

## CHAPTER VII.

## VOLCANOES, EARTHQUAKES, AND GEYSERS.

## VOLCANOES.

80. *Graham Island*. — South of Sicily, in 1831, a new volcano was born. During the eruption large volumes of steam rose into the air, carrying up fragments of lava. The expansion of the steam in the melted rock caused numerous cavities, and broke the lava into bits of porous ash and pumice. Some of the lightest ash drifted away in the wind; much of the pumice was light enough to float on the water; but many of the heavier fragments fell back near the outlet, building a cone which rose 200 feet above the sea and had a circumference of almost three miles. With this single eruption the life of the volcano seems to have ended; and soon the waves cut the loose ash cone away, leaving a shoal to mark its site.

Other volcanoes, some in the sea, some on the land, have become extinct after a single gasp; but most volcanoes have a longer and more varied life. From some, ash is always erupted; from others, streams of liquid lava; and from many, now ash, now lava. Some erupt freely and at frequent intervals; others have violent outbreaks, following long periods of quiet. These differences between volcanoes may best be illustrated by studying a few typical ones.

*Summary.* — *Graham Island* became extinct after a single eruption of ash and pumice, formed by the blowing up of melted rock by included steam. Other volcanoes have a much more varied history.

81. *Stromboli*. — Between Sicily and Vesuvius, in the Lipari Islands, is the ever active volcano Stromboli. It is a small cone, about 6000 feet from bottom to top, half its height being above sea level. Steam rises from a crater on one side of the cone, and the steam clouds glow with light from the melted lava, which always stands in the crater. Every few minutes the steam erupts masses of lava; and sometimes there is a mild eruption which throws pieces outside the crater. The cone is made of such fragments.

*Summary.* — *Stromboli* is a volcano made of fragments of lava thrown out by mild eruptions.



FIG. 195. — Vulcano, one of the Lipari Islands, in full eruption. This cone is now inactive.

82. *Eruptions of 1902 in the West Indies*. — On the 8th of May, 1902, the

beautiful city of St. Pierre, in Martinique, was wiped out of existence by a terrible volcanic eruption from Mont Pelé (Fig. 197). Between 25,000 and 30,000 people were killed in a few seconds, and only one person in St. Pierre, a prisoner in the jail, escaped death. On the previous day there was a destructive eruption from the volcano of La Soufrière, in the neighboring island of St. Vincent.

The last previous eruption of Mont Pelé was in 1851; in 1812 there was a terrific and destructive eruption of La Soufrière. The people of St. Pierre had almost forgotten that danger lurked in the slumbering volcano; and, though the outbreak of 1902 was preceded by distinct warnings,

few heeded them. On April 25 warm water was reported in the old crater; later, dust-laden steam rose from it; then a lake rose, overflowing the crater rim on May 5, and sending a deluge of hot water and mud down a valley.

On the 8th of May came the eruption. A huge column of steam, expelled with great force, bore heated sulphurous gases, dust, ashes, and stones high in the air. The eruption was not nearly so violent as many other eruptions; but, owing to the following peculiar condition, its effect was very disastrous. On the side toward St. Pierre there was a break in the crater wall, with a valley leading toward the city. Down this valley some of the steam, with its load of hot rock fragments and gases,

rushed with the violence of a tornado, destroying everything in its path. It overturned trees and houses, and even carried a hollow iron statue, 11 feet high, a distance of 50 feet. Most of the deaths were probably caused by breathing the steam and hot ashes.

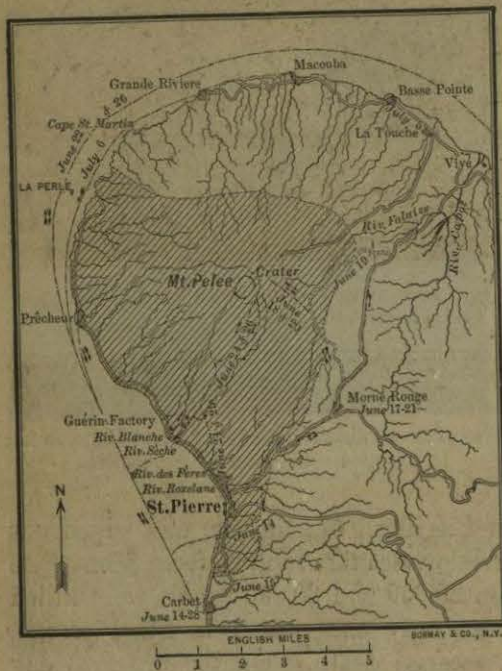


FIG. 196. — The vicinity of Mont Pelé. The shaded area shows the zone of destruction.



FIG. 197. — The ruins of St. Pierre, from a photograph taken June 14. Mont Pelé is in the background.



