ON SOME BURIED BUILDINGS WITH SPECIAL REFERENCE TO HERCULANEUM.

By Professor T. McKENNY HUGHES, M.A., F.R.S., F.S.A.[1]

There is a great deal of exploration going on on sites of historic interest, and I have thought that a small contribution from the point of view of *the burying up* may not be wholly without use and interest at the present time, either to those who are engaged in the fascinating work of unearthing the buried records of remote ages, or to those who, though they have not the opportunity of taking an active part in the work, are watching with interest the results achieved.

There are many agencies which tend to bury all traces of ancient dwellings, or monuments, or cities. When you excavate in Nineveh, Jerusalem, Athens, Rome, or London, you find foundations and chambers, often buried in mortar and brick and stone and masses of ruined walls, but the greater part of the material you have to dig out in most cases is earth; sometimes a rich humus full of organic matter, sometimes fine dust and sand almost entirely of mineral composition.

There are many different ways in which forests, and dwelling houses, and churches, and cities get buried, and the amount and kind of destruction depends upon the mode of interment.

A heavy fall of feathery snow lodging on the branches of a tree may by its accumulated weight break it down, while fine drifting snow creeps round it and up the stem, and leaves its branches unbroken. The flow of molten lava burns everything and crushes the strongest buildings in its path, but gently falling volcanic dust, where it does not break down the roofs by its weight, insinuates itself through the smallest hole or crevice, like the sand in an hour glass, and fills up the rooms and every cranny and corner in them.

[1] Read at the Monthly Meeting of the Institute on 4th June, 1903.

Careful observations of the condition of buried forests, buried dwellings, buried churches, and buried cities teach us what to expect as the result of the various modes of entombment, and what steps to take with a view to the discovery and preservation of what remains.

If we are examining a buried forest we first note whether the trees are broken off or uprooted, whether they lie in different directions and at various levels, or whether they have all fallen together towards the same point of the compass. It is by such observations that you can tell the story of the forest destruction. If the trees are lying in all directions and at different levels you read the history of continuous renewal till the conditions become unfavourable for further growth. You find the traces of forest animals which lived and died in it, and you seek the causes and circumstances of its final destruction. If the last of the trees all lie in one direction you know that it was a catastrophe of some kind; a storm caught a weak place and down they went like ninepins. If the trees are broken near their base you know that the roots held fast till the gusts caught the swaying stems at a disadvantage and snapped them off, for every tree has its play. If the trees have been torn up by their roots you infer that these had no hold in the spongy, sodden soil, and that they were besides probably beginning to rot; and perhaps you may find other proof that the area was liable to floods. The mud settling out of flood waters, or the growth of peat over the swampy ground, buried all up and preserved the record for us.

Similar methods have to be applied to the investigation of buried dwellings or churches, or cities. We must examine the remains to learn how they were overwhelmed, whether by a sudden catastrophe or by slow waste; whether by storm, or fire, or war; or by desertion, decay, and the re-occupation of the ground by man seeking in the old ruins material for new works.

We are guided at each step of our search by the knowledge we have already gained as to the manner of entombment and the consequent probable mode of occurrence of the remains.

The gradual operations of nature frequently result in local catastrophes. Every here and there around the

coast of England, and, more obviously, along the west coast of France, tidal bars and sand-dunes cross the mouths of rivers, deflecting the outfall in the direction of the prevalent winds and currents, and cutting off behind them low ground, which is converted into a swamp by the upland waters. Here peat and, later on, forests of birch and fir-trees grow.

But, in the gradual waste of the coast, protecting promontories are cut away, banks that broke the violence of the waves are shifted, and some storm at length bursts through the sand-banks, and the peat and forest are over-run by the waves at every tide. If the area is subsiding the effect is intensified and the results increased with time. But it is not safe to say that every so-called submerged forest, that is a forest now over-run by the tide, is evidence of a subsidence of land.

There are many local legends that palaces and cities are buried beneath the sea and have been seen, or may still be seen at times through the clear water.

