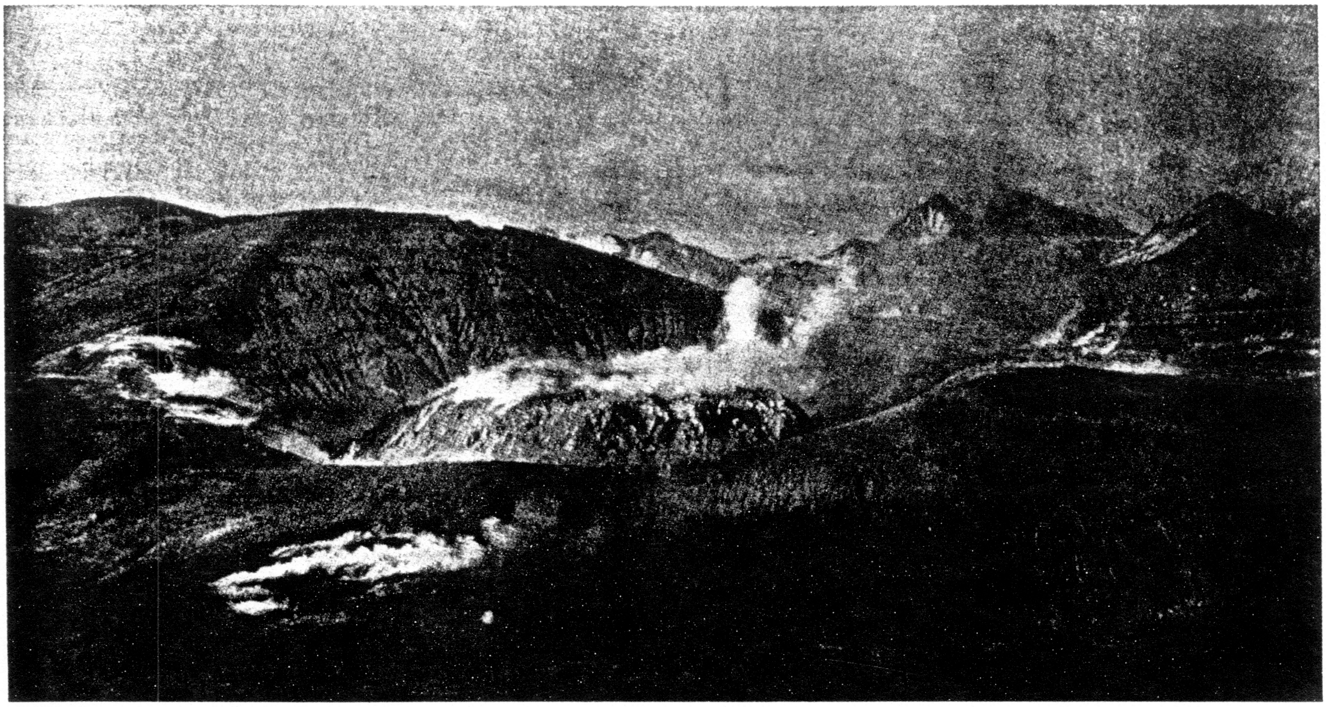
The Volcano Letter

Two dollars per year | Ten cents per copy

No. 379 | Hawaiian Volcano Observatory, National Park, Hawaii | March 31, 1932



Novarupta dome of siliceous soda rhyolite, near Katmai in Alaska, which rose in 1912 in the bottom of a new explosion crater in a valley, and developed a heap 800 feet across and 200 feet high. Photo National Geographic Society.

WILLIAMS ON LAVA DOMES

An essay of unusual importance for volcanology, with excellent illustrations and a thoughtful, philosophical summary of conclusions has just been published by Dr. Howel Williams (The History and Character of Volcanic Domes, Bull. Dept. Geol. Sci., University of California, Volume 21, No. 5, Berkeley 1932, 95 pages, 37 figures).

