

THE ERUPTION OF KATMAI.<sup>1</sup>

THE Katmai expeditions of the National Geographic Society, under the leadership of the present writer, have been exploring the district devastated by the great eruption of Katmai in 1912. As knowledge of this eruption increases, it becomes more and more apparent not only that it was one of the greatest of all eruptions, but that it had many peculiarities which set it apart in a class by itself, without parallel in historic times.

Until the eruption in 1912 there were no definite records of activity in the Katmai district since the occupation of the country by white men, although the natives reported that some of the volcanoes "occasionally smoked." The district was so little known that, so far as can be learned, the volcano was never photographed before the eruption. Fortunately, however, its altitude was precisely determined and

previously laid undisputed claim to this distinction, in every dimension. The comparative measurements are:—

	Katmai	Kilauea
Length... ..	3.0 miles	2.93 miles
Width ... ..	2.75 "	1.95 "
Circumference	8.4 "	7.85 "
Depth ... ..	3700 ft.	500 ft.
Cubage... ..	About 2.0 cubic miles	0.4 cubic mile

Because of its much greater depth, the crater of Katmai forms a much more awe-inspiring spectacle than that of Kilauea. The two are, however, so different in character that they are scarcely comparable. The bottom is occupied by a lake of hot water, through which emerges a single-breached cone, the remnant of the last spasms of the great eruption.

The violence of the explosion was so great that the whole of the tremendous mass thus thrown off the



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[D. B. Church

FIG. 1.—Mount Katmai, the greatest of active volcanoes, after the eruption of 1912. The whole of the former three-peaked top was blown away in the explosion of June, 1912, and in its place is left an enormous crater three miles long, the rim of which forms the present crest of the mountain.

its configuration was roughly indicated by contours on the United States Coast and Geodetic Survey's chart of the district. Before the eruption the volcano was a three-peaked mountain rising nearly 7500 ft. above the broad valley of Katmai River, which stretched from the sea inland to the very foot of the mountains.

In the eruption the whole summit was blown away, and in its place was left an enormous crater. The preliminary explorations of the National Geographic Society's expedition of 1916 revealed the general condition of the volcano, and indicated that this crater was of enormous size. In 1917 the whole area was mapped on a scale of 1:250,000, following the methods and standards of the United States Geological Survey. This survey showed that Katmai is the largest active crater in the world, surpassing Kilauea, which had

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mountain was reduced to fine fragments. No rocks or cinders of large size are to be found anywhere among the *débris*. The largest piece of pumice observed among the ejecta from Katmai is less than a foot in its longest dimension. A further consequence of the violence of the eruption was the very wide distribution of the ejecta. On the crater-rim the depth of the deposit was only 45 ft., less than in many a minor eruption. But Kodiak, a hundred miles to the eastward, was covered by about a foot of ash, while appreciable falls, accompanied by the corrosive fumes of sulphuric acid, were detected so far away as Victoria, B.C., more than 1600 miles distant. World-wide atmospheric effects were also observed, but these were much less pronounced than after the explosion of Krakatoa.

But in the great mantle of ash and pumice thrown out over a wide expanse of country Katmai far sur-

passed Krakatoa. The study of the return of vegetation to these ash-covered areas was one of the primary objects of the expeditions, which have laid out about a hundred vegetation stations, wherein the progress of returning vegetation can be accurately observed. From some of these stations photographs and records have already been obtained for three years.

At Kodiak, and wherever the ash-fall was less than 2 ft., an abundant growth of plants has come up through the ashy covering from old roots, resulting in an almost miraculous recovery of vegetation. But where the ash-fall exceeded 3 ft. none of the old plants were able to penetrate the ashy blanket, although there is abundant evidence that they survived the fury of the eruption even on the slopes of the volcano itself.