There is a heap of stones said to be the ruins of a palace off the coast of North Wales, and there is a ridge of hard rock running out under the sea near Aberystwith, which is called a sarn or paved road. The name "Cantref gwaelod" is probably responsible for the story that a hundred towns are sunk beneath the waves in Cardigan Bay, but although it is true that *cant* means a hundred and *tref* means a town, we must remember that "cantref" is the word commonly used for the territorial division known as a "hundred" in English, and "gwaelod" does not necessarily mean the bottom of the sea, but may refer to the bottom of a valley, or the low ground generally. It is impossible that subsidence to such an extent as to have buried a hundred cities beneath the sea can have taken place here in any recent period, but it may well be that the sea has encroached on a considerable tract of the bottom land on the coast of Cardiganshire, within a period not too remote to have been caught by tradition.

It is where the relics have been suddenly covered up that we may expect, if the conditions for preservation were favourable, to find the most perfect records of the past. If we could find a city submerged beneath the sea in an area of rapid accumulation, and if in consequence of

its being again upheaved, or in some other way, we could get access to it, we should find a fossil worth studying.

Portions of the shore of the Bay of Baiae or, as it is now called, Baia, were thus submerged and lifted up again, and the holes made by lithodomous molluscs in the columns of the temple of Jupiter Serapis clearly tell the story. But this was an earthquake effect, and how much destruction took place in the earthquake, of which this movement was one of the accompaniments, we cannot tell. Moreover the upheaved ruins have been long exposed to the still more destructive agency of man, who carried out mediaeval works with the material brought together by the Romans.

The action of earthquakes in destroying the records of the past must be taken account of, especially along the northern and eastern coasts of the Mediterranean, towards which our thoughts chiefly turn when we think of excavations in search of evidence bearing upon the history of the most interesting peoples of the past.

The story of C. T. Newton's discovery of the ruins of Halicarnassus is of thrilling interest, and shows how important considerations of this kind may become in such researches. It had been the dream of his Oxford life to find the tomb of Mausolus. The descriptions given by classic authors were sufficiently precise to make him think that they could be certainly recognised if found. His opportunity came at last; he was made Vice-Consul at Mytilene, and a gunboat was placed at his disposal to enable him to explore the coast. He shrewdly inferred that in that region of earthquakes a building such as the Mausoleum, perched, as it was said to have been, on the summit of a hill, would under repeated shocks have crumbled down, and that its remains would be found at the foot of the slope. So it was, but the point to which I wish to call attention is that with the exception of a few fragments built into cottages, etc. the ruins were all buried under a thick covering of soil, the result of rainwash, of soil creep, and of earthquake shocks. It was his study of the physical geography and natural phenomena which led him to infer what must have been the manner of destruction and consequent mode of occurrence of ruins in such a country, and thus guided his research.

He bought an olive tree on the flank of the hill, dug it up, and found the *debris* of ancient buildings in the soil which was creeping down. This confirmed his inferences, but it also convinced the proprietor that Newton was mad, and he refused to sell him any more.

However, Newton persuaded the Government to acquire the whole olive-yard, and made the grand discoveries of which the results may now be studied in London.

Layard[1] says that he sometimes found the ruins of Nineveh covered to a depth of 20 feet by fine sand and dust blown from off the plains and mixed with decayed vegetable matter.

Burrowing animals of all kinds disturb and mix up buried objects often of very different age, and Darwin[2] has shown how earthworms bring up finer material from below, distributing it through the interstitial spaces in the ruins, and heaping it over the surface. It may be that tessellated pavements have in some cases been thus undermined and the regularity and flatness of the surface destroyed, but there must be other agents, such as settlements and soil creep, which throw the surface into folds. The concrete on which the *tesserae* are laid is generally too strong and thick, and the *tesserae* too close together, to allow the earthworms to get through, and there are moreover examples of undulating mosaic floors, such as that in St. Mark's in Venice, where earthworms can have played no part in producing the irregularities.

When a city, which has been wholly or partly ruined, is reoccupied, all the building stones that are left at or near the surface are used again, and only the earth and finer materials are left, but, where the site is deserted, nature soon covers up everything with a mantle of soil and vegetation. This is due to the constant operation of the wind and other agencies.