Dr. Williams became interested, in the subject of lava flows which arise so stiffly as to build up at once a plug or dome, by his work at Lassen Volcanic National Park where there are 13 such domes within an area of 50 square miles on an even grander scale than the puys of the Auvergne. Massive protrusions are now known to be common manifestations of volcanic activity. There are plug domes which represent upheaved conduit fillings, domes that grow essentially by expansion from within, and domes built by surface effusion. In the last class the large Hawaiian overflow heapings are better described as "shield volcanoes."

The domes described consecutively are those of the Caribbee Islands including notably the dome and spine of Mont Pelée and the dome at the volcano of Guadeloupe. Next come the Central American domes of Santa Maria in Guatemala, Popocatepetl in Mexico, and some minor ones in these countries. South America has numerous lava domes which are imperfectly known, of which the best example is the acid andesite dome, consisting of viscous hardened lava, having an extremely jagged surface, from which steam and fragmental eruptions continually issue, in the crater of Galeras Volcano. In North America, besides the Lassen domes there are those in the chain of craters south of Mono Lake, California. Here at Panum Crater the obsidian lava was so nearly solid that it rose with essentially vertical walls to about 150 feet without exhibiting a tendency to flow in any direction, so that a deep moat separates the dome from the surrounding rim of lapilli. At the Marysville Buttes in California there are banded rhyolites which form intrusive domes among Tertiary sediments along the flanks of an andesitic laccolith, steep-sided and of oval outline from a quarter mile to a mile in length. They were viscous and contained steam, and the rise of the domes was attended by violent steam explosions, some of which blasted a crater, measuring a mile in diameter, through the core of the laccolith. Next come descriptions of Bogoslof in the Aleutian Islands and its numerous domes, and of the remarkable siliceous dome of Novarupta near Katmai on the Alaskan Peninsua. "The rise of this dome, like that of almost all domes, was preceded by strong pyroclastic explosions, whereby a crater almost three quarters of a mile in diameter was opened," and coarse ejecta measuring eight feet in diameter were flung a quarter mile from their source. The explosive phase was followed by the welling up of viscous magma, which as it was slowly thrust upward broke into huge blocks. It was heaped about 800 feet in diameter and 200 feet high. The glassy lava is banded in general parallel to the margins. "Apparently the magma rose to the surface by the active solution of the country rocks, retaining its heat largely by gas reaction. The original magma was a siliceous soda rhyolite with 75 per cent of silica containing partly fused inclusions of andesite country rock with 62 per cent of silica."

Next come descriptions of Tarumai and Usu domes in Japan, Merapi and Galunggung in Java, and Ruang in the Sangi Islands. A submarine dome during April, 1904, appeared in these islands, and after 1913 three rocks were left emergent above the water. In 1919 a short-lived dome rose above the surface, forming an island 70 meters in diameter and up to 12 meters in height. It consisted of lava blocks of amphibole andesite. There are many other stiff lava domes in the craters of the Dutch East Indies.

Ascension Island in the Atlantic has crater domes of trachyte, and the trachytic eruptions were in all cases preceded by eruptions of basalt. The protrusion of the domes followed long periods of dormancy and was heralded by explosions flinging up obsidian ejecta. The explanation appears to be that after the early outpourings of basalt, the residual magma became differentiated and capped by a siliceous slag. "This sequence of events thus affords another instance of the explosion of a gas-rich, differentiated magma, followed by the quiet upwelling of pasty lava to form" interior heaps in the craters, a sequence apparently common in dome eruptions. The trachytes are poor in vesicles in contrast with the rhyolites and basalts. The diameters of the Ascension Island domes are 400 to 500 meters, and the heights 200 meters more or less. In the Ragged Hill dome, the dome structure is indicated by a pronounced concentric rifting, with plates dipping away 35 degrees, and the platy structure apparently due to thermal contraction. There are inclusions of common basalt in the trachyte. In the case of the Riding School dome, the trachyte flowed over the rim of a basaltic crater after forming a large body in the center of the depression, and then after making a thick flow 700 meters long away from the crater, the surface of the inner dome sank back to form a basin. This withdrawal of magma in the center happened in another dome where the platy structure has an inward dip of from 2 to 5 degrees. At St. Helena there are phonolite domes more deeply eroded than those on Ascension Island, the largest of which, called Great Stone Top, was originally 300 meters high, was fed by a dike only 10 to 15 meters wide, and was accumulated, not in an old crater, but on an almost level floor of basalt. In Samoa there are rhyolite and trachyte domes closely analogous to those of Ascension Island, here also overlying older basalts.

