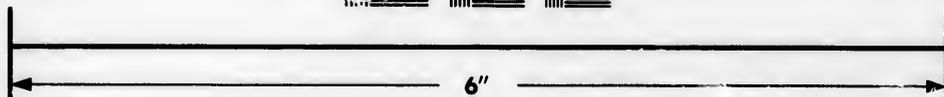
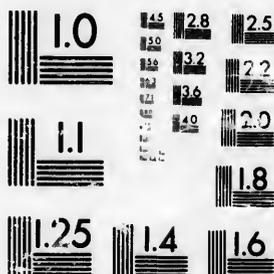


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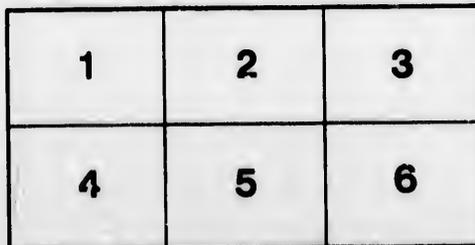
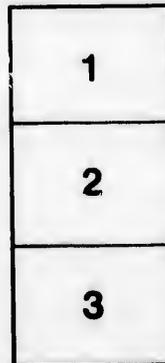
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I. VESUVIUS AND ITS NEIGHBORHOOD;

MEMORANDA OF A VISIT IN 1852.

2. "ON ACCIDENTAL DISCOVERIES."

TWO PAPERS READ BEFORE THE CANADIAN INSTITUTE, AND REPRINTED
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BY

REV. HENRY SCADDING, D.D., CANTAB.

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VESUVIUS AND ITS NEIGHBORHOOD.

Those who have visited Saratoga will perhaps remember the High-Rock Spring. It has its name from the circumstance that its water, containing much lime in solution, has formed a mound of calcareous matter some five feet high, with a well-defined central throat, up which the fluid column in former times ascended. This conical hillock must have had its beginning from the water in the first instance rising with force through the surface of the soil, and depositing a sheet of calcareous matter. The same process going on from year to year, minute strata accumulated, until the present altitude of the mound was attained. The falling of a tree then caused a fracture in the mass, since which occurrence the water, instead of flowing over the top, has found a lateral outlet.

We compare indeed small things with great, and slight with enormous energy ; but the High-Rock Spring may serve to illustrate the manner in which volcanic hills are formed. An aperture is found, in the fissure we will suppose, in the crust of the earth ; fluid matter is forced up from below, and, as it spreads itself out around the orifice from which it issues, it becomes solid ; another ejection takes place : another thickness swells the dimensions of the growing mound : the process is repeated, until, in a succession of years, or in some instances in a few hours, a mountain is accumulated. A central channel is preserved, up which fresh matter still ascends, except when the energy below diminishes or a side-vent is opened.

All the mountain chains upon the globe, indeed, were probably thrown up by the force which we still see active in volcanoes. But with the majority of mountain chains there does not appear to have been any explosion. The elastic gases have lifted the superincumbent strata without forcing for themselves a passage. In many regions of the globe, semi-fluid granite just protruded itself through long fissures in the overlying deposits, and became *set*—a ponderous ocean at the time, in some localities at least—tending to depress and perhaps cool the uprising mass.

The mountains which we call volcanoes have, especially in regard to their upper portion and cone, grown by the accretion of ejected volcanic substances. In some volcanoes these ejections continue to take place from the original orifice or crater ; in others, the interior force has become diminished, so as to be capable of thrusting the molten fluid only up to a certain point, where it continues in a state of ebullition either visible to the eye, or concealed by a crust of solidified lava ; in others lateral openings are formed at points below the ancient crater ; and in others the volcanic energy seems to have worn itself out.

Of the last class are the extinct volcanoes of Auvergne and Velay in France,

of Catalonia in Spain, of the Eifel district in Germany :—of the next to the last are *Ætna*, the Peak of Teneriffe, and *Cotopaxi* :—of the next preceding, *Kirauca* in Hawaii is an example :—and of the first mentioned numerous class, *Vesuvius*, the mountain in respect to which I am about to offer a few memoranda, is a type.

Vesuvius, as compared with other active volcanic mountains, takes a low place, being only 3,947 feet in height, while *Antisana*, in South America, the highest active volcano on the globe, is 19,137 feet high.

But although *Vesuvius* is one of the humblest of volcanic mountains, it has from many circumstances received peculiar attention. It is conveniently accessible to European observers. It is situated in the midst of a region rich in associations mythic and historic, unrivalled for physical beauty, and altogether strongly attractive to every imaginative and thoughtful person who has it in his power to visit foreign lands.

It is a memorable moment when on waking in the morning and finding the steamer in which you have been travelling, still and at anchor, you are told that you are in the Bay of Naples. You hasten to the dock. You take an excited survey of the widely-sweeping panorama which overwhelms the eager eye. Ships in crowds are near you, and craft with the obliquely-set lateen yard-arms. Boats are moving silently on the surface of the iridescent water, which is giving back from the eastern heavens the kindling glories of the rising sun. Sailors are rowing ashore ; you hear the regular creak of the row-locks as they work their oars, contrary to custom, with their faces towards the bow. Fishermen are paying out their long nets, hand over hand, indulging at the same time in a low chant-like song. In front of you, terrace rises above terrace of cheerful habitations, crowned with monastic edifices and massive fortifications. Behind you are castles and encircling moles—one bearing a colossal figure with hand upraised to bless (*St. Januarius*)—another sustaining a lantern or pharos-tower, whose light still gleams down towards you along the surface of the water, though the day comes on apace. To add to the excitement of the scene—drawing again on the incidents of a morning indelibly impressed on my own recollection—a royal salute is fulminated from the castle on the left, which is no sooner ended, than responsively from another in the far distance on the right, a similar series of explosions takes place, each detonation following late after the quick scintillation of the flash, making the deck on which you stand to shake, and reverberating finely among the hills. Be it understood that the King has had an additional Prince born within the palace which you see yonder near the shore, and a festival of sixteen days has been proclaimed—sixteen days, which, every morn and every eve, are to be signalized by similar stunning demonstrations, by illuminations also, and reviews and music, and whatever else may constitute a Neapolitan holiday.

But of all the objects which attract the attention as you gaze around the grand panorama before you, two mountains, side by side, close upon the right, isolated, of purple hue, and well-defined from base to summit, rivet at last the eye. On the morning already referred to, the glow of daybreak had outspread

itself immediately behind them. The planet Venus was splendidly conspicuous vertically over them, looking as if she had been a meteor, shot up and held suspended at the culminating point. And there she remained beautifully visible for a considerable time after the surrounding constellations had "paled their ineffectual fires" before the ascending sun. Over the easternmost of the two mountains rested what appeared at the moment to be a dark cloud, varying considerably in form, looking in shade quite black in parts, and occasionally rolling up pitchy volumes, like the smoke issuing from a great funnel of an Atlantic steamship when fresh coal is being put on below, the whole mass becoming at last magnificently fringed with fiery gold, as the sun gradually emerged from behind it and pierced its murky folds. These twin-mountains together form Vesuvius.

I observe in the ancient, so-called classic maps, that the name attached to the basin which we call the Bay of Naples is "Crater." The old observers had taken notice that there was in this locality a connected system of volcanic vents, and that Vesuvius, Vulture, the Solfatara of the Phlegrean fields, Avernus, Ischia, Stromboli, with *Ætna*, itself, were but minor formations on the lip of a gigantic flue for the escape of the elastic gases, whose egress by their former channel the influx of the Mediterranean had checked. In that old appellation—"Crater"—have we not also a lingering reminiscence of a huge upheaval, and consequent oscillation of ocean, of which tradition spoke—when perhaps the Aral parted company with the Caspian, and the Caspian with the Black Sea, and all three with the Baltic,—when the Black Sea no longer formed a continuous expanse with the Mediterranean,—when Thessaly became dry land, and Pelion fell from Ossa,—when the Red Sea ceased to receive the Jordan, and the valley of the Nile, the Mediterranean,—when the mountain chain which had previously linked the continents of Europe and Africa together was ruptured, and Atlantis, not all a fable, sank beneath the deep?

But be this as it may, Vesuvius is one of a system of volcanic vents, either open or for the present obstructed, which it is interesting to trace in this neighbourhood;—with which system are doubtless connected also the extinct volcanoes of the Albano hills, near Rome, the Solfatara on the road to Tivoli, and the Lago di Bracciano, to the north-west of Rome.