There are, therefore, large areas which were denuded of both plant and animal life and rendered absolutely sterile by the eruption. These present an unparalleled opportunity for the study of the conditions necessary

seventy square miles north of Mount Katmai. Before the eruption this was a system of grass-covered valleys with no sign of volcanic activity. Now it is traversed by hundreds of fissures extending along its margin or criss-crossing its floor. These fissures are the seat of several millions of volcanic vents of all sizes, from great volcanoes pouring forth columns of vapour more than a mile high, down to minute jets of gas which pass unnoticed amongst their greater neighbours. This valley was discovered by the Geographic Society's expedition of 1916; but it was not possible to explore it until 1917, when its study was the principal objective of the party. Four weeks were spent within its confines in the past season; but it cannot be said that its study was more than well begun, so numerous and varied are its phenomena.

In the cataclysm by which the present condition of the valley was produced all traces of the vegetation which formerly clothed its sides were destroyed, so that there remains no wood for



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FIG. 2.—A corner of the Valley of Ten Thousand Smokes. The "cookstove" at which the members of the expedition prepared all their meals is in the foreground.

for the establishment of life on a raw mineral soil without humus or organic matter of any sort. In 1917 chemical and bacteriological studies of the condition of these soils were carried out by J. W. Shipley and Jasper Sayre respectively, in addition to the botanical investigations of the previous expeditions. The zoologist of the expedition, James S. Hine, made extensive studies of the animal life, especially the insect fauna, in the uninjured district to one side of the devastated area. It is expected that the results of these and other investigations will be issued in a series of technical papers to be published in the *Ohio Journal of Science* as soon as they are completed.

But the most sensational, as well as the most important, of the results of the expedition was the discovery of certain phenomena concomitant with the eruption of Katmai, which are even more interesting than the explosion itself.

The most striking of these is the Valley of Ten Thousand Smokes, which occupies an area of about

use as fuel or otherwise. But it was found that one of the small fumaroles furnished a very acceptable substitute for a cooking-stove. The whole area is so broken up and permeated with escaping vapours that it was impossible to find a cool spot for a campsite. A thermometer inserted in the ground 6 in. below the floor of the tent promptly rose to the boiling-point.

By analogy with other regions, it was expected that hot springs and geysers might be found accompanying the gas-emitting volcanoes, but such are altogether absent. The study of the conditions of the valley showed that their presence is impossible by reason of the high temperatures prevailing throughout the area. The vents are so hot that they would instantly vaporize any water that might reach their throats. The expedition, not expecting such high temperatures, was not equipped with the pyrometers necessary for their measurement. All the major vents were hot enough to boil mercury, but how much hotter they

are than that it is impossible to tell until further observations have been made.

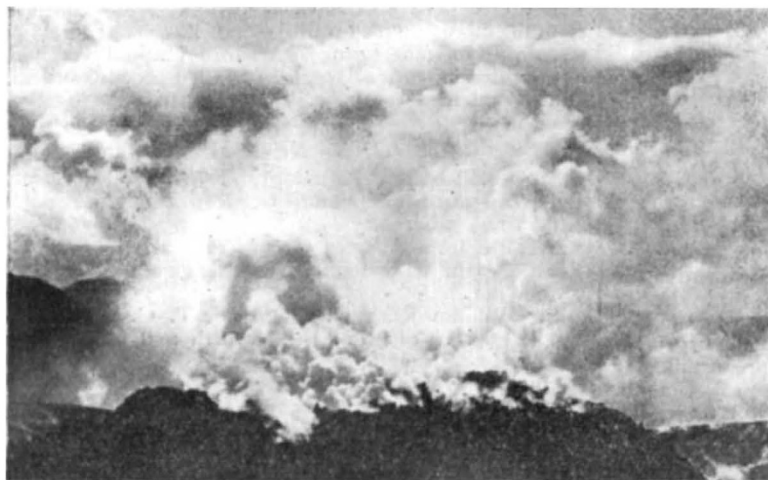
Collections of the gases from the volcanoes were made for study by the Geophysical Laboratory of the Carnegie Institution. The conditions of emission are such that the valley offers a unique opportunity for

character is destined to appeal to a wider circle than that comprised by scientific vulcanologists.