There are certain geographical conditions, however, which make the wind catastrophic in its action. I am not now referring to its devastating effects, such as I mentioned when speaking of the destruction of forests, or the sudden inroads of the sea and changes of the coast

[1] *Nineveh and its Remains.*

[2] Darwin. *Transactions of the Geological Society*, 2nd. s. v. (1840), 505: "The Formation of Vegetable Mould through the action of Worms, 1883."

line caused by storms, but to its transporting power and its action in burying everything under an accumulation of dust and sand. The church of Perranzabuloe in Cornwall had been covered for ages by sand, when some changes in the surface configuration, and the continuance of the wind in one direction for an unwonted time, lifted the sand and again exposed the ancient edifice in exactly the same condition as that in which it was when buried.

The Culbin Sands near Nairn furnish very interesting examples of the mode of accumulation of sand dunes. These hills are not ridges travelling on, but are mounds shifting to and fro with the eddying gusts. Now and then, of course, a long continued dry wind will blow the sand so that the whole result is to carry it forward more in one direction than another and encroach upon the cultivated country, but still the effect of the swirl is seen where the wind is confined between the hummocks. The sand is lifted up in small whirlwinds and urged along the narrow gullies, but the heavier bodies, which have got on to the sand dunes by natural agencies or by accidental transport, drop into the hollows and, eventually, all work their way down to the very bottom, to be covered by the shifting dunes and again exposed in future ages. Any one who had not studied the growth and shifting of sand dunes might well be puzzled to explain the occurrence of beautifully dressed flint arrow-heads and coins of Charles I. together in the same stratum exposed at the very base of the Culbin Sands by some sudden and exceptional storm. The dwellers in those parts watch with interest for the uncovering of the old manor house which was buried some two centuries ago, and has ever since remained covered by an enormous mound of sand.

What has been and is taking place in the Culbin Sands must from the nature of the case have been and still be going on in any region where sand is moving with the shifting winds, and the observations made near home may well be borne in mind by those who are excavating in the sands of Egypt or of Mesopotamia, or the dust of the Mediterranean shores and islands.

Of the various natural agents which suddenly bury cities, and preserve the records of what was going on, and

what had been when the catastrophe occurred, volcanic outbursts are the most important.

The results of volcanic eruption are manifold, but the sequence of causation is pretty simple and constant.

As one of the effects of the crumpling of the earth's surface, the rocky crust cracks, and we feel the vibrations at the surface. This is the earthquake stage.

The fissure thus formed extends down to great depths, where the temperature is so high that the rocks would all be molten were it not for the enormous pressure upon them. But, when this pressure is relieved by the breaking of the rocks above, the highly heated masses fly into a molten state, and well up through the fissure to the surface. This is the lava stage.

When this lava gets near the surface, repressed gases are given off, and the water of springs, rivers, lakes, or seas gets down into the heated rock and is immediately converted into steam, and then comes the most noisy accompaniment of volcanic eruptions. Explosions occur, and masses of lava, or of the rock through which the lava is rising, are shot out and blown to pieces, or reduced to dust by trituration. These fragments are hurled to great heights, and being caught by the upper currents of air, are carried along and showered down over the country far and near, according to their relative size and weight. The steam too is condensed when cooled in the upper regions of the atmosphere, and falls in torrents of rain which flood all the lower ground and sweep everything before them. This is the explosion stage.

When the period of violent activity is passing away, but the rocks beneath are still hot enough to drive off the gases and raise the water to boiling point, the heated water acts on the rocks and dissolves the silica and other minerals, and we see the effect in the altered rocks of a volcanic area in which the fires are dying out, as, for instance, in the bleached rhyolites of the gorge of the Yellowstone river, in the mud volcanoes, and in the geysers, and jets of steam and gas that issue from the deeper fissures. This is the *fumarole* stage.

Thus volcanic regions are apt to be also earthquake regions, but as along lines of weakness caused by fissures the relief comes quickly, the flanks of volcanoes are often

not more subject to violent earthquake shocks than districts more remote from centres of eruptions.