The base of Vesuvius is now encompassed on two sides by railways. The one to the north-east runs to Capua, and is ultimately to reach Rome. The other to the south-east is completed, I believe, now to the ancient port of Brundisium. The south-eastern road has "stations" at Herculaneum and Pompeii, and by this route many persons proceed from Naples to Resina, where the ascent of Vesuvius is usually commenced. But although to travellers in the United States of America the idea of rushing by rail to Rome, Syracuse, and Troy is sufficiently familiar, the tourist who is desirous of keeping his mind in harmony with the past, whose veritable relics he is about to contemplate, will certainly do well to prefer the old public road. By taking this route to Pompeii, you also have the advantage of witnessing a succession of animated scenes of popular life, the whole line of road being an almost continuous suburb of Naples, and

swarming with inhabitants. Here will be seen crowds, who, in their sun-burnt, copper-coloured skins, scantiness of dress, showiness of rude ornament, and want of productive occupation, will strike the Canadian who has visited Caughnawaga, Manitouwaning, or the Sault, as Indians of a rather superior class. In your way out, too, by this route, you will be sure to meet or pass numbers of those nondescript, characteristic vehicles of the neighbourhood, the country caleches, made so brilliant with gay paint and bright brass, in respect to which one is constrained to wonder (first) how fourteen or more passengers—embracing motley groups of peasants, soldiers, ecclesiastics, monks, women, children, and infants in arms—can be placed within them, or slung on to them—for slung on many literally are in nets hanging down behind,—and (secondly) how the one diminutive horse or mule manages to whirl them along as decked with little flags, streaming ribands, jingling bells, and glittering gear, he merrily does. You will have an opportunity of calling, if you feel inclined to do so, at one of the innumerable macaroni manufactories which—at Torre del Annunciata, for example—line the street, where almost every house looks like a chandlery of farthing rushlights, the pipes of the popular esculent suspended in the open air on countless rows of long rods to dry, resembling in colour and diameter that once celebrated article. Within you can examine the process, which will not fail to interest, by which the farinaceous dough of which this staple food of the neighbourhood consists is forced into the various shapes of macaroni, vermicelli, fedelini, ribands, sheets; and the minute little discs resembling the green seeds of the hollyhock, so abundantly to be met with in Neapolitan soups.

At Torre del Greco you can descend from your carriage and examine the lava, which here in vast sheets has found at various times its way into the sea. In 1794 it destroyed the principal portion of this town by passing through it in a stream 1,200 feet wide, and of a thickness varying from 12 to 40 feet, advancing into the Mediterranean a distance of 380 feet. The desolation occasioned by this, and another later fiery flood (1806), is still fresh to the eye. The disintegrating force of the atmosphere has not yet had time to dissolve the rocky surface into soil, which ultimately heals the wounds of earth, and obliterates all scars. The colour of the solid mass is here a dark blueish gray, reminding one of our familiar Kingston limestone when newly quarried. Here and everywhere along the drive out from Naples, the lava is seen turned to useful account. Houses are built of it; the streets are paved with it; the heaps of metal piled by the wayside, for the purpose of repair are composed of the same omnipresent substance.

But in noticing what may be seen at Torre del Annunciata and Torre del Greco I have gone beyond Resina, where, as I have said, the ascent of Vesuvius is usually commenced. In practice, indeed, I believe, persons generally do pass through Resina, visiting Pompeii first, and taking Vesuvius in their return. But inasmuch as "Vesuvius and its neighbourhood" is my subject, I hasten to despatch the mountain first, and reserve what I have to say on its neighbourhood for the second division of my paper.

Deposited, then, at Resina, you procure horses and a guide. An unromantic

carriage-drive has been constructed, by which a considerable portion of the mountain may be circuitously ascended. A more interesting mode of ascent is by a rough bridal-path on horseback. Taking this route you proceed up a sort of watercourse, passing over bare lava which shelves backwards by great flights of broad irregular steps. At first on the right and left are vineyards and gardens till you approach a rather level portion of the mountain, where stand the place of refreshment called the Hermitage and an Astronomical Observatory—not the scene of the discoveries of De Gasparis—that one gazes at with interest close to Naples itself. At this point vegetation ceases, or has been destroyed over the upper portion of the southern and western flanks of the mountain, and the far outskirts of the cone begin to present some rather startling evidences of the desolating power of volcanoes. The whole apex of the mountain rises solemnly before you, apparently a pile of solid lava—of lava which bears very visible marks of having flowed down from the crater above in broad outspreading cataracts. Its furrowed, rutty look is like the surface of one of our unmacadamized back-streets after a sudden frost. Here and there you see where the descending ponderous fluid has met in its course with some solid mass of anterior date, and has coiled heavily around it; leaving great sluggish circular ripples, set fast for ever. You start from Resina very buoyantly; you are carried gaily along on your willing nag. The brilliancy of earth, air, and sky fills the mind with a sort of child-like glee. But as you approach the base of the cone, a sobriety comes over the spirit. Like the child that advances onward into manhood, you find that you have entered a rather stern region, and that nothing short of hard work will enable you to overcome its difficulties.

Arrived at length, after two hours and a half, at the Atrio del Cavallo, near the base of the cone, you dismount. You take a rough scramble up a wild desolate ravine underneath the precipitous walls of Monte Somma, the north-westerly summit of Vesuvius; you notice the stratified layers of the ancient lava, and the buttress-like dykes of subsequent and apparently harder lava jutting out from the semi-circular escarpment of this, the original gigantic crater of the volcano of the pre-historic times; and after satisfying your curiosity as well as the time will admit, you return and begin the ascent of the cone.

The place chosen for this exploit is a part built up, so to speak, with closely-packed fragments of lava and slag, between the interstices and among the prominences of which you insert your feet, to the certain disruption of only moderately strong shoes. The whole inclination of Vesuvius, were it uniform from Resina to the lip of the crater, would be only about thirteen degrees. Up to the base of the cone it is still less; but the cone itself is inclined at an angle of forty-three degrees. The perpendicular height of the cone is about 1000 feet; so that it can easily be conceived that the physical labor of ascending it—to a person not accustomed to climb—is for the time extremely painful. It requires, indeed, many "corragios" from the guide, and some assistance from a looped strap which he throws over his shoulder for you to lay hold of, to enable you to persevere.

While toiling thus sorely up this steep, I began to be convinced that the good Franks of yore really did mean by their word "travail" what some etymologists have asserted. To get "transvallum"—beyond the wall—to scale the precipitous flank of some old Roman camp, was doubtless to their warriors some such task as this—a difficulty memorable enough, certainly, to be embodied in a term.

At length, after numerous rests, and after a lapse of perhaps an hour and a half, you find yourself on the comparatively level platform which leads to the lip of the great crater. The desire accomplished is found to be truly sweet on such an occasion, and the propensity to be noisily elated is quite overpowering. A strong wind blowing in our direction, sweeping down over us a huge column of vapour, which completely obstructs the vision, obliges us several times still to halt in our ascent of the final gently inclined plane.

At last we are on the brink of the great crater, and we find ourselves looking down into a gigantic and tolerably sooty-looking flue, up which from unknown mysterious depths are rolling volumes of what in the distance seems smoke, but which is, in fact, steam—steam carrying up with it a variety of choking gases. The whole breathing apparatus becomes immediately painfully affected, and we are reminded of the sensation suddenly experienced when one passes the nostrils over the edge of some great vat where fermentation is going on. The reverberation of a shout directed by the guide or yourself down into the undefined abyss is sufficiently awe-inspiring. Its effect can in some degree be conceived by imagining how a shout would sound when directed into a hollow cask one thousand feet in diameter.

The view obtained in every direction from this position is in the highest degree interesting and exciting. The Appenines form the background of the picture, a congeries of secondary and tertiary formations, exhibiting in their retiring ranges phase after phase of the finest aerial colouring. On one side you look down upon a city, pre-eminently of the living, ever on the stir and outwardly joyous—the syren-city, a sight of which its inhabitants fondly say might reconcile a man to the relinquishment of life. On another side, in solemn and instructive contrast, you see cities of the dead—historic fossil beds—mines not yet exhausted by the student and philosopher. Around you, on the left and right, are Capri, Positano, Procida, Miseno, Baiæ, names summoning up images of beauty and long trains of shadowy forms and events. Yonder is Posilipo, the "grief-dispelling," the favorite haunt of the poet who, before the Christian era, sang the praises of this region, and whose tomb now consecrates that height. Before you, far and wide, lies the tideless sea, a household word throughout the world, whose name recalls the ideas with which the old cosmographers vainly tried to satisfy inquiring minds—whose serene surface, stretching to the distant south and west, still now as of yore reflects and sets off to best advantage the never tiring, because sublime pageantry attendant on the demise of each successive day.

After traversing a portion of the rim of the great crater,—its whole circumference of 5624 feet,—holding firmly the arm of the experienced guide, you begin

to clamber obliquely down into the interior of the orifice. Your feet sink deep in black pulverized lava or sand. You observe underneath the surface everywhere beautiful primrose-coloured sulphur, perpetually deposited here, I am informed, from the constantly ascending hydro-sulphuric acid gas. You observe the stratification of the successive accumulations on the cone. Everything is sensibly hot to the touch. At the direction of your conductor, you thrust your hand into various holes and crevices, and you are fain to draw it out again as quickly as possible—the heat either remaining from the eruption of 1850, or maintained by the continual ascent of hot vapour from below.