FIG. 198. — Valley of the Roxelane, near St. Pierre, as it appeared May 22, 1902, — the trees killed and the surface covered with volcanic ash.

(From photographs loaned by E. O. Hovey of the American Museum of Natural History.)



FIG. 199. — Vesuvius from Pompeii, whose ruins are now largely excavated. The remnant of Monte Somma forms the ridge on the right, while the present cone of Vesuvius rises in the middle.

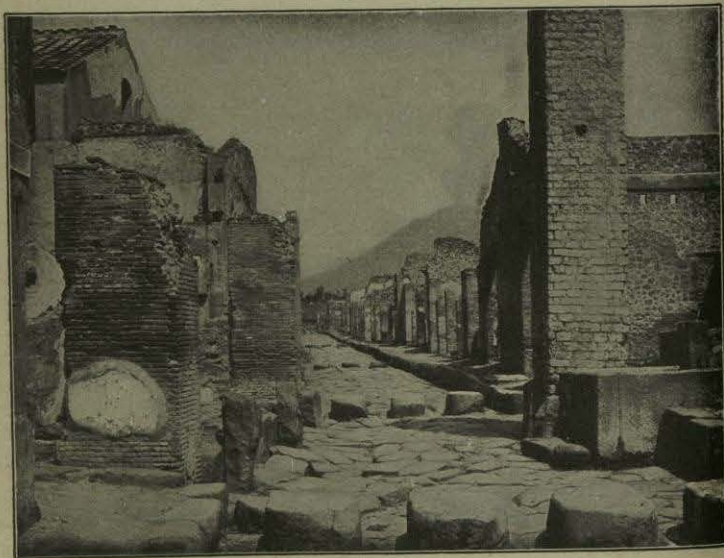


FIG. 200. — A street in Pompeii. On this the ruts of the chariot wheels may still be plainly seen. Ash completely covered all the buildings and filled every crevice compactly. Parts of the city are not yet uncovered.

There have been several later outbursts, all, like the first, erupting ash, with no flowing lava and with no destructive earthquake shocks. The eruptions have built a cone 1500 to 2000 feet high in the old crater, and the ash has fallen over the whole island (Fig. 198) and the sea round about. After the eruption of June 6, a quarter of an inch of ash fell upon a ship over 100 miles from the volcano. At a distance from the volcano the ash deposit is thin; but on and near the cone it is several feet deep, resembling freshly fallen snow. During each eruption the condensed steam causes heavy rains, which wash vast quantities of loose ash down the steep slopes in destructive *mud flows*. Sometime — no one can foretell when — the eruptions will cease, probably to break out again when energy enough has accumulated.

*Summary.* — In May, 1902, after a long period of quiet, *Mont Pelé* and *La Soufrière* burst forth in eruptions of ash, causing much destruction. There have been numerous eruptions since then, and vast quantities of volcanic ash have been thrown out upon the islands and the sea round about. The condensed steam, forming rain, has washed much ash down the volcano side, causing *mud flows*.

**83. Vesuvius.** — At the beginning of the Christian era, Vesuvius, like Pelé, had long been inactive, and people had no fear of it. It had been quiet, or *dormant*, for centuries, and was not even recognized as a volcano. Farms and villages dotted the slopes of Monte Somma (Fig. 201), as it was called, and cities were



FIG. 201. — The form of Vesuvius, or Monte Somma, before 79, according to Strabo. Only a part of the crater rim now stands (Fig. 199), the present cone rising on the site of that part of the crater nearest us.

located at its base. In the year 79 it broke forth in a terrible eruption which buried the farms and villages beneath ash, and destroyed Pompeii and Herculaneum.

Before the eruption there were frequent earthquakes, one of which partly destroyed Pompeii; and, finally, a terrific explosion occurred by which half the crater wall was blown away. The ashes rose thousands of feet in the air, settling on all the country round about. The naturalist Pliny, admiral of the Roman fleet, who was at Misenum (near C. Miseno, Fig. 202), started toward the mountain and lost his life. Letters of Pliny's nephew to the historian Tacitus, telling of the death of his uncle, are the only description of the eruption that we have.

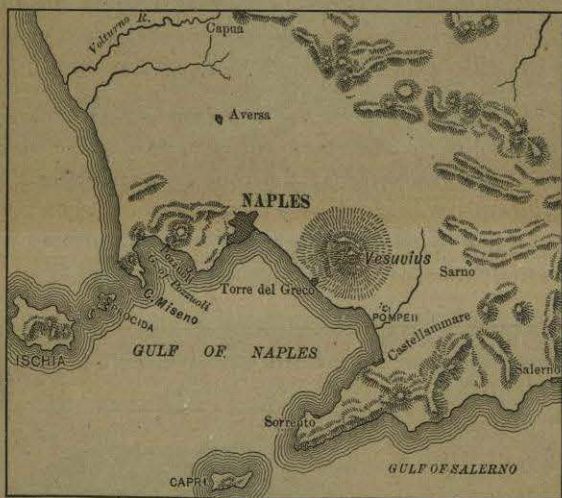


FIG. 202. — Map of the Bay of Naples. There are numerous volcanic cones from Pozzuoli to Ischia.

