Report on the Eruptions of the Soufrière in St. Vincent in 1902, *and on a Visit to Montagne Pelée in Martinique.* Part II.—*The Changes in the Districts and the Subsequent History of the Volcanoes.*

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(Abstract.)

This Report, and the accompanying Report by Dr. Flett on The Petrology of the Ejected Materials, form the sequel to the Report by Drs. Tempest Anderson and J. S. Flett on "The Eruptions of the Soufrière in St. Vincent in 1902, and on a Visit to Montagne Pelée in Martinique, Part I."

At the time when that Report was published it was contemplated that an account should be given later on of the subsequent changes in the deposits of volcanic ejecta, and also on the petrology of the specimens collected in 1902. In the spring of 1907 I visited the West Indies, but Dr. Flett was unfortunately detained in England by his official duties. I am therefore responsible for the field observations on the topography and geology, and on the return of vegetation, while Dr. Flett's Report deals with the petrology of the ejected materials.

A description of the topography of the Soufrière volcano and of the details of the immediate results of the eruption of 1902 are contained in the published Report, Part I. The principal points of interest in the observations made during my second visit lie in (i) the changes wrought by denudation on the deposits left by that eruption; (ii) the light thrown by those changes on the operation of the forces which had moulded the features of this island in its earlier history; (iii) the information I was able to collect with regard to the volcanic disturbances subsequent to the great eruption of May, 1902; and (iv) the return of vegetation to the devastated areas.

In the 1902 eruption a certain amount of the ejecta overtopped the Somma ring, *i.e.*, the remains of the original great crater, and descended some of the valleys to the north of it; but by far the greater portion was discharged into the transverse depression which extends right across the island and separates the Soufrière from the mountain known as Morne Garu, about three miles to the south. The water from the crater lake was discharged at the beginning of the eruption down the Rabaka and Wallibu rivers, while the solid and

gaseous ejecta, in the form of the incandescent avalanches and black clouds, descended to both sides of the island.

The most important geological phenomena were observed in the Wallibu district. These phenomena have been fully described in the published Report (Part I, p. 428 *et seq.*), as also the subsidence of part of the coast. To this district, therefore, attention was especially directed in 1907, with the view of observing the further progress of the changes and the return of vegetation.

A description of the Wallibu valley is given in the full paper. In that district the beds of newer date have been dissected into flat-topped plateaux by small rivers running in deep gorges, which have again been filled in places by ejecta of eruptions and re-excavated in different degrees, and sometimes on different lines, leaving plateaux and terraces of different ages and heights. This action is well exemplified in the lower Valley of the Wallibu. In the 1902 eruption this part of the valley was filled by the incandescent avalanche to a depth of at least 100 feet in the upper part, and less towards the sea, and it was in this deposit of hot ash that the explosions of steam and hot ash, flows of boiling mud and other secondary phenomena took place. In 1907 almost the whole of this ash had been washed away, but a fragment remained in the shape of a terrace 60 to 80 feet high, situated on the north side of the valley. The ash of which it is formed is unstratified, and contains very few ejected blocks or fragments of any kind. The floor of the valley is all composed of water-sorted material, chiefly gravel and coarse sand, but with a good many blocks as big as a man's head. They represent ejected blocks and fragments of lava derived partly from the ash of 1902 and partly from older beds, the fine ash in each case having been washed away. The surface of the gravel bed showed marks of quite recent running water, and during the last winter, 1906–7, the river ran along the foot of the north bank of the valley. When examined in March, 1907, it ran along the south side of the valley, and had already in those few months excavated a new channel about 30 feet in depth. The stratification, as exposed in the side of this new valley, is very distinct, and the sorting by water, mentioned above, is very evident. Further up the mountain the remains of the avalanche became more abundant in the valley bottoms, and here they were also often better preserved, so that traces of the feather pattern erosion, so noticeable in 1902, were still visible on the surface. This was mainly due to the surface of these ash deposits, like those to be presently mentioned on the plateaux and on the ridges, having consolidated into a crust almost like a cement pavement which resists the action of the rain.

Another interesting point was observed with regard to these massive ash deposits. Instead of one stream re-establishing itself along the centre of

the deposit, the tendency is for a new stream to form on each side at or near the junction of the new ash with the old valley slopes; and, as these streams deepen themselves, two new valleys are formed where only one previously existed, and the walls of each are composed on the one side of the new ash and on the other of older tuff, with occasional terraces of new ash. It appears to be due to the fact that the water from the old slopes, in running down into the original valley, meets the soft new ash, and at once turns down along the valley and so starts the new stream, and it seems likely that the chief cause of its so turning is that the surface of the deposit tends to be higher along the middle of the valley than at the sides, as is usual with mud-streams or glaciers. A good example of the action above described is to be found in a wide valley to the north of and parallel with the lower Wallibu valley and bounded on the south by the Wallibu plateau. Before the 1812 eruption the Wallibu river flowed down this valley, but its course was changed after that eruption. The floor of the valley is now occupied by the gorges of two small rivers, divided by a very narrow ridge, formed of ash different from and less consolidated than that composing the walls of the main valley, and considerably lower than the Wallibu plateau. In 1902 both these gorges were filled with new ash to the level of the main valley floor. One of these, the Trespé gorge, now emptied of the 1902 ash, shows its north wall to be much higher than the south, and also formed of older and more consolidated tuff. The same conditions, with sides reversed, are seen in the other gorge, the higher bank in that case being the Wallibu plateau to the south.

The Wallibu plateau is composed of ash older than that dividing the above two small rivers, but still comparatively new, and its flat top and precipitous sides, both north and south, proclaim it to be in an early stage of denudation, while the south bank of the Wallibu river on the south of the plateau is composed of older tuff and lava, and shows a much more mature type of denudation, viz., sloping hills with rounded or ridged tops, and a good deal weathered into valleys or gullies. The north face of the plateau, like the south, is precipitous and obviously much less advanced in weathering than the slopes of the Soufrière on the opposite side of the broad valley of the Wallibu Dry, and Trespé rivers to its north. The mass appears to be the remains of an avalanche, or succession of avalanches, of hot ash poured into the depression between the Soufrière and Morne Garu, on an enormously larger scale than anything formed by recent eruptions. It may be that the present bed of the Wallibu to the south and the broad valley to the north are enlarged and deeply-excavated developments of the valleys that were formed at the sides of this prehistoric avalanche.

Descriptions of the changes in the fans and low plateaux subsequent to 1902; of the shore subsidence; and of the upper slopes of the mountain, are given in the full Report, as well as a detailed description of the crater as seen in 1907. This is best explained by reference to the plates accompanying the Report.

The topography of the old crater is still correctly represented on the Admiralty Chart (published with the Report, Part I). The whole of the interior of the crater is still quite bare, without any trace of returning vegetation; small patches of moss appear about the rim and on the slopes outside, then grasses and herbaceous plants, and lastly, below a height of about 1500 feet, luxuriant tropical vegetation.

The present condition of the devastated areas is described fully in the Report, which contains also a history of subsidiary eruptions which followed the great one of May, 1902. The difference in character between the eruptions of the Soufrière and Montagne Pelée, referred to in the Report of 1902, appears to have continued since that year, the outbursts from the former volcano being generally less frequent but more violent than from the latter.

The Report also contains an account of a subsequent visit to the volcano of Montagne Pelée, in Martinique, with a description of the crater as I then found it; a discussion of the phenomena of the remarkable extrusion and subsequent destruction of the Dome and Spine, which have been described by Lacroix and others, and a comparison of the sequelæ of the great eruptions in the two islands of Martinique and St. Vincent.