For our present enquiry we have therefore to note that these various phenomena do not occur simultaneously, but are successive stages in the development of volcanic activity, and that the remains of a city may be buried under the ruins of what has been shaken down by earthquake shocks; or it may be covered by a mass of lava, or of dry dust and cinders, but that it is most improbable that it can be overwhelmed by boiling mud poured forth when the crater has become as it were a geyser and volcano in one, though it may often be plastered down by cement, formed by rainwash when torrential rains such as usually accompany volcanic eruptions have carried the dust and *scoriae* from the slopes to lower levels; or one part may be buried under one kind of deposit and another part under other products of the same, or of a different period of volcanic activity.

Mud flows of any great extent are from the nature of the case unusual accompaniments of volcanic eruptions. They belong to the last stage of activity when the volcanic fires are dying out. For our present purpose it is most important to have a clear idea of their mode of formation.

When the rocks have been mechanically and chemically disintegrated, and the intermittent action, such as causes geysers, has churned up the flour of rock which has been thus produced, with the hot water in the deep-seated rocks, mud is forced out through the fissure instead of water; when the steam is given off it ceases to rise and what is left sinks back into the vent hole.

One of these mud volcanoes may be seen in operation in the geyser district, a few miles from the Yellowstone Lake at the north end of the Rocky Mountains, and a more awe-inspiring phenomenon it has never fallen to my lot to witness. You stand on a narrow bank of grey clay; a slope of mud plunges steeply down in front of you into a black cave; all is mud, or mud-splashed lava. You feel that you could never climb out if any accident once pushed you over the rim into the slimy depths

below; a feeling of dread comes over you, as you contemplate the horrible abyss.

All are impressed and silent, but soon the stillness is broken by deep sounds issuing from the cave, groans and hisses, sobs and suckings, and a viscous mass belching forth foul gases comes writhing forward in tongues of mud, feeling as it were like Victor Hugo's *pieuvre* for anything to envelop in its coils. Spluttering and slobbering it flings itself up the slope towards you, and then suddenly withdraws again into the depths of its grimy cavern.

In the earlier development of volcanic activity the violent outbursts clear the volcanic neck of water and loose material, and mud is not formed. It must be a very exceptional thing to have such an outburst of mud directly from the volcano as would overwhelm Herculaneum, for instance, in a mud-flow from Vesuvius.

We cannot expect to see much of a city over which a thick mass of molten lava has flowed, or of one buried in what has become a hard cement, but we may hope that many of the objects of every-day life will have been preserved uninjured, and that they can be easily exposed again if they have been gently covered up by showers of ash which was in such proportion as to allow the air to cool it down somewhat, instead of being so thick as to raise the surrounding air to scorching heat and keep up its own temperature, as was the case in the recent terrible eruptions in the West Indies where air and ash fell like fire on the ill-fated inhabitants.

Now let us turn to the towns of Herculaneum, Pompeii, Stabiae, and other places around Vesuvius to see what can be made out respecting the manner in which they were destroyed and buried.

Various writers had inferred from its similarity to Etna, as well as from tradition, and from the character of the rocks, that Vesuvius was of volcanic origin, but there is no record of its having been active within the historic period before the Christian era.

In 63 A.D. an earthquake destroyed a great part of Herculaneum and Pompeii, and those cities must have felt the earthquake which shook Naples so severely in the

following year, but all damage seems to have been repaired. Fifteen years later the great eruption occurred which destroyed Herculaneum, Pompeii, and Stabiae. There were earthquake shocks of considerable violence, as recorded by Pliny the younger, but an examination of the ruins does not lead us to infer that the obliteration of the towns was so much due to their being shaken down as to their being buried up. If we look round from the summit of Vesuvius, or examine a map of the site, we cannot but be struck by the even distribution of the material all round. The great cone has been heaped up by many accumulations of commensurate size and many outbursts of not greatly different intensity. The hollows left between adjacent flows guided denudation and caught subsequent rivers of molten rock. The sides are fluted by these troughs which have been left between the lava-flows of various age. Between two small valleys thus originally formed stood the town of Herculaneum, on a slight elevation near the sea west of the crater. At a somewhat greater distance south-east of the summit and altogether beyond the steeper mountain slopes, stood Pompeii. At Pompeii you may shovel away dry dust and expose frescoes and mosaics which look as bright and fresh as if newly painted. We do not find the upper parts of the buildings in ruin on the floors as if the houses had been shaken down and then covered by ash, but they must often have projected through the ash or risen too near the surface and have been removed since the catastrophe by builders seeking material, who often found it worth while to follow down the walls of ancient buildings to a great depth for the sake of the dressed stone of which they were constructed.