The puys of the Auvergne in France have black basaltic cinder cones with pale-colored craterless domes of trachyte within them, and Scrope in 1825 described them correctly. He observed that basalts tend to yield low, broad cones, because of their high fluidity, whereas lavas of "low specific gravity, especially when combined with a coarse, crystalline texture, will occasion a minimum of fluidity. The trachytic lava seems to have risen upwards from the vent in so pasty or imperfectly liquid a state as to have accumulated above it in the form of a dome or bell, just as would a body of melted wax, or one of moistened clay, if forced outwards through an orifice in the cover of any containing vessel."

The domes of Auvergne are divided into three types, (1) Peléan domes, acid and basic, (2) Peléan domes with craters or with trachyte ejecta, (3) domes with elevated portions of the adjacent rocks. The augite trachyte dome of the Grand Sarcoui has the form of an overturned bowl with a maximum slope of 60 degrees, measures 750 meters across the base, and is 250 meters high. It has a smooth surface and no rock pinnacles, due apparently to the lava having poured uniformly in all directions from a summit vent. On the east flank there are quarries revealing buried talus and the rough structure of an underlying pinnacled dome. This inner heap was of the Pelée type and the overflows at the top were a late phase. In the Puy de Dôme there has been left an irregular truncated pyramid 550 meters high. It is a trachytic protrusion covered by debris from a summit vent. Lacroix explains the sequence by the opening of a fissure in the underlying rocks consisting of granite, gneiss, etc., permitting lava that was partly viscous and partly solid to rise to the surface and build a steep dome. Its crust crumbled, forming great banks of talus cemented by fine dust. Both dome and talus are biotite trachyte. Later eruptions from a new summit crater deposited fragments including pieces of the bedrock pumice, breadcrust bombs, and angular pieces of trachyte. The trachyte ejecta of these final eruptions differed mineralogically from the materials of the dome, and in texture from glassy to coarsely crystalline. The same thing was observed in the dome of Mont Pelée.

The Gulf of Santorini, in the island of Thera of the Grecian Archipelago, produced the first dome eruption well known to European geologists. In February 1866 a new islet appeared in this crater bay composed of lava blocks, pumice, and bottom debris. Steam explosions were frequent. The mass grew without earthquake or visible projection of fragments, silently, but so rapidly that it seemed like the blowing of a soap bubble. It seemed like an expansion movement with the rocks incessantly displaced from the center towards the edge. On the second day the growth was from the edge towards the center. The dome above water measured 70 to 30 meters and was 20 meters high. One could walk on top, although the lava was still glowing beneath. There was no summit crater, but rather a confused heap of big blocks grayish in daytime, fuming, and at night lighted by incandescence, while the lower slopes were covered with cooler debris. There were long crescentic fissures, almost complete circles, on top of the dome. Similar cracks have been observed at Novarupta, Alaska, and at Chaos Crags near Lassen. The first Santorini dome was named Georgios, and on February 15 a second dome, Aphroessa, rose quietly above the sea on its flank. Within two days it grew enormously, and in five days its length had reached 380 meters. Its mode of growth, like the first dome, showed nothing but a progressive displacement of lava blocks. There were, however, occasional eruptions of cinders and lapilli which decapitated and flattened the Georgios dome. On March 8 this measured 350 by 100 meters and stood 50 meters high. The blocks were either scoriaceous or compact glassy andesite. There was an incessant crackling noise and a tinkle like broken porcelain. The fumaroles had temperatures up to 300 degrees C. and the vapor contained hydrochloric and sulphuric acid. On March 10 a third dome, Reka, arose still more quietly without any crackling of blocks breaking asunder in cooling. This heap became joined to Aphroessa. Fouqué called these domes cumulo-volcanoes. New hillocks of blocks were piled up and destroyed, the shapes changed, the rates of growth varied, and Georgios developed a pile of blocks on top enclosed by a circular trench. The end of the activity was on Georgios in October 1870, four years and eight months after the beginning of activity, and the new islet finally stood 120 meters above the sea.