The day was changed to the darkness of night by a heavy cloud of ash; hot ashes and stones fell all about; the air was filled with sulphurous gases; the ground was violently shaken; there was fierce thunder and lightning; and the cries of terror from the people, who rushed madly about, added to the din. Thousands of people were undoubtedly killed, though there is no record of the number, nor even of the villages destroyed.

Pompeii and Herculaneum have been discovered and partly



FIG. 203. — Vesuvius in eruption in 1872, showing the steam rising from the crater; also from the lava that is flowing down the slopes.



FIG. 204. — The ordinary condition of Vesuvius. The lava in the foreground was erupted in 1858.



FIG. 205. — The cone of Vesuvius, in moderate eruption, July 5, 1895.



FIG. 206. — A view into the crater of Vesuvius. This photograph was taken during the above eruption, when the lava was drawn out of the crater. At ordinary times the crater is so filled with steam that one cannot look far down into it.



FIG. 207. — Monte Nuovo, a small ash cone, at the head of the Gulf of Pozzuoli (Fig. 202), which was thrown up during an eruption in 1538. It has not erupted since, and its slopes are now cultivated.



FIG. 208. — The crater of another volcano at Pozzuoli, also extinct. Steam and sulphurous gases, forming sulphur crystals, still rise in this crater, and vegetation is unable to grow where they rise.



FIG. 209.—Etna, with steam rising from its crater. Several small cones, built during eruptions, are also shown on the flanks.



FIG. 210.—An eruption on the flanks of Etna, showing steam rising from one of the small cones. The distant, snow-covered peak is Etna.

excavated (Fig. 199). From these excavations we learn what the life of the Romans was on the day of that fearful outbreak nearly 1900 years ago. The houses had been so well preserved beneath the ash that even pictures painted on the walls are still quite perfect. It is a wonderful experience to walk through those deserted streets (Fig. 200), and to see how the people lived, and what they did, as if they had left but yesterday. Yet it is a picture of life almost at the time of Christ.

Since 79 Vesuvius has had many eruptions, some violent, some moderate (Fig. 205), some of ash, some of lava (Fig. 203). The remnant of old Monte Somma still stands on one side of the present cone, which rises 4200 feet above the level of the Bay of Naples (Fig. 202). At most times visitors may go to the very edge of the crater (Fig. 206). Standing on the side from which the wind blows, one looks down into a deep hole, out of which vast quantities of steam rise with a roar, bearing sulphurous gases. Every few seconds there is a slight explosion, when masses of red-hot lava are thrown up, often higher than the crater wall. At night the lava in the crater causes a glow on the cloud that overhangs Vesuvius.

Occasionally the volcano grows more active; then hot stones rise so high that they fall on the crater edge, and it is unsafe to stand there. This may increase until the stones fall some distance beyond the crater. The small cinder cone that surrounds the crater is made of these loose fragments.

Now and then lava issues from the cone, flowing in a great stream, sometimes clear to the sea. The recent flows form great black, rugged scars on the volcano side (Fig. 204); the older ones are partly decayed and covered with a soil. There is an observatory on the slope of Vesuvius in which scientists study the volcano and attempt to predict eruptions.

Vesuvius is only one of several volcanic cones in the Bay of Naples (Figs. 207, 208). The famous lake Avernus is in a volcanic crater; the island of Ischia is a volcano (Fig. 202); and

there are several others in the same region. All of them have been long extinct, though hot water, steam, and gases still rise in some places. There are numerous proofs that changes in level of the land have accompanied the volcanic activity of this region (Fig. 37).

*Summary.*— *In the year 79, after being long dormant, Vesuvius broke forth in violent eruption, partially destroying the cone and burying Pompeii and Herculaneum, which have been well preserved beneath the volcanic deposits. Since then Vesuvius has had many eruptions of ash and lava, some of them very violent. Ordinarily it is so quiet that one may go to the very edge of the crater, from which steam constantly rises, bearing upward masses of lava. In the neighborhood there are extinct volcanoes.*

**84. Etna.** — The greatest volcano in the Mediterranean is Etna, on the eastern end of Sicily. Steam rises from its crater (Fig. 209), and every few years there is an eruption. Then lava issues from fissures in the mountain side and flows in enormous masses down the slopes, even to the sea, often destroying villages on the way. There are scores of small cones, 200 to 300 feet high, built along these fissures (Figs. 209, 210).