After descending some yards, what with the increasing gloom, the oppressive heat, the obscurity of the undefined depth on the left, the boisterous rush of air every now and then from above, blinding and choking you with steam, the adventure seems—to a novice at least—to be sufficiently beset with terrors; and one is not sorry when it is at last determined to re-ascend without actually setting foot on the floor of the crater, one hundred and fifty feet below.

The place chosen for the descent of the cone is wholly diverse from that just now described in my account of its ascent. Conceive one of those great earth-works which in so many directions are now advancing across our Canadian valleys for railway purposes. Imagine the perpendicular height of the part where the laborers are shooting down load after load of loose soil to be one thousand feet, and the inclination of the slope to be precisely the angle at which the material will remain at rest:—you have then an idea of the part of the cone where tourists go down from the summit of Vesuvius. This side is of course selected from its being composed, not of closely-packed masses of slag and lava, but of pulverized volcanic matter.

Linking yourself firmly to your guides' arm, you plunge fearlessly off. You take strides which seem miraculous. The material in which you plant your heels goes down along with you and after you. You have only to take care that nothing arrests the action of your feet;—any obstruction might send you centrifugally forwards. Everything being in your favour, you are of course at the bottom in an incredibly short space of time. I remarked just now on the never-to-be-forgotten painful exhaustion produced in the ascent of this cone; its descent is equally memorable for the exhilarating and quickening effect which it has on personages even of the gravest carriage.

At the foot of the cone the patient ponies are waiting. After satisfying a number of noisy applicants who claim to have rendered you service, you mount, and, accompanied by men carrying torches—for it is now dark night—you amble gently down to Resina. From thence you drive into Naples. Your mind throughout the day has been receiving impressions which are to endure for life, and it has become in an extraordinary degree excited. You feel and welcome the calming influence of the quiet stars that burn above you, and which recall the kindred splendours of your own far-distant skies.

The first recorded eruption of Vesuvius is that of A.D. 79, when Herculaneum, Pompeii, and Stabiae were overwhelmed. It is supposed that by this explosion

the upper portion of the mountain was considerably reduced in its dimensions. Strabo, the geographer, about the year A. D. 25, describes it as a truncated cone covered with vegetation nearly to its summit. Its configuration, as it then presented itself to the eye from Naples, can easily be imagined by supposing the circle of which Monte Somma is a segment to be continued all round, and the line of the present inclination of the mountain on the south-east side to be produced from the slight rise called Pedamontina until it meets this circle, the axis of the whole cone remaining the same as it is now. The portion which we thus in imagination supply, is supposed to have been broken down by the weight of the lava which accumulated in the crater after the re-awakening of the volcano in A. D. 79.

The north-eastern side of Somma is to this day a smiling slope of vineyards, gardens, farm-houses, and villages. In the days of Strabo, the south-western slopes presented a similar scene. The poet Virgil, who, as I have already said, was familiar with this Campanian coast, and has celebrated in his verse its most striking localities, does not fail to notice Vesuvius; but he does not give us to understand that he was aware of its volcanic character. From Strabo, however, we learn that it was known to be volcanic. Plutarch, in his life of Crassus, mentions a curious use to which the crater in its quiescent state was once put. Spartacus, the Gladiator, who, in B. C. 73, headed a formidable insurrection against the Roman government, entrenched himself here with his forces, after his defeat by Crassus. The swordsman had doubtless defended himself in many an arena before, but in none on so grand a scale as this. Beseiged by the prætor Clodius, who thought it simply sufficient to watch the entrance to the crater—the ravine to which I have already referred as existing between Somma and the present cone—Spartacus and his men let themselves down over the precipice by means of the wild vines which grew there, and suddenly and successfully attacked their assailants in the rear.

The poet Martial, who saw the mountain a few years after the desolating eruption of A. D. 79, records the lamentable change which had taken place in its appearance. "These heights," he says, "Bacchus loved more than his own Nysa; here the rustic Satyrs held their dances; Venus preferred the spot to Lacedæmon; here Hercules himself had sojourned; but now everything lies prostrate beneath fiery floods and melancholy scoriæ."

It may be here stated that the name Vesuvius—which by Roman writers is variously written Vesevus, Vesvius, Vesbius—is said by Neapolitan scholars to have been given to the mountain by the Phœnicians, who, at periods prior to the old Greek foretime, formed settlements along the Italian coasts. Its Syriac form was *Vo-seveev*, "the place of flame." Similarly, *Herculaneum* has been derived from *Horoh-kalie*, "pregnant with fire;" *Pompeii* from *Pum-peeah*, "the mouth of a furnace;" and *Stabia* from *Seteph*, "overflow."

In the remarks which I now offer on Pompeii, I simply speak of the place as one of the accessories of Vesuvius. To do justice to Pompeii, in an archaeological point of view, would require a separate paper. It is well known that this city was not overwhelmed with molten lava, but by showers of sand, ashes,

scoriae, and mud. The persons who lost their lives on the occasion, when compared with the population, were few. The great majority had time to make their escape. To those who first carefully examined the mass as it lay upon the various houses, it was manifest that there had been disturbances in its parts, showing that after the catastrophe, some of the inhabitants returned to recover their effects. The exterior walls of the town, with their gateways and low turrets, are finely disclosed. Towards their base very ancient work is occasionally seen—resembling, in the arrangement of the ponderous irregular masses, the so-called Pelasgic style. In their upper portions a curious mixture of material occurs—of stone with brick-work, carefully stuccoed to resemble stone. Blocks are observed with inscriptions in Oscan—the words and letters appearing reversed, after the manner of types set up. To a Canadian, who is generally too well acquainted with “burnt districts,” the interior of Pompeii has at the first glance the familiar look of a town recently devastated by fire. Bare roofless walls of no great altitude are standing about in all directions. Forests of pillars; perfect and imperfect, supply, in some quarters, the place of the chimneys, which, isolated or in stacks, are with us so conspicuous after a conflagration. The ruins, however, do not look black and fire-scathed. The compact pavement of the streets, is composed of blocks of ancient lava of irregular shapes, laid together after the manner of the old Viæ, resembling somewhat on the surface at least, the memorable flagging which formed our first attempt at trottoir-making in Toronto. Along the top of some of the walls, rows of modern tiles have been placed for protection by the Neapolitan Government. Upon the exterior of the walls along the streets you see inscriptions laid on with a sort of red paint—the names of the owners of the houses or of persons whom the owners desired to honour as patrons. Upon the walls of the Basilica—or Court-house, as we should say—idle persons, standing about, have scratched their autographs. I have taken down one—that of *C. Pumidius Dipilus*, who more than eighteen centuries ago, thought it worth while thus publicly to record the fact that “he was here on the 7th day of October, B.C. 77,” as we should now write the date. “*C. Pumidius Dipilus, hic fuit ad nonas Octobreis, M. Lepid, Q. Catul, Cos.*” The little stones which compose the mosaics on the floors of the larger houses—exhibiting the originals of many of our oil-cloth and carpet patterns—are lava cut up into small blocks. The ancient frescoes on the interior walls—the prototypes of several styles of modern room-paper—are now much faded, though their designs are still clear. Whenever any objects of art and domestic use are unearthed in the excavations which are still occasionally made, they are deposited for safety in the Museo Borbonico in Naples. This museum, which is one of the most interesting in Europe, ought to be well studied by those who desire to have a clear idea of the ancient Græco-Italian life. Here you see a thousand things in the shape of utensil and ornament, personal and domestic, which show that the old Campanians were men like ourselves influenced by the same tastes, wants, and weaknesses. Among innumerable objects of interest, I remember a charred loaf of bread—baked, of course, nearly eighteen centuries ago—bearing the baker’s name (*Cruuius*) legibly stamped upon it.

Thirteen years before the final catastrophe, we learn from Tacitus that the luxurious repose of Pompeii had been disturbed by a terrible earthquake. At the time of the last disaster, the inhabitants had just regained confidence to set about the repairs which had been rendered necessary. It is curious to observe in several quarters the partially new work. In the Forum, for example—the Public Exchange of the city—new lengths in the shafts of the fluted columns, resting on more ancient bases, are to be seen. On the ground are lying portions of columns nearly ready to be put up. Here stone-cutters' tools were found scattered about, as they had been left by their owners. Pillars in Pompeii, however, are not everywhere of stone; many are of brick, stuccoed. Indeed I was rather surprised to find in Rome, as well as here, how largely brick and stucco enter into the material of ancient buildings. Pompeii was situated at the mouth of the Sarnus; and most of the streets which have been uncovered, ran down to the edge of the sea westward from the entrance of the river. But the accumulations of volcanic substances have thrust off both the river and the sea—the former half a mile, the latter two miles, from their ancient places. Up every street, as you look towards the north-west, Vesuvius closes the vista—still showing, by his ever restless column of steam, how capable he is of again rousing up his destructive energies. About two-thirds of the city still remain unexcavated. Where the excavations cease, you can approach and examine the perpendicular sections of the whole mass of accumulated material. You observe immediately that numerous showers of volcanic matter have descended since A. D. 79.