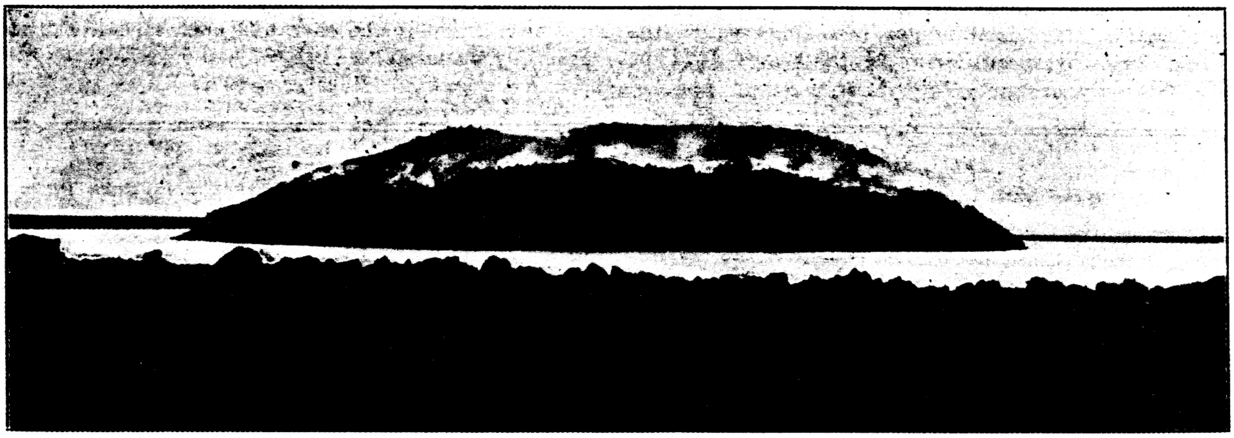
Fifty-five years later in September 1925, the same kind of activity was renewed when Fouqué dome appeared near the earlier island, circular in plan, 150 meters in diameter, and 50 meters high above a plateau of new lava on September 19. The shape of the dome continually changed. There were violent eruptions and a continuous redistribution of the loose blocks. The explosions sent up black cauliflower clouds. The temperature of the upper part of the interior of the dome was 700° to 800° C., there was no definite crater, and small jets of white vapor were emitted all over the surface. The vulcanian explosions took place from different places, mostly near the summit, blowing out loose blocks which fell back, and occasionally decapitating the dome. The blocks were solid and angular, dense, vitreous, and black, and there were no well-defined breadcrust bombs. There were concentric crevices which made a thin ring of bright red incandescence, and in daytime semicircular batteries of narrow jets of gray vapor which formed a crown around the dome. The lava flows associated with the dome had blocky crusts over compact vitreous lava free from vesicles. One small dome on the surface of the flow exhibited concentric banding. In the Georgios dome the lava contained many basic inclusions, very little gas, very little combined water, 65 per cent of silica, and may be called a glassy pyroxene dacite.

In 1831 an island formed by submarine eruption near Pantelleria in the Mediterranean appeared on July 16, had become 65 meters high and 3700 meters in circumference early in August, and was washed away by the end of October. The material was volcanic sand, lapilli, and scoriae arranged in strata around a crater. There appears to have been an upthrust of lava in viscous condition and broken at the top, similar to Bogoslof. There was trachytic pumice, but the island was basaltic. There was much carbon dioxide gas.

