

CHAPTER II. HISTORICAL ACCOUNTS OF SAKURA-JIMA ERUPTIONS.

5. Submarine eruptions in Kagoshima Bay. The island of Sakura-jima is only 42 km distant from the great volcanic masses of Kirishima. The existence of a deep sea area, namely, the northern portion of Kagoshima Bay, between these two mountains, is certainly a remarkable geographical feature, and it is not surprising that there were submarine eruptions and formations of new islands on more than one occasions in our historical times.

The earliest known volcanic disturbance in Kagoshima Bay is that of Dec. 764, which is recorded in "Zoku-Nihonki" (續日本紀), one of the old national histories, as follows:—"Sounds like thunders were heard towards the west, when, at the boundary of the two provinces of Ōsumi and Satsuma, the air was rendered dark by smokes and clouds, from which lightnings flashed out. The sky cleared after seven days, and it was then found out that in the sea off Shinni-mura (信爾村) of Kagoshima, sand and rock collected themselves into three new islets. These latter, exposing to view fires and vapours, like the furnace of a smith, were continuous and looked like a straight-ridged garden-house (四阿之屋). 62 houses were buried under the islets, with the loss of more than 80 lives." The new islets, called Kamizukuri-jima ("Islands created by gods") or Ōnamochi-jima (Island of Ōnamochi), seems to have been shaken by earthquakes for the several succeeding years, as, in July 766, the government sent relief among the distressed people. 13 years later on, or in Jan. 779, there was established the temple of Ōnamochi on one of the new islets, probably because, by that time, the seismic and

volcanic disturbances had already completely ceased. The name of Kagoshima used in former times to be applied to the extensive tract at the boundary of the two provinces of Satsuma and Ōsumi, and the village of Shinni-mura mentioned in the old record is probably identical with the present Shikine-mura* on the north-east coast of Kagoshima Bay, not far from the town of Kokubu. Thus, the above mentioned eruption very likely relates, not to Sakura-jima, but to a submarine volcanic outburst close to the coast of the last named place, where still exist two rocky islets known as Heta-kojima and Oko-jima; the third, whereon formerly stood the temple of Ōnamochi (now removed to the vicinity of Kokubu), having, by the subsequent subsidence, again disappeared under the water. The site is still known as the Miyanosu ("Temple shoal"), its present depth being 21 fathoms. (See fig. 3.) Fig. 6, Pl. XII, is a view of the Kamizukuri-jima taken in Sept. 1914 from the vicinity of Hamanoichi at the northern coast of Kagoshima Bay.

6. **Extinct craters of Sakura-jima.** The three principal peaks of Kita-dake, Naka-dake, and Minami-dake arranged in the direction of N. slightly W. and S. slightly E., form the top ridge of Sakura-jima, whose length is about 1.7 km and whose average elevation is some 1050 m above sea-level. Of these three peaks, the crater of Naka-dake is the oldest, and that of Kita-dake the next oldest, both being completely extinct. The southern peak, Minami-dake, is of a newer date than the other two and has a number of fumaroles emanating from near the summit. The Minami-dake crater, although it gave no lava outflow in the historical times, is still active in a sense, as in the great eruptions of the periods of

* In the Satsuma dialect "Shikine" is pronounced in a short contracted manner, somewhat like "Shinne."

Anci (1779) and of Taisho (1914), it served as the mouth of the premonitory outburst, whereby a black smoke column was shot vertically to a great height.

The crater at the top of *Kita-dake*, or North Peak, is a nice regular depression, 400 to 470 m in diameter, which, being a good deal filled up, looks quite shallow. The rim is composed of three detached rocky remnants, whose maximum height before the eruption was 1133.5 m, but whose heights after the eruption were from 1110 to 1118 m above sea-level; the height reduction being mainly, if not entirely, due to the strong earthquake shocks which broke down to a more or less extent the cliffs at and near the top portions of the island. The level of the crater bottom before the eruption indicated in the Military Survey map was 1037 m. There is no fumarole on *Kita-dake*, which, in fact, gives no sign of activity.

The crater of *Naka-dake*, or Middle Peak, which is slightly lower than *Kita-dake*, is almost entirely filled up, and forms a very shallow basin, about 340 m in N.S. and 150 to 200 m in E.W. direction; the S. rim, which forms at the same time the N. cliff of *Minami-dake*, having the height of 1070 m.

The crater of *Minami-dake*, or South Peak, which is contiguous to that of *Naka-dake*, is much greater than the two others, and have the diameter length of about 640 m in N.S. and 500 m in E.W. direction, with the depth of about 250 m. When visited on April 24th, 1915, fumes were being given out feebly from the W. and N.E. parts of the inside of the crater, as well as from the outside slope, near the top, at the E. and S. sides. The crater of *Minami-dake* presents a sight much grander than that of *Asama-yama*, and has very precipitous inside cliffs; the ridge of the surrounding wall being at places very thin as to barely afford a footing for us to stand on.

The lava outflows in the Bummei period (1468–1476) and subsequent eruptions took place all from side craterlets situated at heights less than 750 m above sea-level.

Nabe-yama and Ebinotsuka. Nabe-yama, so called from its resemblance to an inverted Japanese cooking pot, is a low but highly characteristic parasitic cone, situated 3.0 km to the E. slightly S. of Minami-dake, and a horse-shoe in form, with an opening at the E. side. The N.S. diameter of the flat top ridge is about 900 m and that of the base about 1600 m, the highest point, situated at the W. side, being 358 m above sea-level. Ebinotsuka is a much smaller but similar cone, 122 m in height, which is situated 4.0 km to the due E. of Minami-dake. Although made up entirely of ash and pumice, these two hills have preserved their form perfectly and consequently must have been formed at no very distant epochs. In fact, according to the writings on the Anei eruption (1779) by Ijichi Kiken, of Tarumizu, the Nabe-yama crater is ascribed to the eruption of the 3rd year of the Bummei period, namely, 1471, a supposition which is by no means improbable. The explosion craterlets and lava sources of the eruptions in the Bummei and Anei periods, whose positions are indicated in fig. 2, will be described more in detail in No. 3, of this Volume.

7. Number of Sakura-jima eruptions. The authentic record of the eruptions of Sakura-jima goes back to 1468. Since then there were in the course of $4\frac{1}{2}$ centuries altogether 26 eruptions or groups of eruptions of the volcano, whose dates, both Japanese and European, are given in Table IX. In the following §§ I give accounts of the strong Sakura-jima eruptions in the two periods of Bummei (1468–1476) and Anei (1779).

8. Eruptions in Bummei period, 1468–1476. This series of the vol-

canic outbursts began with a small explosion in 1468. 3 years later, on Nov. 3rd, 1471, a strong eruption took place on the E. side, above Krokami, and threw out ash, sand, and burning stones, the lava outflow forming the cape of Ōmoe-zaki. It is recorded that in this case the burning stones accumulated into a rocky hill, which may possibly refer to the lava-source of Ōmoe-zaki or the parasitic cone of Nabe-yama. Then, the eruption of Sept. 24th, 1475, took place on the S.W. side of Sakura-jima, from the vicinity of Nojiri-mura, causing outflows of lava. The eruption on Oct. 8th of the next year was preceded by strong earthquakes, which had began from the 3rd of the same month and was very active during about 1 week; the lava, which flowed out on this occasion, forming the cape of Moe-zaki at the S.W. end of Sakura-jima. (See fig. 2.)

Fig. 5, (Pl. XII), is the view of Moe-zaki, photographed in Sept. 1915. The lava flow of the Bummei period remains, after the lapse of 440 years, still in a fresh state, being covered principally by slender pine trees.

9. Eruptions in Anei period, 1779. The eruption of the 8th year of Anei took place in a fine and quiet weather. The local earthquakes, which constituted the precursory disturbances of the volcanic outburst, were composed of very sharp movements of short duration, often quite strong in intensity. These began to occur in the island already from about 6 p.m. on Nov. 8th (lunar calendar, Sept. 29th), the festival day of the Gosha-Daimyojin, of Akamizu, the principal temple in the island, with a high frequency of 30 to 40 in one hour, not decreasing in activity even after the noon of the next day, the 9th (lunar calendar, Oct. 1st). On the morning of the latter day, the colour of the sea water became purple, while the well waters at the beaches bubbled up and flowed

out copiously in small streamlets. In the city of Kagoshima, earthquakes were incessantly felt since 8 or 9 p.m., on Nov. 8th, till the next day, at about 11 a.m., thin white smokes were vertically projected from the Shiramizu ("White pond"), or the crater at the top, of Minami-dake. This was the opening step in the process of the eruption, and was followed at about 2 p.m. by a tremendous outburst from a place termed Moeno-kashira ("Source of burning") at the S. flank of Minami-dake and above the village of Furusato. The detonation of the explosion was excessively loud, and the column of dense gray and black smokes, like masses of cotton, which gave out innumerable flashes of lightning, ascended vertically, pierced through layers of clouds, and reached a height of 3 *ri* 2 *cho* 16 *ken**, or 12,030 metres, thence, spreading out in the form of an open umbrella, was gradually carried eastwards. (See fig. 11.) From the town of Tarumizu (province of Ōsumi), situated at a distance of 8 km to the S.E. from the scene of eruption, could be distinctly observed with naked eye the lava fragments which were projected out from among the smokes like groups of flying birds, causing at once conflagrations of the houses or plants they fell on. After a time, the smokes spread over the city and caused the precipitation of ash, followed by that of sand, rendering the air completely dark, while the earthquakes and thunders became more and more intensified. At the first strong outbreak, the inhabitants of Kagoshima, which suffered no direct damage from the eruption or the earthquakes, were seized by panic, in consequence of the imagined dangers from the rushing of gigantic *tsunamis*, an enormous accumulation of burning stones and ashes, etc. Thereupon, by order from the feudal

* According to the estimation made at the Meiji-kwan (old astronomical observatory) in the city of Kagoshima.