Near the Amphitheatre, the different strata with their thicknesses may be traced as follows, beginning with the surface:—(1) Black sparkling sand (recent), 3 inches; (2) Vegetable mould, 3 feet; (3) Brown incoherent tuff, 1 foot 6 inches; (4) Small scorie and white lapilli, 3 inches; (5) Brown earthy tuff, 9 inches; (6) Brown earthy tuff, with lapilli, 4 feet; (7) Layer of whitish lapilli, 1 inch; (8) Grey solid tuff, 3 inches; (9) Pumice and white lapilli, 3 inches:—in all, 10 feet 4 inches (Lyell). Another observation, where the thickness is 20 feet, gives the arrangement of the strata as follows, beginning from below:—Separating the whole into five parts—the first three consist of pumice-stone in small pieces, resembling a light white cinder, and covering the pavement to the depth of 12 feet; the next portion, composed of six parts, begins with a stratum of small black stones, 3 inches in thickness; to this succeeds a thin layer of dry mud; upon this lies another stratum of little stones, of a mixed hue, in which blue predominates; then comes a second stratum of mud, separated from a third by a thin wavy line of mixed blue stones: this completes the fourth portion; while the fifth or highest division consists entirely of vegetable earth or decomposed volcanic matter (Gell). In the neighbourhood of Pompeii you see large fields of the cotton-plant, which about here reaches its northern limit in Europe. On leaving the inn near the ruined city, I was taken by surprise, by being presented with a bouquet of bursting cotton-pods and flowers, accompanied by a salute upon the hand—the graceful offerings of a handsome peasant to whom during the day I had given a few baiocchi for some little service rendered.

Herculaneum is situated nine English miles to the westward of Pompeii. It was overwhelmed, as is well known, with material more solid than that which came down upon the latter city. And sheets of fluid have flowed over its site since its first obliteration. So that now the excavations have to be made as in a quarry of solid rock, to a depth varying from 70 to 112 feet. Care is taken, when any additional building has been opened and searched, to throw back the material into its former place—lest the superincumbent mass, on which the present town of Resina is built, should break through. Consequently, the parts which you are enabled to examine are limited. With the aid of torches, the shape and dimensions of the theatre—capable of accommodating 8,000 persons—can be well made out, where it is a curious thing to see the capitals of pillars embedded, like ammonites or portions of the mastodon, in almost solid rock. From Herculaneum have been derived some of the most interesting of the objects in the Museo Borbonico in Naples. In a villa here were found the striking statues of Æschines and Agrippina, authentic busts of Plato, Socrates, Demosthenes, Scipio Africanus, Seneca, and others, with beautiful bronzes—some of them made to look life-like by the insertion of glass eyes. But its most interesting relics are the papyri-rolls, resembling brown charred sticks, two inches in diameter, and from six to eight inches long. Some of them—displayed now under convenient glass-cases—have been successfully unrolled and deciphered. But the regretted decades of Livy and History of Sallust are desiderata still. No works of importance have been discovered, with the exception perhaps, of a treatise by Epicurus, entitled “De Natura.”

Stabie, overwhelmed also in A.D. 79, and situated under a portion of the modern town of Castellamare, four English miles eastwards from Pompeii, has ceased to be examined. Having been reduced to ruins by Sulla in the course of the Marsic war, B.C. 91, is not supposed to be so rich in relics as the two towns which have been excavated. Oplontis, a small Roman village, overwhelmed with its more distinguished neighbours, was cut into during the construction of the Western Railway from Naples, about two miles eastward from Herculaneum; a few mosaics and sculptured animals were found.

We shall now pay a rapid visit to the volcanic district westwards of Vesuvius—appropriately named the Phelgræan fields, “the fields of fire,” if the Greek etymology of the name be the correct one. We shall tread on ground teeming with recollections of illustrious or remarkable men. I shall be pardoned, then, if here and there, though still looking at things in general in a volcanic point of view, I indulge in some brief historical notices as I pass. Traversing the whole length of the ever-lively Naples—where, doubtless, we have before our eyes a picture of an old Greek community, in modernized costume,—we arrive on its western side at a tunnel perforating the mass of ancient volcanic tufa, known as the hill of Posilipo. Here, before you enter, you may leave your carriage for a short time, and ascend by some steps on the left, and examine the dilapidated columbarium to which tradition points as once the receptacle of the ashes of Virgil. It is certain that the poet had a house on this hill, and that therein he composed his Georgics and Eclogues and the greater portion of his

Æneid. It is a spot which harmonizes well with the poet's memory, having within view numerous localities whose names have become household words through his pen—a spot rendered in an additional degree venerable now, by reminiscences of illustrious men, who, from Statius and Petrarch, to Milton, Thomson, and Gray, with pious steps, have visited it,—Milton at the tomb of Virgil! Was it not there, while standing at the shrine of a kindred scul, that the inspiration, already stirring the fair young English bard, shaped the effectual resolve to leave words behind him which the world "should not willingly let die?"—It is curious to remember that in the middle ages the name of Virgil! was popularly known only as that of a magician—doubtless from the assumed familiarity which he exhibits in his 6th Book with the world of spirits. It was from the prevalence of this idea, that Dante made him the conductor of himself through the realms below.—Dante in his turn was, for similar reasons, pointed at by the rustics of his day as the man who had visited the abodes of the dead. And to close the list of popular misunderstandings in respect to famous persons—Horace, by the peasantry in the neighbourhood of the Sabine farm, is at this moment believed to have been an Englishman, from the numerous English who take such pains to scramble to the spot.—But we must return to the tunnel below, which itself—though it bears to this day visible marks, not of the magician's wand, but of instruments more substantial—was once popularly attributed to the supernatural power of Virgil. It may be briefly described as 2,244 feet long, 21½ feet wide, from 69 to 25 feet in height; gloomy, dusty, and unsavory. There are several other similar grottoes, as they are illusively called, in this neighbourhood—all artificial, and dating back before the Christian era. They are short cuts from town to town, made through the rather soft volcanic rock.—You are now on the road which leads to Pozzuoli. You are interested at observing evidences of the latitude in which you are. You notice in the hills specimens of the palmetto-palm. You perceive the stone-pine—the familiar object in Italian views—stretching out its flat peculiar top. You see the aloe and the cactus in profusion. You observe peasants under trees dancing to the sound of the guitar. You meet rude ass-drawn and ox-drawn vehicles loaded with strange tropical-looking fruits and vegetables.

You soon enter upon the Phlegrean fields in earnest. You arrive at the well known Lake Agnano—an irregularly-shaped ancient crater, three miles in circumference, filled with a sheet of water. From fissures in its walls issues sulphurous vapour of a temperature of 180° Fahrenheit, showing that a highly heated mass is not far off. Here you have exhibited to you the world-famous but rather insignificant *Grotto del Cane*—a small cell containing a spiracle from below, up which rushes carbonic acid gas, mingled with steam—A little to the westward you come to another partially extinct crater—the Solfatara—an irregular oval plain, sounding treacherously hollow to the tread, and full of steaming and smoky fumaroles, which at night emit a glow as from a furnace, showing that they communicate immediately with red-hot material. Within the base of what was the ancient cone of the Solfatara, in the far depths, water is incessantly heard in the act of boiling, in which state it finds an

outlet. It is stated to be an aluminous water containing iron, lime, and free sulphuric acid. Some of the hills which form part of this ancient crater are white with an aluminous efflorescence.

You next approach Astroni, a very perfect crater, four miles in circumference, bearing on its floor three small but deep lakes. It reminds you, on a small scale, of those circular valleys, which, with the aid of a good telescope, you see on the surface of the moon. Indeed I doubt not but that in these Phlegræan fields, we have by analogy many hints given of what we should meet with, were we permitted to take a stroll on the lunar disc.—Travelling still westwards, you come next to a very conspicuous and perfectly formed crater, three miles and a half in circumference—Monte Barbaro (the ancient Gaurus)—covered with vineyards producing the wine which Horace sings of as Falernian; and near by are two more similar craters, only smaller—Cigliano and Campana. Proceeding yet westwards, you come to Avernus itself, the dread entrance to Hades. In the old prehistoric era, this crater no doubt possessed some of the awfulness of the present interior of Vesuvius. The Cumæan colonists transplanted to this neighbourhood the myths of their native Greece, and easily established Campanian duplicates of their own Styx, Cocytus, and Acheron. Here is the scene of the well-known *Nekuia* of the 11th Book of the Odyssey, and of the descent of Æneas in the 6th Book of the Æneid. The ancient Italians must have enjoyed these references of the poets more keenly than modern readers can. They must have felt the Æneid to have been a *national* poem much more thoroughly than we do—the mere *naming* of a locality being sufficient to call up to their minds the often visited spot—with its brilliant colouring and historic and poetic associations—Avernus is now a cheerful place; a beautiful lake, abounding in fish, lies in its basin, and over it and on it feathered fowl sport with impunity. The etymology of Avernus (quasi *Aornos*, “birdless” is now supposed to be fanciful, though Virgil, and Lucretius before him, adopted it. The true origin of the name appears to be in the Phœnician *Evoron*, denoting “gloom” or “darkness.” But though the old composition of the name may not be true, still it is probable that in the ancient times birds would seldom be seen about the spot. Instinct would lead them to shun the breath of a volcano, as surely as it leads their congeners to revel so joyously, as we see them doing, in the wholesome spray of our Niagara.