Other domes are described in the Lipari Islands and in the older lavas of Italy, in the Eifel region and elsewhere in Germany, in the Milos Archipelago of Greece, among the Virunga volcanoes of East Africa, in Kamchatka, in the Philippines, in Iceland, in the Azores, and in several places in California including the flanks of Mount Shasta.

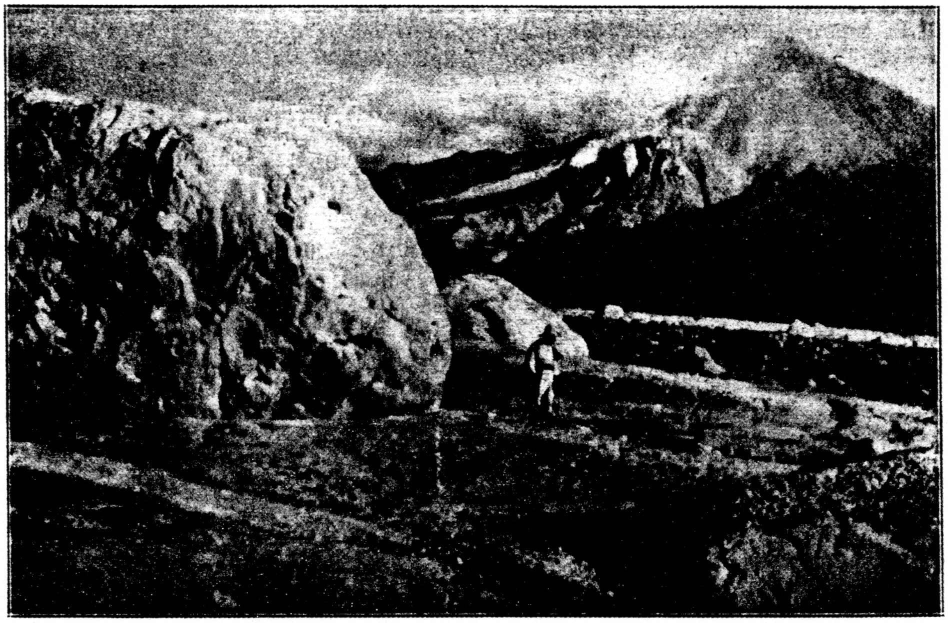
Summarizing the characteristics of dome outflow, the largest are one to two miles across and the smallest only a few meters. In shape most of them are truncated domes and pyramids with lower slopes concealed by talus. Breaking up of crusts during upheaval, and the formation of concentric or radial ridges are characteristic features. Slickensides or scrapings are often to be seen along the walls of fissures. Glassiness is very characteristic of the lava of domes, also porphyritic structure, and and the upwelling of the lava is preceded by explosions flinging out pumice and tuff. There are usually many basic inclusions. The rocks are mostly andesties, trachytes, and rhyolites. The temperatures at times of protrusion are estimated to have been less than 850° C. Shepherd and Merwin estimated that the gas pressure inside the Pelée dome was about 100 atmospheres. Intense solfataric action is seldom conspicuous during and after upheaval. The gas content of the lavas is small, 0.15 per cent by weight at Lassen, 0.10 per cent at Santorini. The breadcrust bombs of Pelée contain six times as much gas as the material of the dome. The gases listed as extracted from rock of Pelée, Lassen, and Kilauea show excessive carbon dioxide, sulphur, chlorine, and fluorine for the former and relatively high hydrogen and carbon monoxide for an aa lava of the latter. Lassen Peak andesites have excessive combined water. One is impressed by the great excess in all these analyses of H_2O, 70 to 96 per cent, as compared with H_2, one per cent or less; CO_2, one to 20 per cent, as compared with CO, measuring from less than one to three per cent; and SO_2, on the other hand, always less than one per cent, is in less amount than the sulphur from which it is derived, which approaches one or two per cent. The unoxidized hydrogen reaching its maximum in the Kilauea lava (6.18 per cent), and the fact that one of Day and Shepherd's analyses of the gas from the liquid lava yielded seven per cent, makes it reasonable to suppose that hydrogen is the fundamental volcanic gas, but that it oxidizes during the rise of magma and consolidation, just as do the metallic ingredients in combination with silica.