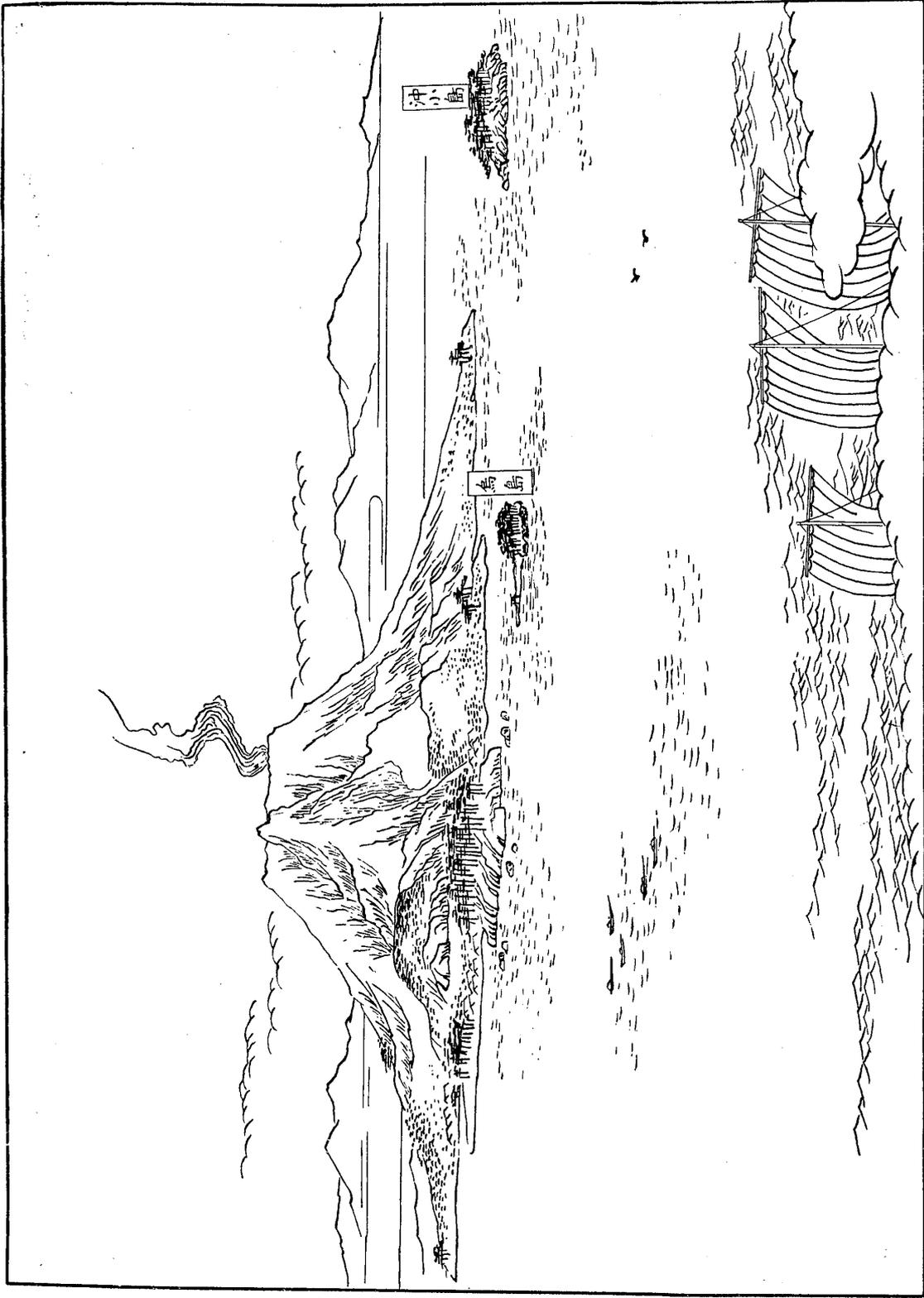


Fig. 4. Sakura-jima, as it appeared from Kagoshima 70 years ago, with the islets of Karasu-jima and Oko-jima respectively near the middle and at the right-hand side of the picture.
(Reproduced from the "Sangoku Meishō Zue.")



Fig. 5. Moe-Zaki, (" Burning Cape ") at the S.W. end of Sakura-jima, formed by the lava flow of 1476.



Fig. 6. View from N.E. of Kanzukuri-jima (" Islets created by gods "), the Heta-Kojima and Oko-jima of the present day, formed in 764 near the N. coast of Kagoshima Bay.



Fig. 7. View from W. of Moe-jima (" Burning Islet "), formed in 1780 off the N.E. coast of Sakura-jima.
(F. OMORI, photo.)

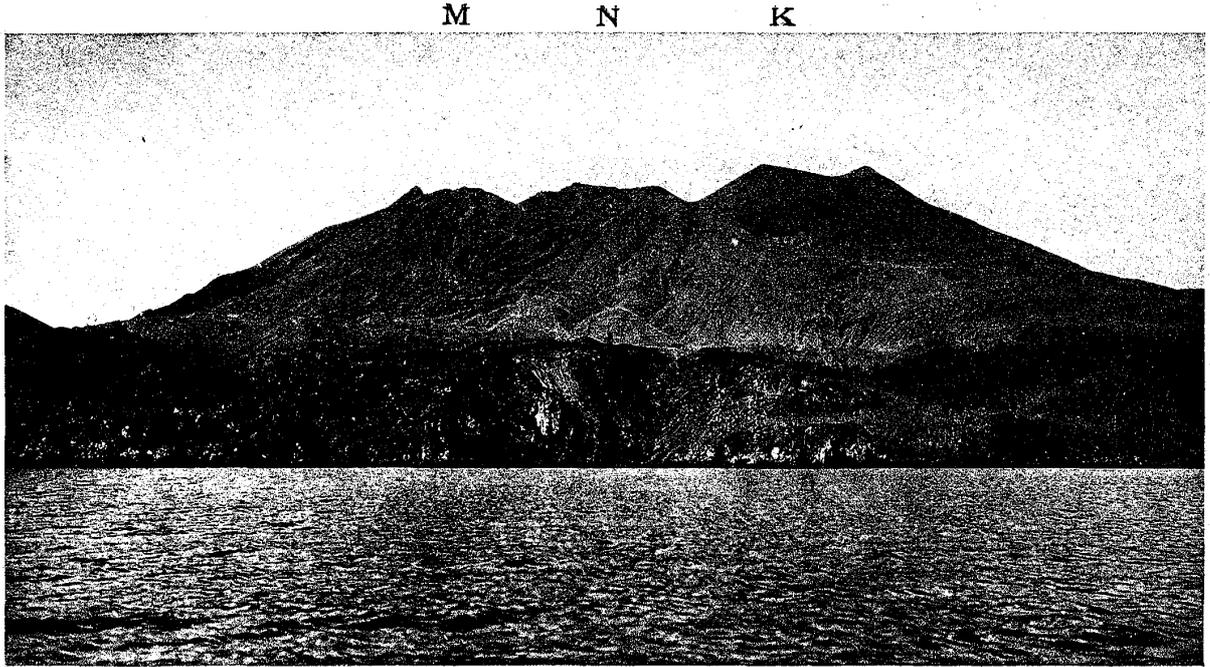


Fig. 8. View from N.E. of Sakura-jima with Kita-dake (K), Naka-dake (N), and Minami-dake (M) tops arranged from right to left. At the upper flank of Kita-dake, there are shown two old large side "Higona", or craterlets. In the fore-ground, at the middle, there stands the half buried Sono-yama, with lava flows of 1779 on both sides. (F. OMORI, photo.)



Fig. 9. Sono-yama (S) and Pond (P), with the lava flow (L) of 1779 at the right-hand side. Kita-dake and Naka-dake tops are shown on the back-ground. (F. OMORI, photo.)

government, prayers were being fervently offered in the nine principal Buddhist temples of the city for the pacification of the volcanic disturbances, when, at about 4 o'clock on the same afternoon, strong outbursts took place also from the N.E. slope of the mountain, at a locality termed Kamekake (瓶掛), above the old village of Komen (高免).

The violence of the eruption was considerably augmented about 12 hours after the commencement, namely, in the early morning of the next day, Nov. 10th. Thus, at the village of Futamata (二股), on the N. coast of the island, hot lava fragments began to fall there from about 3 a.m. on the 10th; while, in the city of Kagoshima, the detonations became specially strong from about 5 a.m. on the same day. It is probable that the eruption entered in the morning of the 10th on its phase of the maximum explosive activity, followed then by the epoch of the lava outflow. Thus, the lava stream on the Furusato side probably flowed out on the night of Nov. 11th, as it is recorded that an Arimra villager, who had been staying at Akamizu to partake in the festival of that place, thence walked on the same day along the south coast of the island to the village of Seto without encountering any lava stream at all. In fact, the Anei lava at Furusato is not covered by pumice and consequently must have flown out subsequent to the heavy precipitation of the latter.

The eruption was most active on Nov. 9th and 10th. At Tarumizu and the neighbourhood, to the S.E. of Sakura-jima, the smokes became thinner on the next two days, the sky becoming gradually clear after one week, on the 16th. The weather, which had remained fair during the first three days of the eruption, changed on Nov. 12th, when, in Kagoshima, there was first, under an easterly wind, a precipitation of ashes and the air became dark

between 10 a.m. and 2 p.m. Ashes fell there also on the 13th and 15th of the same month.