The hills on the northern side of this lake—the walls of the ancient crater—are richly covered with chestnut trees and vines. The rim of the bowl on the southern side has been broken down, just as we have seen the southern side of the ancient crater of Vesuvius carried away. It is in consequence of a celebrated “cut” made by Agrippa—the bold engineer statesman to whom Augustus owes so much of the éclat of his reign—that we see the lake of Avernus reduced to the limited dimensions of a mile and a half in circumference, and five hundred feet in depth. Between it and the sea, towards the south-east, we can see the famous *Lacus Lucrinus*, itself a crater, lower down on the flank of the ancient volcano. Into this lake Agrippa admitted the sea by a canal; then by another canal he let down Avernus into Lucrinus—thus forming a

magnificent double dock, where the Roman fleet, quadrupled, might float securely. This port, a grand topic with the poets and historians of the day, existed in good order until A.D. 1538, when the long dormant volcano over which the united lakes reposed suddenly awoke.—A short distance to the south-east, you may observe a conspicuous hill, resembling the cone of a volcano. This is the celebrated Monte Nuovo, which was thrown up in the space of forty-eight hours on the occasion now spoken of. After a succession of volcanic shocks a fissure took place near the Lucrine Lake; from the aperture rose to a great height, first cold water, then hot;—then followed masses of ashes and lapilli, descending on the country in torrents of mud; then followed volleys of dry ashes and red-hot pumice stones. And in forty-eight hours a hill was formed 440 feet in height, and a mile and a half in circumference, filling up a large portion of the Lucrine Lake, and ruining Agrippa's harbour. On the top of the hill is a crater one-fourth of a mile in circumference, and 419 feet deep. It is only of late years that the scorïæ on its surface has become sufficiently decomposed to admit of the growth of small trees thereupon. The line of the coast in the immediate neighbourhood was, during this explosion, elevated to such an extent that the sea seemed to have retired 400 paces.—The profusion of the mountain of Jorullo, in Mexico, in A.D. 1759, is a well known parallel to Monte Nuovo. Both are interesting, as throwing light on the nascent condition of volcanic hills.—To the south-west of Lucrine, you come to Fusaro (the old Acherusian), famous to this day for its oysters, another water-filled crater, and still further on is Mare Morte, another. To arrive at the latter, you pass through Elysium—the tract which is said to be the original and veritable prototype of that fair creation of poets.

To the north of Avernus, I should have mentioned just now, one more crater is traceable in this region; and a fragment of its ancient walls constitutes the acropolis of the venerable Cumæ, the earliest Greek settlement in Italy.—The Lake Licola, to the north of Cumæ, which *looks* like one of the system of volcanic lakes, which we have been tracing out, is in reality, it is said, the remains of the canal which Nero is known to have commenced with the intention of carrying it through the Pontine marshes as far as Ostia.

From Mare Morte, or rather from the beach called Miliseola—corrupted from *Militis schola*, an ancient military parade-ground—we take the ferry and cross a narrow strait two miles to the island of Procida, and from thence, over two miles more of sea, to Ischia. These two pyramidal masses—so impressive on the memory of the visitor to Naples, and so celebrated in song and history—are stated by those who have scientifically examined them, to be parts of one great volcanic mountain. Here, prior to the awakening of Vesuvius in A.D. 79, was the principal safety valve of this fiery region—Homer, Pindar, Virgil, and Ovid celebrate the eruptions of Mount Epomæus in this identical Ischia; and here Typhœus was fabled to be buried. Once only since the Christian era, has it exhibited activity. In 1302 great damage was done by an eruption of lava.

We now make the trajet back from Ischia to the mainland again. We pass the conspicuous promontory of Misenum—retaining, in accordance with the

poet's prediction, "æternum per sæcula nomen." On the left we coast along by the once voluptuous and still beautifully situated Baiæ—the favorite watering-place of southern Italy in its old palmy days. As you gaze now into the sea two hundred yards from the shore, you see the sunken substructions of villas, temples, and baths—the former haunts of luxurious emperors, patricians, poets, and orators. This coast, too, has known the presence of Hannibal, Alaric, Genseric, and Totila.—You have Pozzuoli—the old Puteoli before you—covering the flanks and summit of a bold hill jutting out into the sea; the dark masses which you observe at regular distances above the sunny surface of the calm water, are the piers of the ancient mole, once surmounted by a light. We land on the west side of the hill. We are conducted at once to the Serápeon which stands near—a temple of the Egyptian Serápis—a ruin which has become memorable among physical observers—as proving to the eye, by the perforations of the marine borers called *Lithodomi* in its still erect columns, that the land subsequently to the erection of the building, must have gently sunk and remained submerged for many years, and then that it must as gently again have been raised. The perforations on the columns are now seen at a height of twelve feet; they cover a space of nine feet; and then above them comes an uninjured space of twenty feet, which must have been the portion of the columns appearing above the surface of the sea, when the stratum on which they stand had sunk down to the lowest point. The shore is supposed to be again descending. In order to approach the pillars for close examination, you have to walk through an inch or two of salt water. The edifice has been large. Its exterior colonade was 140 feet long, 122 feet wide. Here was found the remarkable sitting-figure of Serápis, having his hand on a three-headed dog, now to be seen in the Museum at Naples.

We must not delay in Puteoli, though its associations tempt one to do so. As the southern terminus of the Appian Way—a high road to Rome—It was, before Naples existed, the principal focus of the Italian trade with the East. The Greek colonists from Cumæ called the place *Dicaearchia*; but the Romans preferred the appellation "Puteoli," as having, in sound at least, an allusion to the hot sulphureous "wells," which abound in this volcanic locality.—Here we tread in the foot-prints of St. Paul; and standing on the now solitary beach we can perhaps more vividly realize the interesting fact than we do when surrounded by the mosaics and marbles which encrust his shrines in Rome. The Apostle, as we know from Acts xxvii. 13, landed at Puteoli a prisoner in chains, and after his perilous voyage was allowed to rest here for seven days.—On a neighbouring rising ground you may be conducted over a remarkably perfect amphitheatre [480 by 382 feet], where, in A.D. 66, Nero contended publicly with wild animals, and where, in the time of Diocletian, Januarius, the supposed patron of Naples, with other Christians, suffered martyrdom. Here you may also be conducted over no inconsiderable remains of the Villa Puteolana of Cicero—familiar to the reader of his letters to Atticus, and distinguished as the spot where he wrote his *Questiones Academicæ* and his work *De Fato*: and also as the place where the Emperor Hadrian died.

Passing through Puteoli towards the east, you come out on a noticeable stripe of land between the precipitous cliff and the sea. By the marine deposits here found, mingled with the remains of human workmanship, it appears that this stripe, like the shore westward of Puteoli, has been successfully depressed and elevated. On the sides of the cliff, 35 feet above the present sea level, the borings of lithodomi may be observed, and on the summit of the cliff are substructions of villas which once overhung the sea.

As you leave this narrow stripe, the road by which you travel passes through a massive stream of solid lava, which, in prehistoric times, flowed down from the Solfatara already visited, and here entered the sea in a stream one-fourth of a mile in breadth, and seventy feet in thickness.

You pass, also, on the left, some stone quarries, in which, exposed to the hottest rays of the sun, you see—for the first time perhaps, in your life—unfortunate human beings working in iron fetters. Alas! that the clank of those degrading links should be associated forever in the recollections of anyone with the name of Italy!—The labourers in the stone quarries of Epipolæ—whom perhaps, your imaginations may summon up—were more happy. The fortune of war had placed them there. But what is it that, in the Neapolitan states, according to the testimony of Mr. Gladstone, causes men, and perhaps some of these, to be thus condemned to chains?