The rate of growth of domes is rapid. That at Santa Maria rose 100 meters in a week, the dome of Mont Pelée rose 25 meters in a day, that of Tarumai rose 100 meters in four days. The internal structure may have concentric layering, or it may have fan structure, or it may spread



Lava heap of Bogoslof Volcano in the Aleutian Islands, surrounded by warm salt-water lagoon and ring bars of explosion debris. Activity of 1926-28, photo Wheeler.

2958



In distance Santa Maria Volcano in Guatemala after eruption of November 2, 1929, in middle distance the lava dome which had risen in the crater in the flank of the volcano, and in foreground gigantic bowlders carried with floods of the eruption. Photo Sapper and Termer.

with irregular fissuring and sprouting like aa lava. In most cases talus forms around the border. The propelling force Williams considers to be the expansive pressure of internal gas, and generally the dome is the top of a plug forming a seal to the conduit at the close of an active period. T.A.J.

KILAUEA REPORT No. 1053

WEEK ENDING MARCH 27, 1932

Section of Volcanology, U. S. Geological Survey
T. A. Jaggar, Volcanologist in Charge.

In Halemaumau pit the afternoon of March 21 the fume at the foot of the southwest talus appeared denser than usual. Scars of two small slides had appeared on the south wall; one over the northwest talus at 2:24 p. m. raised a cloud of dust. On March 22 at 10:55 a. m. a sound like floor cracking was heard. Slide dust arose at 12:30 p. m. March 23, and a larger avalanche at 1:40 p. m. dumped fresh debris on NW talus. At 2 p. m. dust continued to rise. The avalanche tremor was registered by the pit seismograph. This avalanche fell directly from the rock of the northwest rim for a length of 150 feet, and left large bowlders below. On March 26 glow was still reported visible in evening in crack at south edge of Halemaumau floor.

Observatory seismographs registered 66 tremors for the week, and two very feeble local seisms, one of which indicated origin 16 miles away. A distant earthquake was recorded beginning at 1:36:32 p. m. Hawaiian time (10 hrs. 30 m. slower than Greenwich) March 25, of probable distance 2980 miles from Hawaii. Tilting of the ground was very slight to the east, and microseismic motion was generally moderate.

THE VOLCANO LETTER

The Volcano Letter combines the earlier weekly of that name, with the former monthly Bulletin of the Hawaiian Volcano Observatory. It is published weekly, on Thursdays, by the Hawaiian Volcano Research Association, on behalf of the section of volcanology, U. S. Geological Survey. It promotes experimental recording of earth processes.

Readers are requested to send articles, photographs, publications and clippings about volcano and earthquake events, instruments and investigations, especially around the Pacific.

Subcription for non-members two dollars per year of 52 numbers. Address the Observatory.

HAWAIIAN VOLCANO OBSERVATORY
Founded 1911

This laboratory at Kilauea Volcano belongs to the Hawaiian Volcano Research Association and is leased and operated by the United States Geological Survey.

It maintains seismographs at three places near Kilauea Volcano, also at Hilo, and at Kealakekua in Kona District. It keeps a journal of Hawaiian volcanic activity and publishes occasional Bulletins.

Membership in the Hawaiian Volcano Research Association is limited to patrons of Pacific science who desire personally to aid in supporting the work.

The work of volcano research so supported is in collaboration with the work of the United States Geological Survey, but supplements it with buildings, research fellows, instrumental plants, explorations and special investigations for which there is no governmental provision. The Geological Survey maintains volcano stations in Alaska, California and Hawaii.

Persons desiring application blanks for membership ($5.00 or more) should address the Secretary, Hawaiian Volcano Research Association, 320 James Campbell Building, Honolulu, T. H.