Detonative sounds. The sounds of the eruption must of course have been perceived at a considerable distance from the volcano. Thus, at the city of Ōita, 206 km to the N.E.N. of Sakura-jima, sounds like gun boomings were heard during the night of the 8th and on the 9th, Nov. At the much nearer town of Miyakonojō, there were 5 or 6 earthquakes during the night of Nov. 8th, and the sky became cloudy from about the noon of the next day, when sounds like thunders began to be heard.

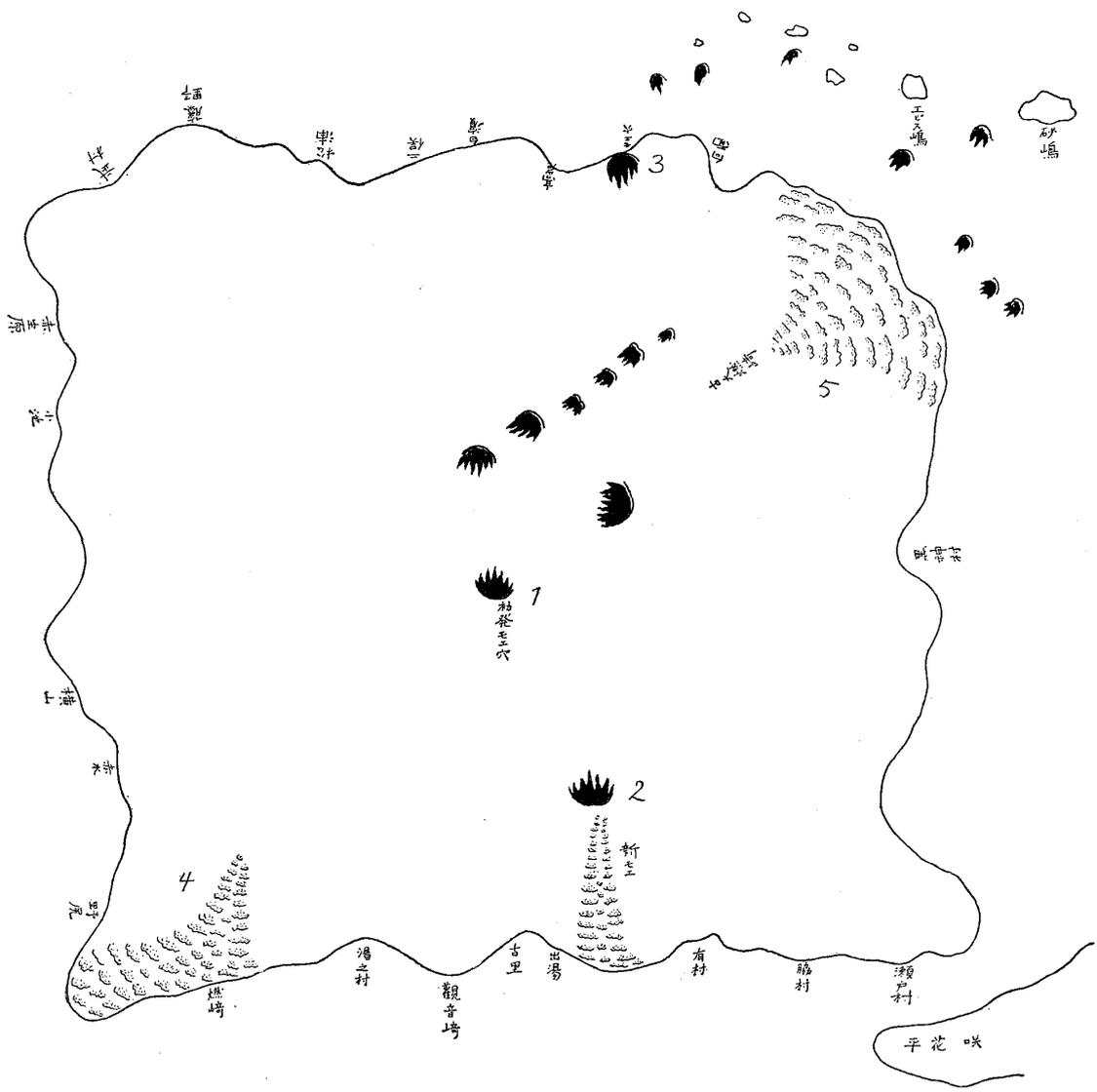
Ash-precipitation. According to § 18, the accumulation of pumice on this occasion was very thick in the eastern and south-eastern parts of Sakura-jima, being about 2.3 to 2.8 m at the Arimra-Yunohama beach terrace, and 1.03 m at Krokami. The precipitations at these two places were due to the eruptions respectively from the S. and the N.E.N. side craterlets. Outside the island, the accumulation was thickest and amounted to 3–6 ft on the Sakkabira (Hayasaki) promontory and at the village of Obama, on the coast of the province of Ōsumi, and 4.8 to 5.4 km to the E.S.E. of the Furusato side craterlets, thence gradually diminishing southwards, till it was reduced to about 0.25 ft at Tarumizu, 11 km to the S.E.S. of the same sources of eruption. On the N. coast of Kagoshima Bay, there fell at Shikine ashes only, not mixed with sand or pumice. In the province of Hyuga, the amount of precipitation was about 10 mm at Miyakonojō and Miyazaki, and 120 mm at the town of Obi, these three places being situated respectively 42 km to the N.68°E., 83 km to the N.63°E., and 66 km to the N.86°E. of Sakura-jima.

The ashes were carried, as in the case of the eruption of 1914, principally towards the east, their slight precipitation, on

Fig. 10. Old Sketch Map of Sakura-jima Eruption in Anei Period (1779), illustrating the outbursts from different places in and out of the Island.

(Reproduced from Ijichi Kiken's "Accounts of the Personal Experiences in the Anei Catastrophe.")

- (1) Craterlet whence the first or earliest eruption took place.
- (2) Source of the Furusato Lava Stream.
- (3) Craterlet still remaining in the vicinity of the present village of Komen.
- (4) Moe-zaki (Bummei Period). (5) Ōmoe-zaki (Bummei Period).



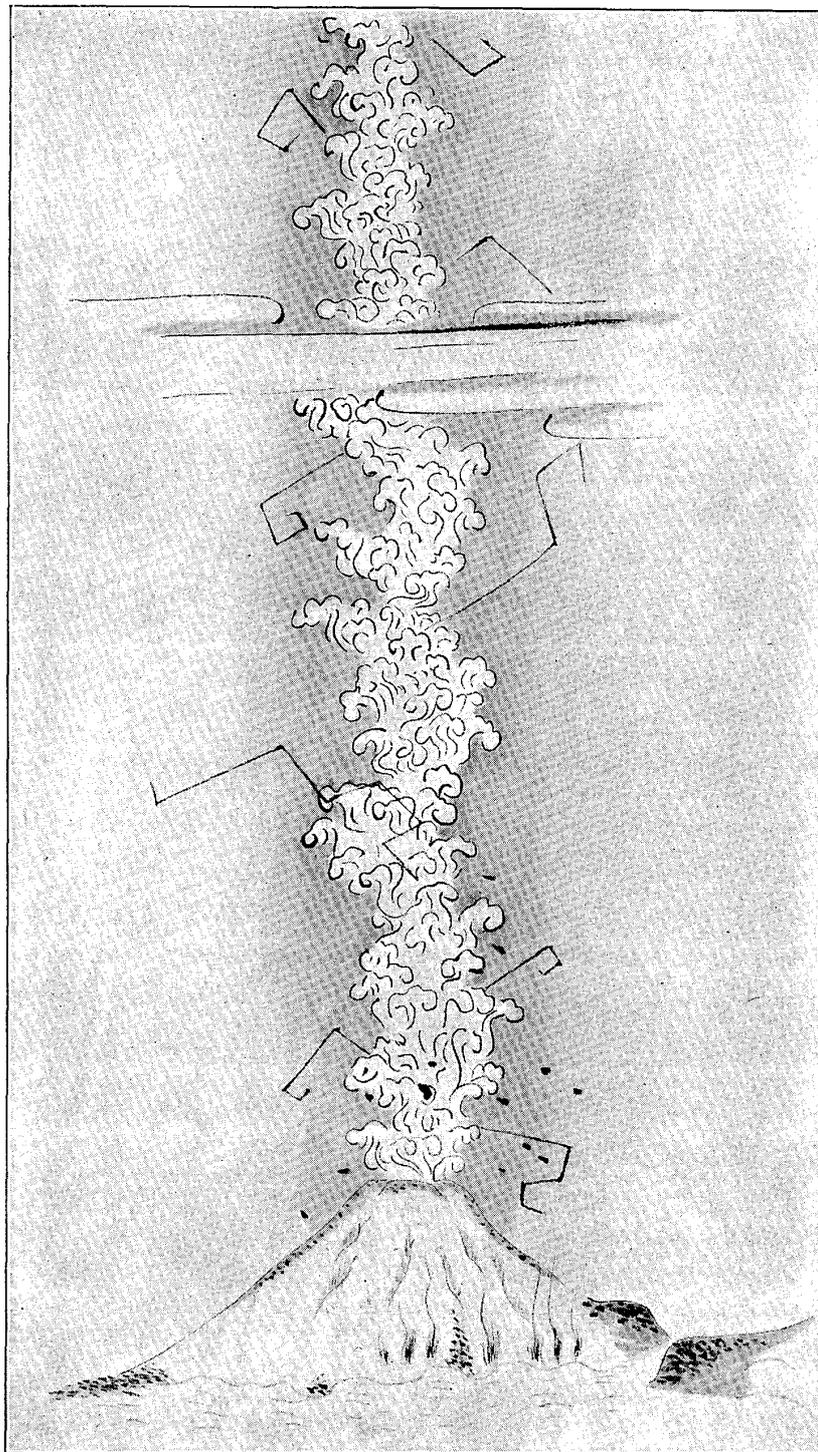


Fig. 11. View of Sakura-jima taken from Tarumizu, illustrating the first outburst in the eruption of 1779. The crooked lines shooting out of the smoke column are the symbolical representations of lightning flashes. The original drawing is given by Ijichi Kiken in his "Accounts of the personal experiences of the Anei catastrophe."