Proceeding by the coast road homewards towards Naples, you remark, to the westward of the heights of Posilipo, a few hundred yards from the shore, a small island. This is Nisida, the last volcanic object in the neighbourhood of Vesuvius which we have to notice. It is a cone with an extinct crater, into which, on the south side, the sea finds an entrance by a breach in the rim. A convenient little harbour is thus formed.—You may gaze on the island of Nisida with interest, for several historical reasons. Here Lucullus, the celebrated conqueror of Mithridates, possessed a villa which, a few years after his death, became remarkable as being the place where Marcus Junius Brutus retired after participating in the assassination of Cæsar, and where he left his Portia, the daughter of Cato, when he departed for Greece, destined never to return. It was here, too, that the interview took place between him and Cicero, of which the latter has left a graphic account, wherein the orator declares that he found the patriot “*nihil nisi de pace et concordia civium cogitantem.*” In yonder little volcanic isle we have, then, a memento of the final but unsuccessful struggle for Roman liberty. We, curiously enough, have before us in the same object the scene of the extinction of the Western empire itself in the person of its last chief.—In exile here, a pensioner on the generosity of Odoacer, the first king of Italy, lived and died the son of Orestes, Romulus Augustulus, the closing member of that series of puppets who, from A.D. 455 to 476, filled the throne and brought contempt upon the name of the Emperors of the West.

Since the great explosion of Vesuvius in A.D. 79, the craters of the Phlegrean fields appear to have become for the most part quiescent. The interruptions of their repose have been three, already noticed in passing; one in 1198, when

the Solfatara emitted a stream of lava ; one in 1302, when Epomeo, in Ischia, did the same ; the third in 1538, when Monte Nuovo was thrown up.

The intervals which have occurred between the fifty-two eruptions of Vesuvius, since that of A.D. 79, I make out to be respectively the following—124 (years), 269, 40, 308, 43, 13, 90, 167, 194, 131, 29, 22, 12, 2, 2, 3, 6, 5, 5, 3, 8, 2, 7, 14, 3, 4, 2, 6, 1, 3, 6, 3, 5, 2, 1, 6, 10, 1, 4, 3, 1, 4, 3, 2, 6, 3, 3, 4, 6, 2, 3 (1850).

In the earlier portion of the Christian era, some eruptions may not have been recorded. The generations of men who could forget the sites of considerable cities may have neglected to record the activity of a volcano. If there have been no omissions, the eruptions of Vesuvius appear to have become more frequent since the year 1631.—It has also been observed that there is a degree of alternation between the movements of Etna and Vesuvius. In no instance have the two mountains been in active eruption simultaneously. Hence they appear to be escape-valves to one connected mass of igneous matter—the upward pressure of the elastic gases with which it is charged finding relief by the one, when the other is obstructed.

While standing on the summit of Vesuvius, and contemplating the enormous column of steam which is generally in the act of being blown off, one is inclined to rush to the conclusion that the molten rock which overspreads the surrounding scene far and wide, has been shot up by nothing more or less than the familiar force which, with such irresistible power, lifts the piston. But further reflection induces a correction of this opinion. It is likely that the steam is simply produced by the infiltration of sea-water on the heated mass within the base of the mountain.

When we consider the fact that the ground on which we tread is but the surface of a rind,—that by experiment this rind increases 1° Fahrenheit in temperature for every fifty-four feet of vertical depth,—that at the depth of twenty miles granite must be in a state of fusion—we cannot fail to see that it is probable that the seat of all volcanic energy is in some common central igneous mass with which all the volcanic vents more or less communicate ; and that these vents are very possibly established and maintained in order that the globe may not one day fly to pieces like a Rupert's drop.

But what is it that determines the moment when those fierce ebullitions must occur which ruffle the surface of the Phlegethon below, and cause its molten waves to rise on high, and so rudely flout the roofs of the cavernous crypts over which men dwell, shaking them and their structures, “massy-proof,” from their propriety ? What generates those expansive gases whose excess from time to time thrusts up before them the fiery fluid through which they seek to force their way ?

These are queries which remain unresolved. Like the storms which observers notice, but cannot explain, in the magnetic world—these movements in the inner abysses of the earth must still, for the present, be classed as mysteries.

We doubtless here have glimpses of the forces, whatever they are, which, in the old foretime of our planet's history, burst apart the primitive crust ; which tilted its strata in divers directions, as the uneasy polar sea bursts up its ice ; which exposed huge sections of those strata with their contents, to the view, the use, and the delight of men ; superinducing, apparently, at first, a scene of ruin,—harsh, sharp, bare, and confused ; a scene, however, which resolved itself at last into what we now call mountain, hill, and vale ; interspersed with river, cataract, lake, and sea ; softened in outline by abrasion and disintegration, by slopes of alluvion and surfaces of mould, and coloured warmly over by mosses, lichens, herbage, and woods, and blue ethereal haze.

But though the seat of volcanic energy be at the core of the globe, and its force, as is most probable, supplied by chemical agency operating there on an enormous scale—may it not be possible to explain, in some instances, some of the visible phenomena on mechanical principles ? May there not be, in the case of many volcanoes, rude natural channels and reservoirs within the stratified parts of the earth's crust, into or through which the fiery fluid may pass, on its rising towards the surface—channels which, having a certain amount of inclination, may cause liquid lava to act as water in the hydraulic ram, producing earthquake-shocks when the throes are ineffectual—and ejections of matter high into the air, when a passage has at last been cleared ?—reservoirs, in the shape of huge natural caverns, which gradually becoming filled with the rising fluid, produce, by atmospheric compression over its surface, a continuous stream for a time—like the air-bor in the fire-engine ?

I conclude with the remark that in Canada—in western Canada, at least—we appear to be happily situated outside the circle of dangerous volcanic influence. It is true we now and then hear of vague rumblings at St. Catharines and Dundas ; of a sort of volcanic tide-wave in the Lake near Cobourg ; of detonations on the north shore of Lake Huron. We are assured, also, that an undulation of the earthquake at Lisbon in 1755 was felt on Lake Ontario. We know that in 1663, in the lower portions of the Province, there was an earthquake with volcanic ashes, which lasted for six months ; that in 1785, and again in 1814, at Quebec, there was pitchy darkness at noon-day, with black rain and volcanic ashes—due, it has been supposed, to a crater in the terra incognita of Labrador. We can see, moreover, that the basin of Lake Superior, in the far dim foretime of this continent, was a focus of volcanic action. We notice trap in the river St. Marie, and Gros Cap is porphyritic. Col. Fremont describes an extinct crater in the neighbourhood of the Great Salt Lake, and an active volcano, 70 miles to the north-east of San Francisco. Mount Elias, in the Russian territory, is an open volcanic vent. And Commander McClure, of the *Investigator*, reports lava along the American Coast of the Polar Sea. But in Canada, on the whole, it is a matter of congratulation that we have thus far been permitted to acquire a strong confidence in the ground on which we tread, and that we are spared the presence amongst us of any of those points of communication between the upper and nether worlds—which in other lands are exceedingly interesting,—but also sometimes very inconvenient.

ON ACCIDENTAL DISCOVERIES.

I shall ask you to transport yourselves in imagination, for a few moments, to the sea-side. The brilliant blue of the heavens—the stillness, and rather inconvenient glare of light on the surface of the water, may tell you that it is the Mediterranean. The arid aspect of the precipitous shore, with the dark palm-tress that stand out distinctly here and there along the strand, indicate that it is the Syrian coast. Yonder bold promontory on the right is the famous Cape Carmel. The spacious bay which you gaze into is the Bay of Acre. The river which you see entering between the ridge of low rocks and the beach of white sand on the left, is the Belus. To that beach of white sand let me direct your attention. A group of sea-faring men are there rising from their mid-day repast; their vessel—a small trading craft—has been run in close to the shore; their meal and siesta over, they are gathering up their rude culinary utensils, and are about to resume their voyage. The fire upon the beach has smouldered away; the pale ashes have become of the same temperature as the surrounding sand.

But while the party are busy in re-embarking, one—he is possibly the commander of the vessel—observes something in those ashes. Something that glistens strikes his eye; he touches it with his knife; he lifts it out from among the mingled ashes and sand, a bright, irregularly-shaped mass. Something has been fused in that fire; whilst fluid it has “run,” as we may say, in several directions; where, in one place, it has met with the rock underneath, it has spread out in small sheets, which are, to some extent transparent.

Now, it will be necessary to explain. Yonder vessel bears in its hold, among other merchandise, some tons of rough nitre—a substance produced naturally in the neighbourhood of the Dead Sea. It was used possibly of old, as now, in the preservation of fish and meats. The sailors, on landing, having failed to find near at hand stones adapted for the purpose, took some lumps of this portion of their cargo to rest their camp-kettle upon. The fire has acted on those lumps, as also on the silicious sand on which they are placed; fusion and amalgamation of the two substances have ensued; the hard transparent material, noticed by the commander of the vessel, is the result. The captain, during the remainder of the voyage, is more silent than usual; he is ruminating on what he has observed—“If this nitre and this sand, thus subjected to fire, will produce this hard, transparent substance once, they will do so again; if this substance spread itself out so readily upon the flat rock, becoming solid and continuing transparent, it will spread more conveniently, and be rendered more transparent by means of surfaces which I can prepare for its reception—

may, will it not assume any form of which I may be able to construct the mould!"