As a spectacle of the action of the grandest of all the forces of Nature, the Valley of Ten Thousand Smokes is so far beyond anything else known to us on the globe as to make it quite certain that it will rank as the first wonder of the world when once its remarkable features are understood by the public. For here, continually rising quietly from the ground without explosive action of any sort, is more vapour than is given off by all the rest of the world's volcanoes put together (except during a period of dangerous eruption). The majesty of the sight presented by its myriads of steam columns, gracefully circling up from the ground which habitually hangs over the valley, is a matchless and awe-inspiring spectacle. No pictures or descriptions, interesting as they may be, can convey the slightest conception of the beauty and magnitude of this wonder of wonders.

At the present time this Valley of Ten Thousand Smokes is so difficult of access that the only human beings who have ever set foot in it are the members of the National Geographic Society's expeditions.

But this difficulty is due not so much to its remoteness from ordinary means of travel as to the generally primitive and unsettled condition of the part of the world in which it lies. Were means of transportation provided, it would be quite possible to land from an ocean liner in the morning and cover the whole of



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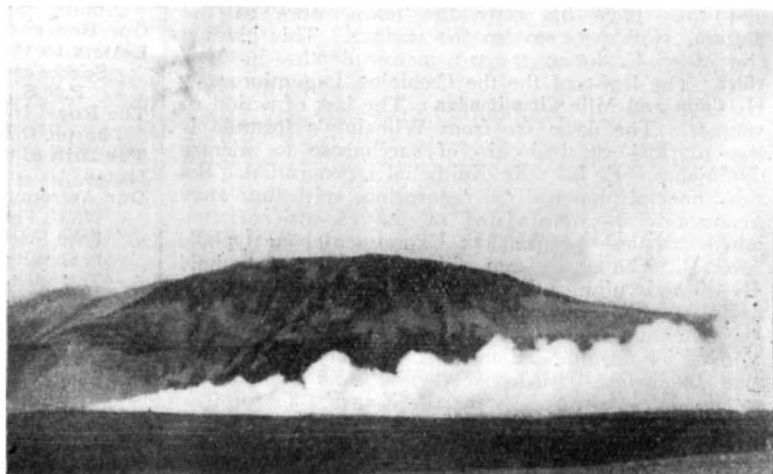
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FIG. 3.—Novarupta Volcano. The column of dust and vapour from this great volcano, which has burst up through the sandstone floor of the Valley of Ten Thousand Smokes, often obscures the sky for miles around.

the collection of volcanic gases without danger of contamination with the atmosphere. Samples from representative vents were taken, both in vacuum tubes and by pumping the gases through tubes filled with barium hydroxide. Observations on the ground were sufficient to indicate the presence of a considerable variety of gases. The vents likewise produce a great variety of solid deposits. These are of all colours of the rainbow, and represent a considerable diversity of chemical composition. Their study is likewise being prosecuted by the Geophysical Laboratory.

It is not possible, in advance of the completion of the analyses now under way, to give a definite statement concerning the chemistry of the vents. But the field observations on the volcanoes, on the temperatures of the vents, and on the character of their emanations and sublimations make it manifest that the Valley of Ten Thousand Smokes is not a superficial phenomenon due to the cooling off of a hot body of ejecta or some such circumstance. It is clear, rather, that its fumaroles are truly volcanic vents furnishing avenues of escape for an immense body of magma lying somewhere beneath the surface. What the relations of this mass of magma may be to the explosion of Katmai and to the geology of the country round about are problems which must await further study.

But while the phenomena of this district present a unique opportunity for the study of some features of volcanism not hitherto revealed, its remarkable



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FIG. 4.—One of the Ten Thousand Smokes. The man seen standing silhouetted against the cloud near the vent gives an idea of the magnitude of the vent.

the district in a single day by automobile. It would, of course, require a longer period to see its manifold wonders, and the readers of NATURE will, I am sure, be glad to know that the first steps towards making it accessible are now being taken.

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