Nov. 10th and 11th having been reported from the coast of Tosa, and some places in Kii, Owari, Ise, and the Kanto provinces. In Yedo (Tokyo) it was cloudy and cold on Nov. 9th, and the ashes which had began to fall in the night of the 9th, like mist or snow, ceased on the 10th, when the weather became fair. In Osaka, there was some precipitation of sand on the 9th. At the town of Tanabe, on the S.W. coast of the peninsula of Kii, the precipitation of ashy sand, which continued from about 8 p.m. on the 8th till the morning of the 9th, was some 3 mm in thickness, the amount being greater along the S.E. coast of the same province. In Nagasaki the ashes began to fall from the evening of the 9th.

Assuming the ashes thrown out by the first outburst of Sakura-jima on Nov. 9, at about 11 a.m. to have been carried to the distant places named above, their progress through the radial distance of 960 km to Yedo took about 12 hours, giving the high mean velocity of 80 km or 50 miles per hour. On the other hand, the precipitation of ash and sand at some places nearer the volcano occurred after a comparatively long time interval. Thus, at Miyakonojō, the ashes (white sands) began to fall only at 4 p.m. on the 9th, or about 5 hours after the commencement of the eruption.

10. Sono-yama and pond at Moto-Komen. Sono-yama, which is a small solitary hill, 78 m in height, situated near the N.E. coast of Sakura-jima and opposite Moe-jima, was not buried by the lava flow in the Anei period, 1779. As will be seen from figs. 8 and 9, (Pl. XIII), the lava which enveloped the hill from back was divided into two branches and descended along the two sides, and again uniting at the front, have formed a small pond 70 m long and 50 m wide. The shortest distance between the pond and the sea is

100 m and is along the line of contact of the two lava branches, whose height is 6 to 8 m above sea surface. The water in the pond, which is blue and salty and has a depth of about 7 fathoms, rises and falls with the tide motion of the external sea, there being apparently some sort of communication between the two bodies

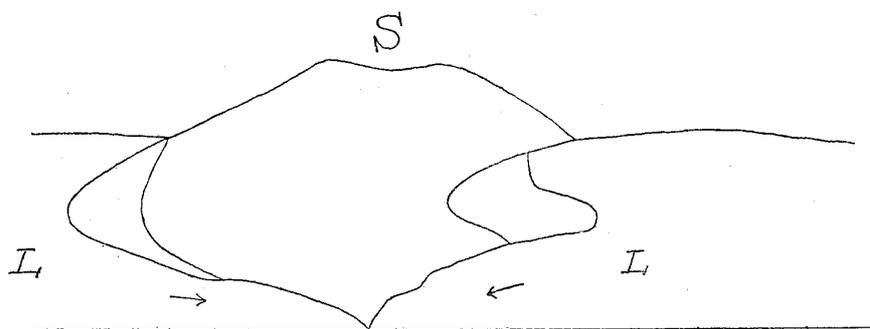


Fig. 12. Sono-yama seen from sea (E.N.E.).
S....Sono-yama. L....Lava flow of 1779.

of water. In fact, the old lavas forming the projecting coasts of the island, namely, Nishiseko-hana, Kwannon-zaki, Ōmoe-zaki, Moe-zaki, etc., are very discontinuous, being broken through with wide and deep chasms and also with cavities of different size. Hence it must be quite easy for the sea water to permeate for not a small distance inward from the actual coast.

The neighbourhood of Sono-yama is called Moto-Komen, ("Old Komen"), because it is the original site of the village of Komen. To the east of the hill there had existed, before the Anei period, a small inlet, wherein two large fishing vessels could lay at anchor. As the old village was buried under the lava in 1779, the inhabitants emigrated to the vicinity of the town of Kokubu at the north coast of Kagoshima Bay, but came back after the lapse of 27 years and settled at the present site of Komen.

The small narrow sea-coast place of Uranomae, $\frac{1}{2}$ km to the S.E. of Moto-Komen belonged originally to the old village of Ko-

men. It is bounded on the W. side by the terminal and side "embankments" of the Anei lava flows, and on the E. side by Ōmoe-zaki, or lava stream of the Bummei (1471) eruption.

A large "dry lake," or depression area, about $\frac{1}{2}$ km in length, near the junction of the Krokami and Uranomae roads, is an uncovered or lava-free piece of ground, which probably had formed the outside slope of a hill. Similar, but smaller, spots exist also in the vicinity of Sono-yama.

11. Damage caused by Anei outburst, and after-eruptions. According to the official report under the date of Jan. 15th, 1780, the damage caused by the eruption consisted of the death of 79 men and 74 women, beside 285 horses killed, and of the destruction of 13 temples, 500 houses, and 12 boats, the injuries to the cultivated fields amounting to 10,520 *koku* in permanent loss and 13,041 *koku** in temporary loss.

The inscription on a stone monument (櫻島燃亡靈等碑), erected in the winter of 1779 on the ground of the Nanzenji temple in Kagoshima to the memory of the unfortunate victims, put the number of the latter at the different Sakura-jima villages at 148, as follows:—Furusato, 6; Arimra, 57; Waki, 34; Seto, 46; Krokami, 5. Thus the amount of casualty was greatest at the three villages of Seto, Waki, and Arimra, at the S.E. coast of the island, while there was no loss of life at Komen, on the N. coast, which occupied the site now known as Moto-Komen and was entirely buried under the lavas. Again, the houses in Furusato, Arimra, Waki, and Krokami, were almost entirely burnt down by volcanic ejecta. At Seto, however, there remained some houses standing, as the shortest radial distance was 4 km and the fiery

* 1 *koku*, a Japanese measure used for both wet and dry goods, is equal to 5.0 bushels or 180.4 litres.

lava pieces were precipitated there only to a slight amount, on account of a sufficient removal of the village from the craterlets. The disastrous consequences of the great volcanic convulsion lasted for a long succeeding time interval, and according to the 2nd official report under the date of July 27th, 1780, there was a further addition of the temporary damage to cultivated field to the amount of 15,651 *koku*, beside 21,500 mandarin orange trees and 129,500 other trees destroyed, while 1,576 horses and 135 cattle died from the want of forage.

On Sept. 9th, 1780, at midnight, a submarine outburst took place, which sent up fires and smokes to a considerable height, causing "tsunami," whose waves were 20 ft high at the beach of Koike on the W. coast of Sakura-jima, at the N.E. base of Hakamagoshi. The official report under the date of Nov. 28th, 1780, states that some of the new islets, which had arisen off the N.E. coast of Sakura-jima, gradually increased in size, and that the stronger submarine eruptions were accompanied by large sea-water disturbances, which rushed in over the neighbouring coasts and also flooded the strand streets of the Kagoshima city. The damage resulting from these "tsunami," up to Sept. 1780, was as follows :—permanent and temporary losses to cultivated field, respectively 675 and 17,647 *koku* ; numbers of houses completely and partially destroyed by the waves, respectively 168 and 630 ; habitation grounds washed by sea-water, 417 pieces ; lengths of broken embankment roads, masonry walls, and river banks, respectively 11,380 ; 1,237 ; and 670 *ken*.*

On April 11th, 1781, at about 4 p.m., outbursts took place from several points under the sea near the new islet (Moe-jima) as well as from the older land craterlets and threw up mud,

* 1 *ken*=6 feet very nearly.

ash, and sand, accompanied by earthquakes, causing a "tsunami," upsetting three boats at Uranomae (between Moto-Komen and Ōmoe-zaki, and opposite the Moe-jima islet) and drowning 14 men and 1 woman who had come from Matsuura (松浦), Shirahama (白濱), and Taniyama (谷山), for fishing or collecting fuel thereabouts. On this occasion, there was at Koike the in-rush of large waves 10 times repeated, while mud rain fell at Krokami and Seto to the thickness of nearly 1 foot. On May 1st, 1781, detonations and outbursts followed from the same sites as on the preceding occasion. The damage due to these disturbances was as follows:—temporary loss to cultivated field, 1503 *koku*; number of houses partially and completely destroyed by the waves, respectively 672 and 23; habitation grounds washed by sea-water, 273; broken bridges, 6; lengths of broken embankment roads, masonry walls, and river banks, respectively 7,349; 1,190; and 1,625 *ken*.

On Jan. 18th, 1782, at 4 p.m., submarine eruptions took place off the coast of Moto-Komen, the firely smokes being well observed from Koike. None of the subsequent eruptions was submarine.

On Nov. 20th, 1785, at midnight, outbursts with low detonative sounds took place from the former craterlets, which, though of a short duration, were attended by flashes of lightnings and sent up fires and smokes to a great height, precipitating ash at Seto and some pumice at Krokami. The people fled across to Ushine and Tarumizu, but there was no casualty.