You will perceive that it is *glass* that has been discovered—a substance that contributes so much to the comfort and gratification of man—a substance that excludes from his house the inclemencies of the atmosphere, and yet admits freely the sun's rays; that adorns his hospitable board with a variety of vessels of brilliant hue and graceful shape—that permits him to refresh his eyes in winter with the green leaves and blooms of summer—that helps to repair his vision when defective, and to add incredible powers to it when at its best—a substance that, elaborated into massive plates, lends lustre along the street to his multifarious handywork; and, on occasion, forms walls of what, prior to experience, would be deemed of fabulous extent, to shelter in vast store-houses the gathered masterpieces of his skill.

The narrative just given may or may not be authentic. Pliny met with some such story, and thought it interesting enough to be treasured up in that curious depot of fact and fancy—his "Natural History." I simply use it as an illustrative introduction to some examples of accidental discovery in Science and the Arts, which I have thought it might not be inappropriate to enumerate to you this evening.

That glass was in some manner discovered at an early period of the world's history, is certain. Articles of this material, very skilfully constructed, have been found in the palaces of Nineveh, and the ancient tombs of Egypt and Italy. The number of glass vessels to be seen in the great Museum at Naples, collected from the buried cities of Herculaneum and Pompeii, is truly astonishing. In that Museum are also preserved numerous fragments of *flat* glass from the latter place, together with bronze lattice-work with panes of glass actually inserted, proving that glazed windows were by no means unknown eighteen centuries ago.

Could we be admitted to the secret history of discoveries and inventions in general, I dare say we should find that many more have originated in what was apparently an accident, than we are now aware of. We know that the devotees of the so-called Occult Sciences in the Mediæval period—the Alchemists—the transmuters of metals and searchers after the elixir of life—lighted on facts that tended largely to the development of the real science of Chemistry.

We have dim traditions from the mythological times of the accidental invention of musical instruments. The wind whistles over the sheaf of broken reeds in the arms of the shepherd-god, and gives him the idea of the syrinx—the pipes of Pan—which perhaps in turn suggests the miniature organ of St. Cecilia. Again, Hermes strikes his foot against the shell of the sun-dried tortoise, and the tightly-strained tendons give out musical tones. He thus literally stumbles on the lyre—the germ of our harp and piano-forte. The colossal statue of Memnon (Amenophis) in Egypt, emits music from its head—cavities in the sculpture producing vibrations in the air. The fact is converted into a miracle, and gives birth to a series of adroit uses of the simple laws of nature for the creation of surprise in the minds of the ignorant.

Were we living in an age of infantile simplicity, to what myths might we not expect those mystic chords to give rise which in these days are so rapidly encircling the earth as with a zone ! Listen to the excellent music which they discourse over your heads as you walk abroad ! We overlook the phenomenon as a mere trifle—the principle of which, however, might lead us at least to the Æolian harp—were we not long forestalled in that ; and are absorbed—and justly so—in the sublimer contemplation of a system of artificial nerves, gradually throwing themselves out over the globe, along which may rush impulses from the will and soul of man.

Of chance discoveries hinted at in very ancient history, I find one or two cases more. The gracefully-curling leaves of an Acanthus plant, surrounding a basket left by accident upon it, catch the eye of a sculptor who has a quick sense of the beautiful. A new style of ornament for the column is instantly conceived. The Corinthian capital thenceforward in all after ages gives pleasure to the frequenters of Temple and Forum. Again the hand of affection, on one occasion, is prompted to delineate on a wall the shadow of a head, to be a memento, during an anticipated absence, of the beloved reality. The art of portrait-painting takes its rise from the circumstance.

The popular tradition is that the falling of an apple first suggested to Newton the idea of universal gravitation. Sir David Brewster, very reasonably, gives no credence to the story. Still, we can well imagine the philosopher in his orchard at Woolstrop, using such a casual occurrence by way of illustration to a friend :—“ If this earth be a globe, and what is ‘ up ’ to us is ‘ down ’ to our antipodes, why does yonder apple, for example, descend to the surface in preference to rising outwards into space ? ” And may we not ask, in connection with Newton, is it not exceedingly likely that the resolution of white light into its component parts by the prism, may have been suggested to him by the beautiful colours which he must often have seen projected on the walls and ceiling of a room from the crystal drops of a chandelier ? But questions like this it is easy to put, in the case of almost every invention, after it has taken place. We are so fortunate as to be put at once in possession of the result, without being obliged so much as to think of the steps which led to it. Still, it is interesting sometimes to conjecture what those steps were.

The bold stroke of Columbus, by which he caused the egg to stand alone, has become a proverb. Any person visiting now the heights behind Genoa, and remembering that the great navigator was once familiar with that scene, can imagine it to be exceedingly natural that he should have discovered America. “ If Africa lies yonder, though invisible to the eye, what reason is there, why I should not believe, when I look out on the Atlantic from behind Lisbon, for example, that there is as certainly land to be arrived at, by persevering to the West ? ”

By a pleasant train of association, the mention of Genoa and Columbus suggests to me the memory of Pisa and Galileo—with another example of happy accidental discovery. It was in the magnificent cathedral at Pisa that the gentle oscillations of a chandelier gave Galileo (1642) the idea of the applica-

tion of the pendulum, as a regulator in an apparatus for the measurement of time—a combination that ripened at last into that exquisite piece of mechanism—the Astronomical Clock.

The recent ingenious experiment of M. Foucault, to demonstrate to the eye the motion of the earth, was the result of a chance observation. While engaged about a turning-lathe, he took notice that a certain slip of metal, when set in motion, vibrated in a plane of its own, independently of the movement of the part of the lathe on which it was carried round. Hence, he thought he could by a certain contrivance exhibit to the eye the revolution of the earth on its axis. He obtains permission to suspend from the dome of the Pantheon at Paris, a pendulum of some 280 feet in length, and demonstrates the accuracy of the idea which he had conceived. However difficult of brief explanation the phenomenon may be, it is nevertheless a fact—and it is with a degree of awe that one witnesses it—that the pavement of the Church seems very sensibly to rotate, the pendulum at every oscillation returning to a different point on the graduated circle placed below the dome.

The inventor of spectacles was a great benefactor—but having found no chronicler, his name is lost. He was, probably some one who himself suffered from defective vision—the necessity of an individual often leading to contrivances which benefit a class. Friar Bacon has been mentioned as the inventor, but not with certainty. Spectacles, however, became generally known in Europe about his time (1214-1292). I have often thought that a person afflicted with short sight, would be very apt to hit upon a remedy. I remember, as a boy, discovering that many of the little blisters in common window glass would partially correct short-sight; also, that the polished bottom of a common tumbler would occasionally do the same—facts that might lead any one to the construction of concave lenses.

Sir Francis Palegrave in his "Merchant and Friar," amusingly represent the good Abbot as scouting the idea that the *shape* had anything to do with the marvellous effect which a certain lens was discovered to have on the vision of the short-sighted young Emperor. According to the notion of the age, it was simply the innate *virtue* of the transparent gem of which the lens was composed that produced the result.

The defect of sight arising from the approach of old age, calls of course, as we all know, for a lens of the reverse shape of that required by the short-sighted. The construction of such a lens may readily have been suggested by noticing the magnifying power of a drop of water, or a globule of clear glass. A lens of this description once made, and used in frames for the correction of vision, soon led to important combinations.

An ingenious lad—the son of a spectacle-maker at Middleburgh in Holland—takes it into his head to look through two of these convex lenses at once, varying the distance between them by means of his two hands. He observes that the vane on the church steeple is brought wonderfully close to his eye—but that the image seen is reversed. The casual circumstance gives birth to a

noble progeny of inventions. Here is the rudimental germ of the Telescope, the Microscope, the Cameras for various purposes.

When Lawrence Koster, at Haarlem in 1430, let fall on a piece of paper the fragment of beech bark on which he had playfully cut in relief the initials of his name, little dreamed he as the stain produced by the moist sap first attracted his attention, what a revelation had been made to him, and through him to the world. Metal types and the art of printing thus had their beginning.

Bradley, the celebrated astronomer, (1748), is amusing himself with sailing on the Thames in a pleasure boat: the wind is blowing strongly; frequent tacks are made; he notices that at every turn of the boat, the vane at the mast-head, instead of keeping steadily in the direction of the wind, exhibits an uncertain sort of motion. By a train of reasoning he arrives at an important conclusion on the subject of the aberration of light, starting a theory that has relieved astronomers from a perplexity under which they had previously laboured.

M. Malus, a French Colonel of Engineers, (1810), casually turning about in his hand a double refracting prism, as the sun is setting, observes one of the images of a window in the Palace of the Luxembourg disappear—and it leads him to the discovery which has rendered his name distinguished, of the polarization of light by reflection.