Pompeii was obviously buried in dry ashes. We cannot now exactly explain how the ash of the same eruption travelled south-east to Pompeii and Stabiae and west to Herculaneum and Misenum. The movements of Pliny's ships indicate a north-westerly or westerly wind below, but what we have recently heard of the dust being caught in upper currents in the eruptions in the West Indies and carried against the direction of the wind which was blowing near the ground, provides us with one explanation of this difficulty; and the account that, although the darkness was very great at Misenum, no large quantity of ash fell

there, seems to confirm the idea that heavy dustclouds were travelling to and fro in the upper currents of the atmosphere. However that may be, Pompeii was buried and still lies in dry ashes. Yet it would seem that the greater body of dust was carried west.

It has often been stated that Pompeii was buried under ash and Herculaneum under lava. But any one who examines the ruins can see that the excavations are not in true lava, that is, in rock which flowed out in a molten state, but in what the Italians call *lava d' acqua*, and we have now to consider what was its origin. It is not mud like that of a mud volcano, but is composed of the same material exactly as the ash, only it is consolidated into a hard rock.

There is no evidence on the ground that such a mud flow ever issued from Vesuvius. The *lava d' acqua* of that region is quite a different thing from the mud that issues from the mud volcano of the Yellowstone River-basin. The mud of the mud volcano is a homogeneous grey paste of very finely divided matter. The concrete in which so much of Herculaneum is buried is a fine speckly breccia of different coarseness and composition, and obviously a consolidated ash.

Now the fine ash of Pozzuoli, a place close by Naples, readily combines with water to form a cement which is known as Pozzuolana or Roman cement. The Trass or volcanic ash of the Brohlthal on the Rhine is used for the same purpose. If then torrents of rain from the condensed steam fell during the eruption of A.D. 79 they must have carried the dust and ash down the slopes into the two valleys out of which Herculaneum rose, and filled them and all the low-lying buildings and hollow places with what was really liquid Pozzuolana or Roman cement. The higher parts between the two valleys would be above the inundations, and probably have large areas buried under dust and ash which was not thoroughly wetted and would not get similarly consolidated.

The theatres of those days were often built with a view to the arrangement of seats for the spectators tier above tier, by taking advantage of rising ground behind, from which they could gain access to the upper seats. For this reason theatres are apt to be built on the low-

lying ground. The floor of the theatre at Herculaneum is 85 feet below the present surface of the ground, and the excavations have been carried down to the very base. An examination of the material which fills it amply confirms the view now put forward, for the ash contains fragments of brick and other material such as would be washed down the flooded streets; and in the very lowest layer in the basement of the theatre my wife found fragments of Roman pottery.

Herculaneum was a smaller city than Pompeii. There are but few earlier notices of it; from these, however, we may gather that although it changed rulers several times, there is no record of its having suffered any great destruction or desolation. It was a place of much greater wealth and refinement than Pompeii, and was becoming more and more popular as a residence for imperial and noble Romans. We might expect, therefore, to find here treasures of literature and art that would well repay the work of exploration, costly as that must be, seeing that the ruins are so deeply buried and so many of them run under the town of Resina. But a clear understanding of the reason of each difficulty helps to overcome it.

As Sir Charles Newton was guided in his search for the Mausoleum by the knowledge of the manner in which buildings crumble down the hill-slopes under the influence of frequent earthquakes and earth tremors, and as a knowledge of the mode of accumulation and the movements of blown sand explains the curious mixture of remains of very different age at the base of sand dunes, and teaches us what indications prepare us to look out for from the uncovering of long buried buildings, so a study of the conditions under which Herculaneum was entombed may enable us to select parts of the ancient city in which the objects are better preserved and easier of access than any of those yet explored. A careful survey with borings should be made to find where the heavy rain-wash filled up hollows and where dry ash fell gently over the rising ground.