12. Anei new islets. Fig. 10 is a reproduction of the map given by Ijichi Kiken, of Tarumizu, in his accounts of the personal experiences in the Anei catastrophe, indicating the eruptions from a number of points, several of which were situated off the N.E. coast of Sakura-jima. The remarkable consequence of the numerous submarine outbursts was the production in the 8th and

9th years of Anei of a number of islets, within the maximum distance of 3.1 km from the coast, between Nishiseko-hana and Uranomae, whose order of appearance was as follows:—

		Japanese Calendar [8th Year of Anei.]	European Calendar.
1st Series	No. 1. Ichiban-jima.	10th month, 14th day	Nov. 21st, 1779.
	No. 2. Inoko-jima.	„ „ 15th „	„ 22nd, „
	No. 3. Nakano-shima.	11th „ 6th (night)	Dec. 13th, „
	No. 4. Iwo-jima.	12th „ 9th („)	Jan. 15th, 1780.
		[9th Year of Anei.]	
2nd Series	No. 5. [Moe-jima.]	4th month, 8th day	May 11th, 1780.
	No. 5' [„ „]	„ „ „ „	„ „ „
	No. 6. [„ „]	6th „ 11th „	July 12th, „
	No. 6' [Doro-jima.]	9th „ 2nd „	Sept. 29th, „
	No. 6'' [„ „]	10th „ 13th „	Nov. 9th, „

Of the new islets, whose original number was nine, the four of the 1st series were composed of lava, and remained separate. On the other hand, the five of the 2nd series were composed of pumice and sand, and suffered subsequent unifications in two groups, due probably to the elevation of their bases.

No. 1 lava island again disappeared under water 8 months 10 days after its formation, namely, on Aug. 1st, 1780. The two sandy islets, Nos. 5 and 5' were amalgamated into one 23 days later on, namely, on June 3rd, 1780, the result being the Moe-jima of the present day. The three other sandy islets, Nos. 6, 6', and 6'', were also subsequently connected into one, called Doro-jima (Mud Island) or Yebisu-jima (Fisherman's Island), the latter name having been given on account of the abundance of fish in its neighbourhood.

The 4 lava islets of the 1st series were formed successively from W. toward E. between Nov. 21st, 1779, nearly 2 weeks

from the day of the first Anei outburst, and Jan. 15th, 1780, or during the 54 days immediately after the decline of the eruptive activity. The two groups of the sandy islets were, on the other hand, formed between the 6th and 12th months after the commencement of the eruption. This wide difference in the dates of formation of these two series of islets seems to point out also a dissimilarity in their nature.

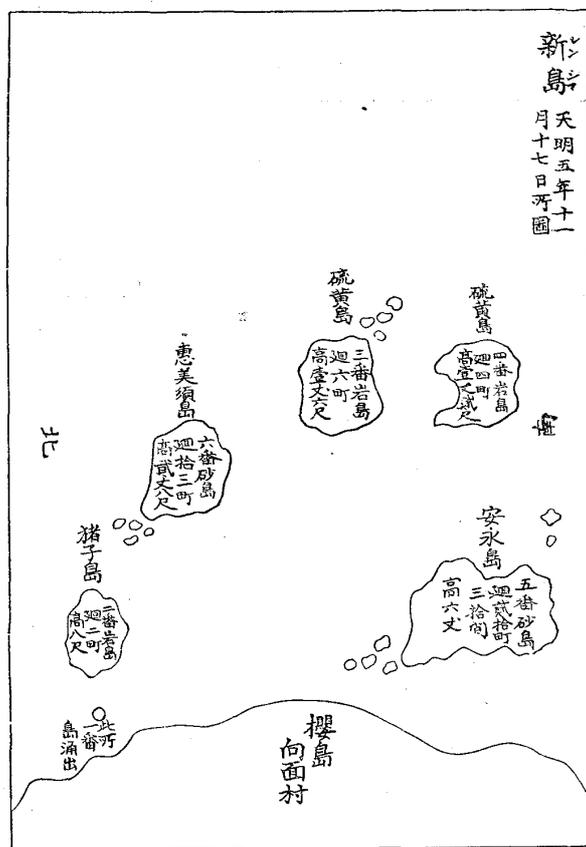


Fig. 13. Map of the Anei new islets formed off the coast of Moto-Komen, drawn on Dec. 18th, 1785, giving the height and circumference of the five principal ones. From left (north) to right (south), Inoko-jima, Doro-jima (Yebisu-jima), Iwo-jima (Nakano-shima), Iwo-jima, and Moe-jima (largest).

According to fig. 13, which is a reproduction of a drawing made on Dec. 18th, 1785, as well as according to an official document under the same date, the three lava islets of Inoko-jima, Nakano-shima, and Iwo-jima were low in elevation and had the heights respectively of 8, 16, and 12 *shaku* while the two sandy islets of Moe-jima and Doro-jima were respectively 60 and 28 *shaku* in height. The comparison of the former, with the present, dimensions of the islets in question is given in fig. 14 and is as follows:—

Islets.		Dimensions*	
		in 1785.	at the present time.
Lava Islets.	Inoko-jima.	Height. 8 shaku.	Circumference. 2 cho.
	Nakano-shima.	16	6
	Iwo-jima.	12	4
Sandy Islets.	Moe-jima.	60	20½
	Doro-jima.	28	13

{ At high tide, entirely covered by water, except two or three points.
 Height = 22 shaku. Cirfce = 4 cho.
 „ 9 „ „ 5 „
 „ 145 „ „ 16 „
 { Almost entirely covered by water, except two or three points.

* 1 shaku=1 foot very nearly; 1 cho=360 shaku.

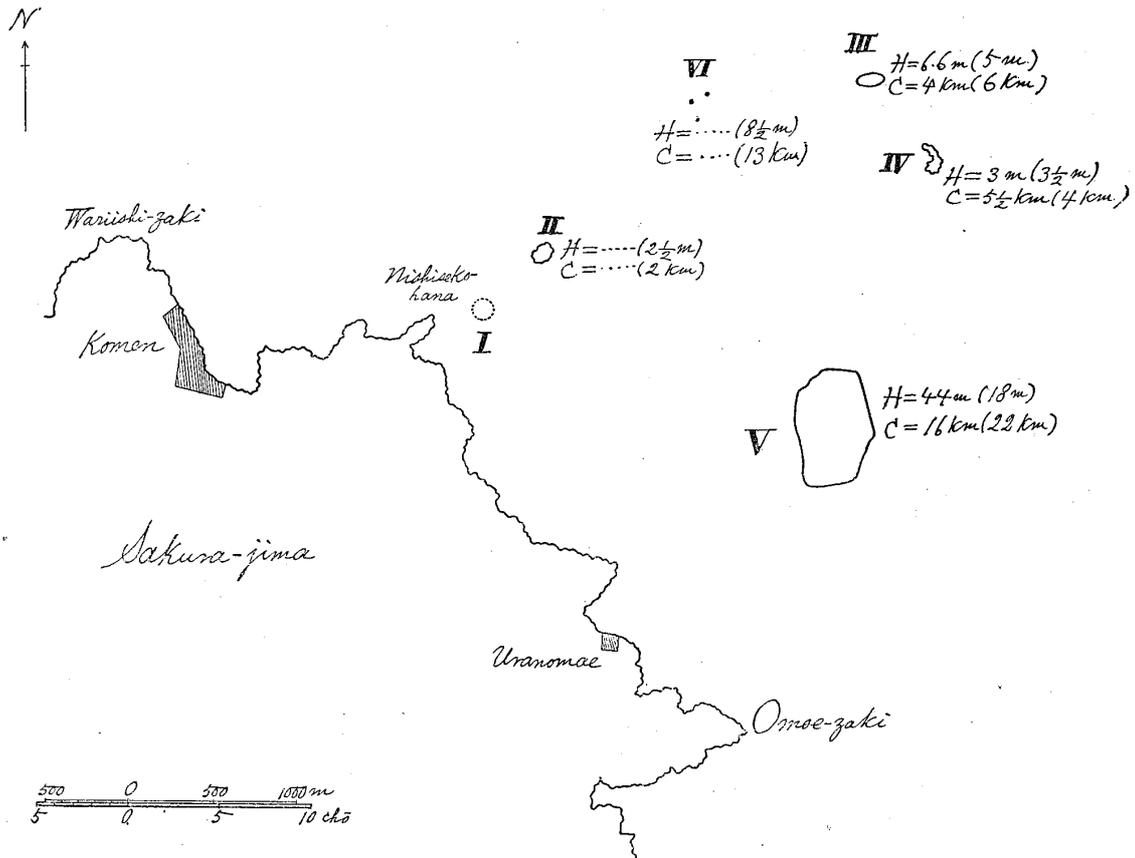


Fig. 14. Map of the Anei Islets, indicating the height (H) and circumference (C) in 1785. The corresponding numbers, measured from the 1/50000 Military Survey map (previous to the recent eruption), are given in brackets.

- I ... Ichiban-jima (submerged).
- II ... Inoko-jima.
- III ... Nakano-shima.
- IV ... Iwo-jima.
- V ... Moe-jima.
- VI ... Doro-jima.

The circumferences of the different islets seem on the whole to have been lessened since the Anei period, the diminution being specially marked in the case of Doro-jima.

The new Anei islets rose, according to the documents of the times, from the sea bottom originally 70 to 90 fathoms in depth. This looks likely enough from an inspection of fig. 3, the portion of Kagoshima Bay to the north of Sakura-jima having nearly an uniform depth of 70 to 80 fathoms, except about the islets in question off the N.E. coast of the island, where the water is shallow. (See fig. 16.) The submarine extension of the lava of 1779, which is most marked about Cape Nishiseko-hana, seems to end at a distance of only about 1 km from the apex of the latter, and the line of 50 fathoms depth which includes the Anei islets and extends about 4 km from the N.E. coast of Sakura-jima, marks approximately the boundary of the area probably elevated during the eruption in question, being separated from the latter coast by a narrow ditch of depth greater than 50-70 fathoms, to be supposed to represent the remnant of the original sea bottom. The three islets of Inoko-jima, Nakano-shima, and Iwo-jima, together with the submerged Ichiban-jima, lie roughly on a straight line joining the land craterlets of 1779, and seem to have been the results of lava eruptions from the sea bottom subjected to a previous elevation. The formation of two sandy islets of Doro-jima and Moe-jima, which have an extensive submerged base and together constitute a shoal parallel to the coast and normal to the craterlets zone above mentioned, may not be the direct result of submarine eruptions, but be due entirely to the elevation phenomena.