We might narrate how friction on amber originated the science and name of electricity—how experiments with jet, with sealing wax and India Rubber, might lead to the same result—how Louis Galvani, (1737) at Bologna, by taking notice of the spasmodic action of the legs of dead frogs when touched by his electrically-charged scalpel, discovered that phase of electric science that retains his name—how Masso Finiguerra, (1450) at Florence, while working at his business as an annealer of gold and silver, discovered the art of engraving on copper-plates, so as to obtain impressions on paper therefrom—how Louis Von Liegen, (1643,)—or, as some say, Prince Rupert—invented the process of mezzotint, by observing the corrosion of rust on a gun-barrel—how Alonzo Barba at Potosi, (1640,) happening to mix some powdered silver ore with quicksilver—with the view of fixing, if possible, the latter substance—found all the pure silver of the ore absorbed by the quicksilver, and so arrived at the secret of forming amalgams—how the casual observation of Francis Joseph Gall, (1757,) while yet a boy at school—to the effect that those of his companions who had prominent eyes had facility in remembering words—led at last to his curious theory of phrenology—how M. Argand, by perceiving a draught created by the passing of the neck of a broken bottle over a flame was led to invent the well-known Argand Lamp—how M. de Courtois, (1813,) by accident detected iodine in sea-weed, from which material, since his time, it has been extensively manufactured.

These, and other equally interesting examples of happy discoveries by accident, I might narrate at length; but, I hasten to speak of the steam-engine,

whose history presents us with actual anecdotes in point. With these I shall conclude.

And first, the Marquis of Worcester, (1650,) while a political prisoner, in the Tower, conceives from the dancing motion of the cover of the vessel in which he is cooking his dinner, the idea of a piston driven by steam—an idea that results at last in the perfect engine of James Watt.

Then, Capt. Savery, (1680,) flings into the fire a wine-flask from which he has just removed the contents ; he perceives that steam is generated by a few drops which remain in it. Something prompts him at this moment to snatch it from the fire, and to plunge its neck into a bowl of water ; the water rushes up into the body of the flask, a partial vacuum having been created therein. This leads him to the construction of the engine known by his name, useful for raising water from small depths.

Again, up to the time of Newcomen, (1705,) the condensation of the steam within the cylinder was effected by the external application of cold water. He observes on one occasion that the piston continued its movements after the external application had ceased ; and the cause of this he finds to be a jet of water entering the cylinder through a small aperture which had escaped his notice. A well known simplification of the engine is the consequence.

Lastly, the boy Humphrey Potter, set to open and shut the steam valves, contrives by means of strings to make the working beam supply his place ; thus originating arrangements by which the beam is made to execute several secondary offices.

The discoveries to which I have alluded, I have spoken of as accidental. This is a phraseology which we rather unreflectingly employ. Doubtless, all the capabilities of things—the agreeable as well as the useful—are intentional. They have existed from the beginning, and have been designed for the good of men ; and when an individual is so fortunate as to detect any one of them, he is simply fulfilling the Divine will.

On looking back over history, I think too we can discern, in the case of several important discoveries at least, that the moment of their occurrence has not been utterly accidental. When the mariner's compass was invented, it was soon to be required. Columbus, Vasco de Gama and Cabot lived in the next age. When Lawrence Koster saw his initials impressed on paper from the piece of beech-bark, the intellect of the fifteenth century was heaving, fermenting—struggling for some means of embodying and circulating its aspirations, more rapid, more universal than the reed of the solitary scribe.

The disclosure of the continent of America itself, had it no connection at the time with the approaching overburdened condition of the population of the old world, with its social theories becoming obsolete and requiring a free field in which to be re-constructed ?

If such a view of events be well-grounded, what are we to think of the present age ? Is the curious accumulation of wonders, in the midst of which we

find ourselves, accidental? Are the facilities for intercommunication among our fellow-men, accidental? Is the abundance of gold, accidental? Is the perfection to which the arts—the certainty to which the sciences—are so rapidly tending, accidental? If not, there are signs enough to invest this age with an enormous amount of interest—nay, with a degree of solemnity. For, what are our *duties* in such an age? Surely our responsibilities are greater than those of our forefathers. The facilities which we enjoy—the powers which we are enabled to exert—were not intended to be mere toys for our amusement: are we not expected to work out with them results which shall in some degree be proportionate to the trust?

An era of great importance is just opening upon ourselves. We are beginning to feel that the wave of the world's movement has reached us, and that we are being lifted forward on its tide. Our opportunity has arrived; we shall, I doubt not, embrace it with energy.

It is in such times, in most countries, that ideas of sterling value are struck out. We may expect to see an intellectual activity among ourselves surpassing any that has as yet characterized us. One remark it will be useful to add. In every instance which I have adduced of what I have called "accidental discoveries," the accident was such as would be very unlikely to occur to an unobservant, unthinking, badly-informed person. The more observant—the more thoughtful—the more completely informed we are—each in our several professions—the more likely we may be sure, we shall be, to light on ideas that will be of practical advantage to the world.

Let each man stand, then, judiciously on the watch, and challenge every phenomenon with intelligence. Nature is not exhausted; there are yet latent secrets within her stores. Clues to additional truths are floating about in the air above, in the water beneath; let but the observer come who has the eye to see, the hand to lay hold of them. In arrangements already established, there are combinations and simplifications possible, which may eclipse the original inventions on which they are founded.

All countries have contributed names to the list of those who have made posterity mindful of them for services rendered in science and the arts. From the omens of her existing history, we cannot doubt but that Canada will contribute names to that list.

In what direction will the first great manifestations be amongst us? Will it be in the mill, or the loom, or the plough? In the canal or the railway? In the modes of navigation on lake and river? In the purifying and working of the metals? Will it be in the department of the chemist, the anatomist, the therapist? Or will it be in the shape of literature and metaphysical speculation?

Our country has a wreath ready for each one of her sons who shall give to the question a practical response.

The paper on "Accidental Discoveries" was intended to be followed up by another which was to bear the title of "Nature's Hints." In this production the idea was to maintain that it was part of the Divine Plan gradually to educate mankind in physical science and contrivances in the Arts, by means of phenomena in Nature, and the structure of various forms in the animal kingdom.

These were to be observed from time to time by the human mind and utilized practically.

Thus the moon comparatively close at hand, gave in its form, phases and movements, hints, for many a year not heeded, of things as they are in the solar system, and even in the larger universe beyond.

That the earth itself was globular in form like the moon was shown by the way in which the high summits of peaks and promontories presented themselves to the eye on a distant ocean horizon, long before their massive bases are discovered, proving that the surface before the eye is spherical and not flat; the same fact being also shown by the masts of ships when approaching the shore.

That some such indrawing force as that which we now style gravitation existed, was proved by the manner in which ships everywhere adhered to the globular surface, and also by the manner in which the great unsheltered sea itself kept in its bed; a hint was thus given of that mighty and mysterious force by which under the Divine management the universe is held together so to speak.

From a study of the anatomy of the eye resulted the Telescope in one direction and the Microscope in another.

The study of the Trachea and Larynx would in due time suggest the organ pipe and ultimately the construction of the grandest of human musical inventions, the Church Organ.

The primitive man doubtless very soon began to develop in some way the musical faculty that was in him, besides being the possessor of the gift of articulate speech, he was (if one may so express himself) a humming and whistling animal; and by having recourse to these powers which sometimes seem to us so trivial and commonplace, he was enabled to give utterance to certain simple combinations of sounds which gave pleasure to him, and which he would desire sometimes to recall, and give fixity to; hence would be suggested at last the necessity of some musical notation, rude enough at the outset, but culminating at last in the elaborate score of a maestro.

The computation of numbers began with the Fingers of the Human hand; and the expansion of numerals to any extent by multiples of Ten, was suggested as the most convenient method.

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Useful implements for cutting and piercing were in due time suggested by the incisorial teeth of man and other animals, and the beaks of birds. The action of molars showed how the process of trituration might be performed in the case of seeds and contents of nuts. Such may have been the germ origin of the manufacture of flour. The shell of the sea shore used for the dipping up of fluids led to the use of the spoon; the claw of the feline race probably in late ages gave rise to the fork. It is notorious that the nautilus and its occupant furnished the model for the oared galley. The inner rind of the Papyrus plant was soon seen to be a substance adapted to writing purposes, as also was the fine interior bark (liber) of the Linden and other trees, notably of the white birch so familiar to us Canadians.

The form and fashion of the spider's web may have led the primeval man to a framework for the covering of his hut or tent. The fleecy gossamer of the same ingenious spinner, resulted in many a textile fabric of a more substantial character. The tailor-bird showed how to fasten materials together by means of stitches. The chimney swallow performed the same feat by means of a fine glue. The hanging nests of the oriole, trochilus, and other birds suspended by loops of thread to branches of trees and shrubs existed before the powder wallets, and other pensile appliances employed by human beings about their persons and dwellings. The beautiful forms of minute ice crystals and the fern shaped tracings of hoar frost on smooth surfaces have supplied ideas for the ornamentation of dress-fabrics and the decoration of house interiors.

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