Etna rises 10,870 feet above the sea, and at its base has a circumference of over 60 miles. It is so high that, although oranges and bananas grow at its base, the climate at the top is frigid. This great cone is made entirely of lava and ash forced out from within the earth by steam. The recent lava flows, those only a few score years old, are barren masses of black rock too rough to cross. But this lava decays so readily, and forms so fertile a soil, that in a century portions of a flow are fit for cultivation. Soil is often gathered in baskets and placed between the lava blocks for the planting of grapevines.

*Summary.*— *The huge cone of Etna is made of lava, issuing mainly as great flows from fissures in its flanks. This lava decays quickly, forming a fertile soil.*

**85. Krakatoa.** — For a century the small volcanic island of Krakatoa, near Java, in the Straits of Sunda, was dormant. In August, 1883, it broke forth in the most terrific eruption that civilized man has known. A large part of the cone, together with ash from below, was hurled high into the air, and the site of the destroyed cone was occupied by water 1000 feet deep (Fig. 220). Every vestige of life on the island was destroyed, and its surface was deeply covered with ash.

For miles around, the sea was so thickly covered with pumice that the movement of vessels was interfered with. The finer ash was thrown so high into the air that it was carried all round the earth, causing brilliant sunsets in Asia, Europe, and America.

So violent was the explosion that a great air wave was started which passed three times around the earth. Windows were broken 100 miles from the volcano, and the sound of the explosion was heard more than 150 miles away. A water wave was also caused which spread all over the Pacific, being measured on the coasts of Africa, Australia, and California. Near the volcano this wave washed over the land to a height of 50 to 100 feet, killing 35,000 people.

Since then Krakatoa has been quiet. It may have become extinct; but more probably it is only dormant, and will again burst forth when the pent-up steam once more gathers sufficient energy to force its way to the surface.

*Summary.*— *After a century of quiet, Krakatoa burst forth, in 1883, in the most violent eruption known. Half the cone was blown away; ash fell all about, and was carried far and wide by the winds; a great air wave passed three times round the earth; and a water wave spread over the Pacific. Since then the volcano has been quiet.*

**86. Hawaiian Volcanoes.** — There are numerous volcanic cones in the Hawaiian Islands (Fig. 224), most of them extinct. The two highest are Mauna Loa and Mauna Kea, which, with the smaller Kilauea, are on the island of Hawaii (Fig. 211). This island, the greatest volcanic mountain in

the world, rises nearly 14,000 feet above sea level, and 30,000 feet above the sea floor.

On the top of Mauna Loa is a great crater two or three miles in diameter. This is partly frozen over, but steam rises from cracks in the surface, and in one part there is a lava

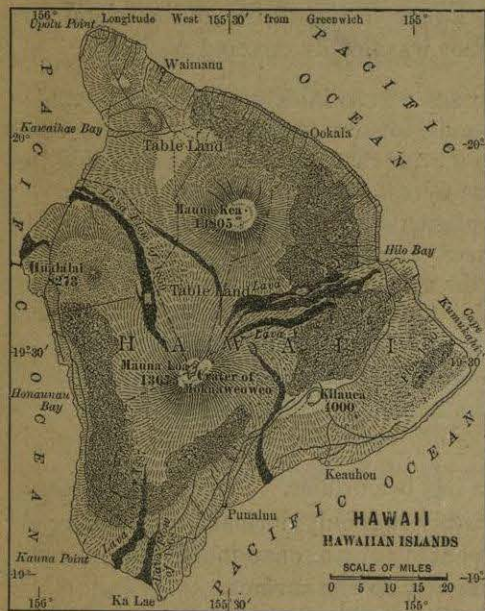


FIG. 211.—The dark areas represent lava flows which start from fissures.

lake, from which jets or fountains of lava rise, sometimes several hundred feet. A similar condition exists in the crater of Kilauea; but Mauna Kea is extinct. Such extensive craters (Figs. 212, 213) are called *calderas*. The lava slowly rises, overflowing the crater floor and freezing on it (Fig. 212), as water sometimes flows over the ice on a pond. Before the lava rises high enough to flow out over the rim of the crater, its weight and the steam pressure usually open a fissure in the mountain side through which the lava is drained (Fig. 211). This occurs, on the average, once in about seven years, and no violent ash eruptions have ever been recorded. The fissures are usually formed above sea level, but sometimes occur beneath the sea. Some of the lava streams are 30 or 40 miles long and 2 or 3 miles wide.



FIG. 212.—Lava lake, frozen at the surface, in the crater of a Hawaiian volcano.



FIG. 213.—Lava lake in the crater of a Hawaiian volcano.