Fig. 15. Moe-jima (Anei-jima) seen from W.

This supposition was also put forward by Mr. K. Yamaguchi, of Kagoshima Girls' Normal School, who found shell fossils among the pumice layers of Moe-jima. The latter has a series of transverse stepwise dislocations, which dip down southwards, apparently indicating the location of the centre of elevation between the two sandy islets. Fig. 7, Pl. XII, is a west side view of Moe-jima, taken in Sept. 1914 from a near distance. The village occupies the low ground at the middle between the N. and the S. elevations. The islet was inhabited first in May 1800, or nearly 20 year after its formation in the 9th year of the Anei period.

It is interesting to note that the centre of depression caused by the great recent eruption of Sakura-jima is situated under the sea to the north of the island, adjacent to the above-mentioned area elevated subsequent to the Anei (1779) eruption.

13. Condition after the Anei eruption. After the great eruption of Anei (1779), the volcano caused ash-precipitation at intervals even as late as 1809; the sounds like distant thunders being sometimes heard with easterly winds in the city of Kagoshima. It is thus probable that the slight eruptive disturbances did not completely cease for more than 30 years. In the earlier part of the Meiji era, which began with 1868, only white smokes were issuing from the top of Minami-dake, and it is said that these vapours became much abundant between the end of 1878 and about March of the next year. More recently, the white smokes from the top decreased very much, such that these could be observed from the city of Kagoshima only once or twice each year; the mountain having continued in this state till the occurrence of the great outburst of 1914. Almost simultaneously the Ōshima (Izu) was undergoing a similar change in the volcanic activity; its smokes, gradually reduced in amount, finally stopped completely in 1909-10, as a



Fig. 16. Map showing the Sea-depth about the Anei Islets.
 (The depth is given in fathoms.)

- I....No.1 Islet (submerged). II....Inoko-jima. III....Nakano-shima.
 IV....Iwo-jima. V....Moe-jima. VI....Doro-jima.

precursory event to the great eruption of the mountain in 1912. A temporary extinction of once abundant smoke emission from a volcano seems thus to be often the first stage in the course of a subsequent strong outburst.

Fig. 4 is a fac-simile of a picture given in the "Sangoku-Meishō Zue," a collection of historical and geographical informations relating to the three Shimazu provinces of Satsuma, Ōsumi, and Hyuga, compiled in 1844, and represents the view of Sakura-jima taken from Kagoshima city, with the islets of Oko-jima and Karasu-jima at the right-hand side, the latter of which has been buried by the lava flows of 1914.

14. SUMMARY. The 26 eruptions of Sakura-jima between 1476 and 1914 may be grouped more or less distinctly into 3 principal activity epochs, I, II, and III, and two auxiliary epochs, II,A and II,B, both premonitory to II, (Table IX), namely, as follows.

I: *Active eruption epoch.* This extends over 8 years, 1468 to 1476, and includes the 5 eruptions Nos. 1 to 5, amongst which those in 1471, 1475, and 1476 were large outbursts.

II,A: *Epoch of premonitory disturbances.* There were 4 small eruptions, Nos. 6 to 9, which occurred in the course of the 100 years, 1642 to 1742, at the successive intervals of 36, 28, and 36 years, with the mean of 33 years.

II,B: *Epoch of premonitory disturbances.* This extends over 24 years, 1742 to 1766, from the eruption No. 9 to the eruption No. 13, all of which were also small, and whose successive intervals were much shorter than in the preceding epoch, being respectively seven, seven, and ten years.* 13 years after the eruption No. 13, there took place the catastrophe of the 8th year of

* Taking simply the years of occurrence of eruptions, or counting as one the two disturbances in June and July, 1766.

Anei (1779). The mean interval during this epoch was about 9 years.

II: *Active eruption epoch.* The great eruption of 1779 (No. 14), which began on Nov. 9th and diminished in intensity after a few days, continued to be followed for about 12 months by frequent volcanic outbursts. Further, during about 20 years between Sept. 9th of the next year and March 27th, 1799, there were 10 small eruptions: of which the five, Nos. 15 to 19, happened in the course of the earlier 16 months, and were each a submarine outburst accompanied by a "tsunami," or sea-water disturbance. The subsequent eruptions were different in character, each being a small explosion in the island, probably from a former craterlet, which caused some ash-precipitation, but was accompanied by no "tsunami." During the 115 years between the II. and III. epochs, there was no eruption, with the single exception of No. 25, which probably consisted in a slight ash-ejection.

III: *Great recent eruption.* Jan. 12th, 1914 to April 1915.*

In each of the three great eruption epochs I, II, and III, there took place a marked lava outflow from a number of craterlets arranged at two nearly opposite sides or bases of the mountain: in I, at the E.N.E. and S.W. sides; in II, at the N.E.N. and S. sides; and in III, at the E.S.E. and W.N.W. sides. The course of eruption in the I. epoch differed, however, in a marked way from those of the II. and III. epochs. Namely, in each of the two latter, the lava outflows took place from the two opposite mountain sides simultaneously, i.e., with the time difference of only a few minutes or a couple of hours; while in the case of the I.

* As pointed out in No. 1, of this Volume, the Strait of Seto, between Sakura-jima and the mainland of Ōsumi has actually been blocked up on Jan. 29th, 1914, converting the island actually into a peninsula. In these pages, however, Sakura-jima is still often termed an island, meaning thereby the former insular volcano.

epoch, the first outburst occurred in 1471 at the E.N.E. part of the island, followed by two strong ones at the S.W. part respectively about 4 and 5 years later on. It seems probable that the underground tension, or the intensity of the volcanic force, reached a greater accumulation in the two later epochs, necessitating a simultaneous opening of several craterlets along a fissure or line of weakness, and from both flanks of the mountain.

15. Lava areas and craterlets of the different eruptions. Fig. 2, which is to replace the preliminary map (Pl. 2) given in the preceding Number of the Bulletin, embodies the results of my researches respecting the areas of the lava outflows and the positions of the craterlets of the I. (Bummei, 1468-1476), II. (Anei, 1779), and III. (Taisho, 1914) great eruptions. The extension of the lava areas is, leaving out the portions under sea-water, as follows:—

I. Epoch (Bummei)	{	E.N.E. Branch	4.3 sq. km.	} Total Area.	
		S.W. ,, (Higher or 1st Stage Area) ...	0.8 ,,		} 6.4 sq. km.
		S.W. ,, (Lower or 2nd Stage Area) ...	1.3 ,,		
II. Epoch (Anei)	{	N.E.N. Branch.....	4.8 ,,	} 6.1 ,,	
		S. ,,	1.3 ,,		
III. Epoch (Taisho)	{	E.S.E. Branch.....	8.5 ,,	} 16.8 ,,	
		W.N.W. ,,	8.3 ,,		

Thus the land lava area of the III. (1914) eruption was very extensive and is nearly 17 sq. km, or 1.3 times those of the I. (Bummei) and II. (Anei) eruptions put together.

16. Volcanic eruption and lunar age. That volcanic eruptions are more frequent at the time of high tide is a generally accepted idea, which is recorded also in the old accounts of the Anei period catastrophe, and which is verified more or less in the cases of the *strong* Sakura-jima outbursts. Thus the latter, five in number, happened as follows:—

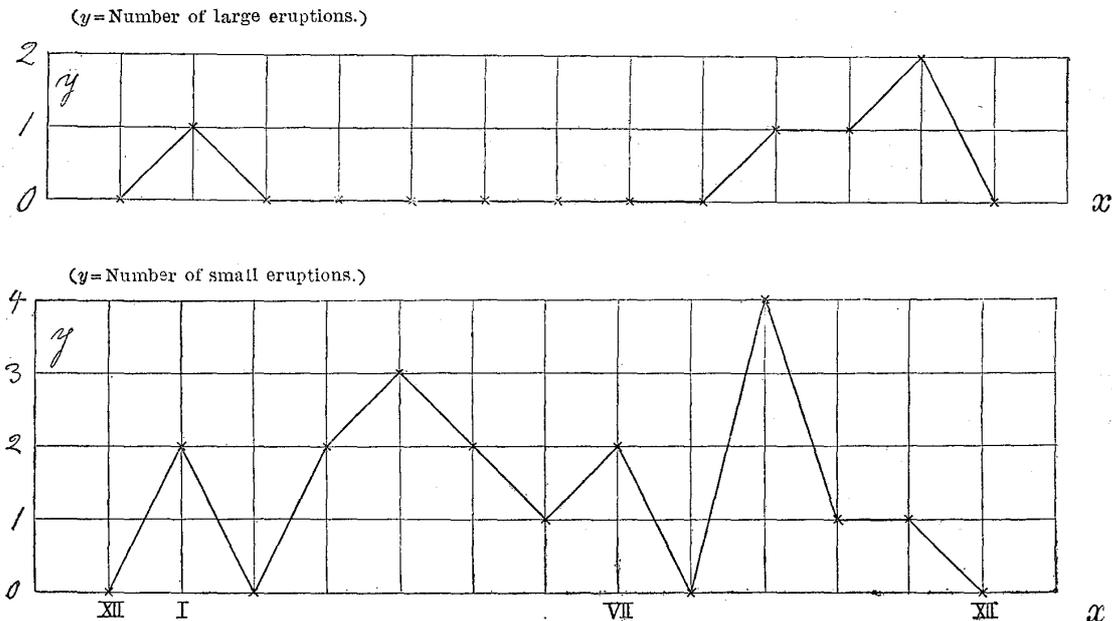
No. 14,.. .. . 1st lunar day.
 Nos. 4 and 26, 15th „
 Nos. 2 and 5, 2nd „

The occurrence of these Sakura-jima strong eruptions at the time of the new moon and at or near the full moon is certainly a noteworthy fact. The great outburst of the Taal Volcano (Manila), in 1911, commenced its final or most active phase on the 30th of January, which also corresponded to the 15th lunar day.

17. Annual distribution of eruptions. The annual distribution of the 23 Sakura-jima eruptions, of which the month of occurrence is known, is as follows:—

Month.	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Number of Strong Eruptions.	1	0	0	0	0	0	0	0	1	1	2	0
Number of Small Eruptions.	2	0	2	3	2	1	2	0	4	1	1	0

Fig. 17. Annual Distribution of Sakura-jima Eruptions. (x =month.)



Thus the strong Sakura-jima eruptions occurred exclusively in September to January, while the small ones indicated a tendency of an opposite annual frequency variation and occurred mostly in March to September. (See fig. 17.)

18. Accumulation of pumice and formation of soil. The extensive lava flows and the thick accumulation of pumice and ash caused by the recent eruption of Sakura-jima naturally formed or modified the courses of several ravines and streamlets in the island, producing in some places nicely cut sectional exposures which indicated the local amount of pumice accumulation during, and of the more or less perfect black soil formed since, the volcanic outbreaks of the last 5 centuries or more. Three well-defined examples are illustrated in figs. 18, 19, and 20.

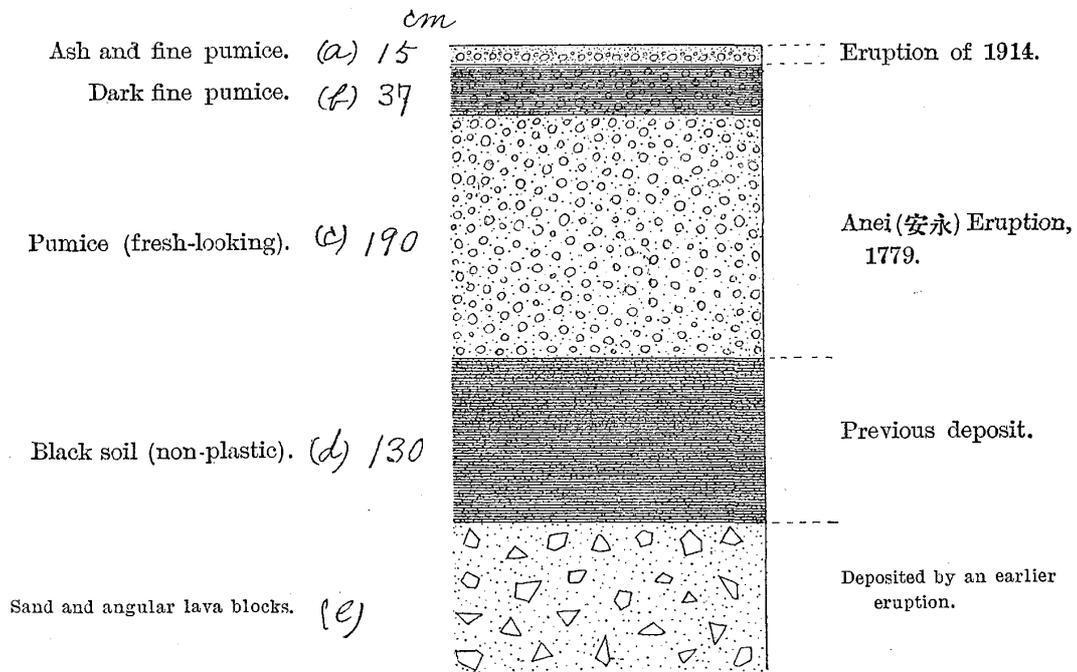


Fig. 18. Section showing the Accumulation of Pumice and Ash at Yunohama Beach.

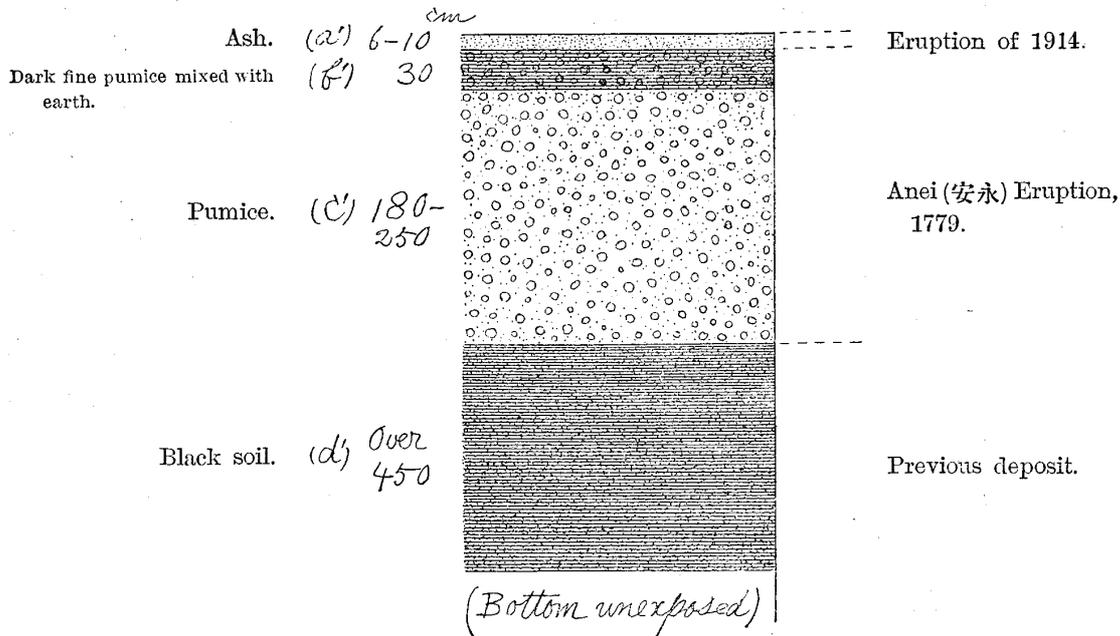


Fig. 19. Section showing the Accumulation of Pumice and Ash at Yunohama District 150-300 m above sea-level.

According to fig. 18, at the Yunohama beach close to the W. boundary of the recent S.E. side lava flow, the thickness of the new precipitation of pumice and ash was 15 cm, while the accumulation during the Anei eruption, in 1779, due to the emission from the two craterlets at the southern flank of Minami-dake, above the village of Furusato, was about 2.3 metres. Of this latter amount, the upper portion, 37 cm in thickness, is composed of fine dark pumice mixed with earth, being the partial conversion to soil of the volcanic debris accomplished during the past 135 years. Then there follows a layer of black incoherent earth, 1.3 m in thickness, which probably represents an accumulation of volcanic sand and ash converted into soil during a very long period of rest, and which is different in composition from the underlying bed made up of sand mixed with angular rock pieces.

At the height of 150 to 300 m above sea-level and to the

north of Yunohama, namely, on the S.E. flank of Minami-dake $1\frac{1}{2}$ to 2 km from its top, the sectional formation is slightly different. As shown in fig. 19, there the recent ash accumulation was 6–10 cm in thickness, or a little less than at the Yunohama beach. The Anei accumulation of pumice amounted from 2.1 to 2.8 m, of which the upper portion, 30 cm in thickness, had been converted partially into earth. The underlying layer of black earth, whose lower portion is not exposed, is very thick, the exposed portion alone amounting to $4\frac{1}{2}$ –6 m.

Finally, at Krokami, about 1 km from the E. coast, the precipitation during the recent outbursts consisted of 20 cm of surface covering of ash and 2.0 m of pumice, while that due to the Anei (1779) eruption was 1.03 m of pumice, of which the upper 13 cm has been partially converted into earth (See fig. 20.) The

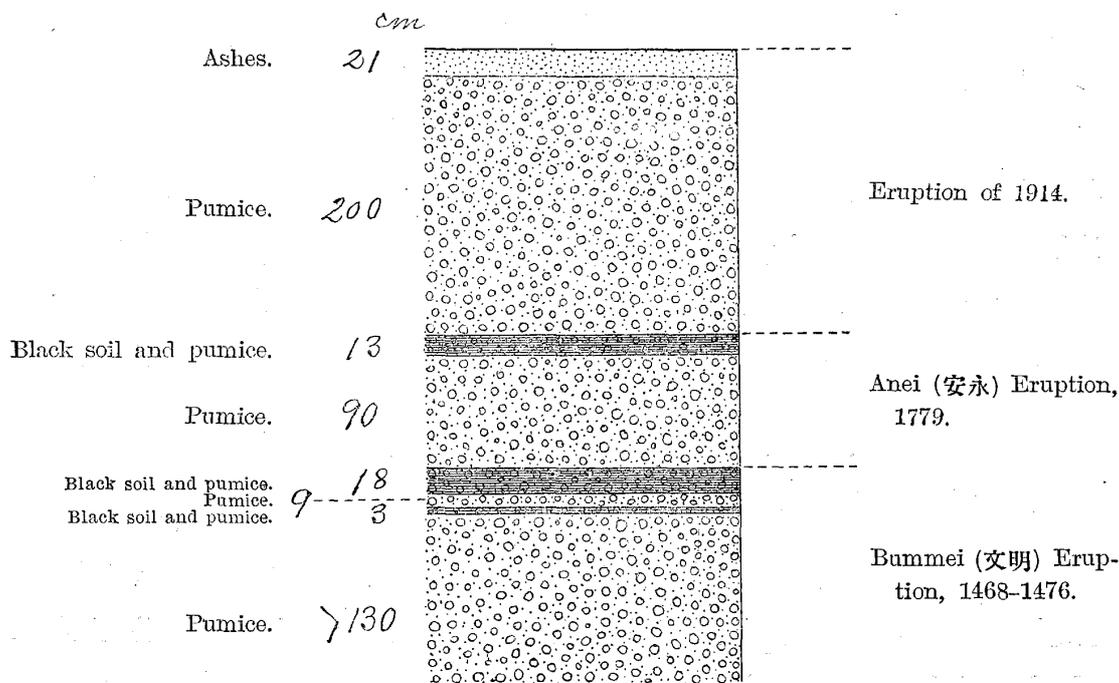


Fig. 20. Section showing the Accumulation of Pumice and Ash along the Stream Bank above Krokami.

accumulation of *débris* during the prolonged eruptions of the Bummei period (1468–1476) is made up of pumice layer (bottom not exposed) more than 1.3 m in thickness, superposed with two thin layers of black earth mixed with pumice respectively 18 cm (upper) and 3 cm (lower) in thickness, interposed with a white pumice layer of 9 cm. In the valley grounds at the N.W. foot of Nabe-yama, the new pumice accumulation in 1914 amounted to 4.0 m. The pumice layer due to the Anei (1779) eruption at the N. flank of the same hill was 1.1 m in thickness.

Comparing together the three cases mentioned above, we see that the thick layer of black earth beneath the pumice accumulation of the Anei (1779) eruption, which is absent at Krokami, is 1.3 m thick at the Yunohama beach, being increased to over $4\frac{1}{2}$ m at places 150–300 m higher up. This particular layer might have been due to a thick precipitation of dusts thrown out many years ago from the Minami-dake crater,

The amount of the pumice accumulation due to the catastrophe of 1779, under the prevailing N.W. winds, was at the Krokami district only one-half of that in the neighbourhood of Yunohama; this difference having been caused by the S.E. proximity of the latter place to the Furusato craterlets, while the former was probably out of the most direct course of ash-transportation from the different craterlets of the N.E. or Komen district. On the other hand, the precipitation due to the Bummei eruption in the vicinity of Nojiri, in which the lava flow resulted in the formation of Moe-zaki, is not to be well recognized at Yunohama, while the effect of the eastern craterlets about Ōmoe-zaki is indicated at Krokami in two distinct stages, namely, a powerful outburst in 1471 with a thick precipitation of pumice, followed some years after by a much weaker disturbance.

TABLE IX. LIST OF THE ERUPTIONS OF SAKURA-JIMA.

*...Strong eruption.

Japanese Date. (Nos. 1-25, Lunar Calendar)	Group.	No.	日 本 曆	European Date.	Remarks.
Onin, 2nd Year.	I. Active Eruption Epoch. (Bunnei Period)	1	應仁二年	1468.	Burning from the mountain top. { Eruption from the Krokami side. The Onoe-zaki was formed. { Eruption from the Nojiri side. The Moe-zaki was formed. { At the S.W. part of the Island, a piece of land was newly formed and was finally connected with Sakura-jima.
Bunnei, 3rd year Sept. 12.		2*	文明三年九月十二日	Nov. 3, 1471.	
" , 5th " , April		3	同 五年四月	May, 1473.	
" , 7th " , Aug. 15.		4*	同 七年八月十五日	Sept. 24, 1475.	
" , 8th " , Sept. 12.		5*	同 八年九月十二日	Oct. 8, 1476.	
Kwanai, 19th year, March 7.	II, A. Prenomitory Epoch.	6	寛永十九年三月七日	April 6, 1642.	Sacred burning on the mountain.
Empo, 6th " , Jan. 9.		7	延寶六年一月九日	March 1, 1678.	
Hoel, 2nd " , Dec.	II, B. Prenomitory Epoch.	8	寶永二年十二月	Jan, 1706.	{ Eruption from the Nojiri side. The Ohira-yama (木平山) made eruption. { Probably a small explosion. There were detonations and earthquakes of different intensities. { Also probably a small explosion. There were 7 earthquakes and 9 detonations.
Kwanpo, 2nd " , March 2		9	寬保二年三月二日	April 6, 1742	
Kwanzen, 2nd " , Aug.		10	寬延二年八月	Sept., 1749.	
Horeki, 6th " ,		11	寶曆六年	1736.	
Meiwa, 3rd " , April 28		12	明和三年四月廿八日(改朔)	June 5, 1766. (Daysbreak)	
" , " , June 21.	13	同 年六月廿一日(午後十時)	July 27, 1766. (10 p.m.)		
Anei, 8th year, Oct. 1.	Great Eruption.	14*	安永八年十月一日	Nov. 9, 1779.	Great outbursts.
" , 9th " , Aug. 11.		15	同 九年八月十一日(夜半)	Sept. 9, 1780. (12 p.m.)	
" , " , Oct. 4	II. Active Eruption Epoch. (Anei Period.)	16	同 年十月四日(午後十時)	Oct. 31, 1780. (10 p.m.)	{ Submarine eruption accompanied by a small "tsunami." { Do. { Eruption took place from (near?) the new islet (Moe-jima) off Komen, accompanied by a small "tsunami." { Submarine eruption off the coast of Komen.
Tennei, 1st " , March 18.		17	天明元年三月十八日(午後四時)	April 11, 1781. (4 p.m.)	
" , " , April 8.		18	同 年四月八日	May 1, 1781.	
" , " , Dec. 5.		19	同 年十二月五日(午後四時)	Jan. 18, 1782. (4 p.m.)	
Tennei, 3rd year, Aug. 7.		20	同 三年八月七日	Sept. 3, 1783.	
" , 5th " , Oct. 19.	21	同 五年十月十九日(夜半)	Nov. 20, 1785. (12 p.m.)	{ Small eruption from an earlier craterlet in the vicinity of Komen. { Detonation and ash-precipitation. { Smoke emission and ash-precipitation. { Do.	
Kwansei, 2nd. " , June 18.	22	寬政二年六月十八日(夜半)	July 29, 1790. (12 p.m.)		
" , 3rd. " , Aug. 14.	23	同 三年八月十四日(午後四時)	Sept. 11, 1791. (4 p.m.)		
" , 11th " , Feb. 22.	24	同 十一年二月廿二日	March 27, 1799.		
Manyen, 1st year.		25	萬延元年		1860.
Taisho, 3rd year, Jan. 12.	III. Active Eruption Epoch. (Taisho Period.)	26*	大正三年一月十二日	Jan. 12, 1914.	Great outbursts.

The rate of decomposition into soil of the surface portion of pumice layer is very various, being 30 to 37 cm at the Yunohama district for the duration of 135 years after the eruption of 1779, but only 13 cm at Krokami for the same time interval, and 18 cm during the long preceding interval of 303 years after the eruption in 1476.

19. Note on distribution of newer lava flows. A glance at the map of Sakura-jima shows that the extensive newer lava outflows, namely, those of the three great eruptions of 1468-1476, of 1779, and of 1914, all took place in the W. and in the S. to N.E. flanks of the volcano, there being also the promontories of Kwannon-zaki, Nagasaki-hana, and Wariishi-zaki, formed by the lava flows of older unknown dates. On the contrary, in the N.W. part of the island between Take and Shirahama, there is no craterlet and no lava outflow of comparatively new date, and from this fact it is thought possible by some people that the future outburst may occur from the same spot. Under the influence of this supposition, coupled to the earth-heat phenomena of Saido,* the inhabitants of the villages of Fujino, Saido, etc., were panic-stricken by the Kiri-shima earthquakes of July 14th, 1915, several of them having fled across the sea for safety.

The Bummei eruptions, 1468-1476, took place approximately along an E.N.E. and a S.W. radius, and the eruption of Anei, 1779, along a N.E. and a S. radius, while the recent eruption occurred along an E.S.E. and W.N.W. diameter through the Minami-dake crater. The line of disturbance, or craterlets axis, in the last case is, however, not a quite new one, but may be regarded as very nearly identical with the much older line of

* Phenomena of emanation of gas and of increase of earth-temperature, which will be considered in detail in the next Number of this Volume.

Karasu-jima, Hikinohira, and Nabe-yama. In other words, the centre of eruptive activity has gone back, after a sort of shifting of radius of disturbance, in 1914 to an old site, but not to the N.W. compartment, which is thus likely not to become the scene of eruption even in future.

CHAPTER III. METEOROLOGICAL CONDITIONS AT THE TIME OF THE ERUPTION OF 1914.

20. Meteorological elements for 1913. During the 12 months preceding the eruption of Jan. 1914, the meteorological conditions at Kagoshima were abnormal in no special way. Thus, according to Tables X and XI the mean barometric pressure and air temperature in 1913 were respectively 751.7 mm and 16°.4 C, while the corresponding quantities during the 5 years, 1906–1910, were 751.4 mm and 16°.5 C. The amount of the precipitation in 1913 was, however, only 1604 mm and much smaller than the average value of 2337 mm for the 5 years interval above referred to.

21. Weather in Kagoshima at the time of eruption. At the commencement of January 1914, the weather at Kagoshima was changeful, there being in particular an unusual amount of snow-fall on the morning of the 8th. On the day of the actual eruption and during the three previous days, namely, from the 9th to the 12th, the barometer was steadily very high and ranged between 773.0 and 769.2 mm, while the wind velocity was low and varied from 2.3 to 3.5 m/sec. In fact, till 6 a.m. on the 13th, whole Japan was under an exceptionally high atmospheric pressure and the weather was calm and clear at most places, as was also characteristic of the great Sakura-jima eruption of 1779 and of the