

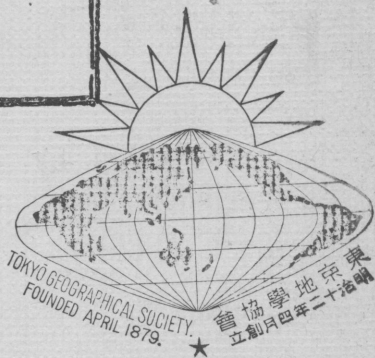
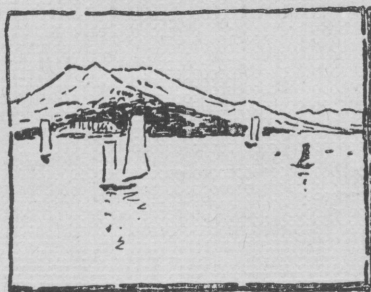
# GUIDE-BOOK EXCURSION E-4, 5

會協學地京東

Nov. 16th-19th, 1926)

No.

## SAKURA-JIMA VOLCANO

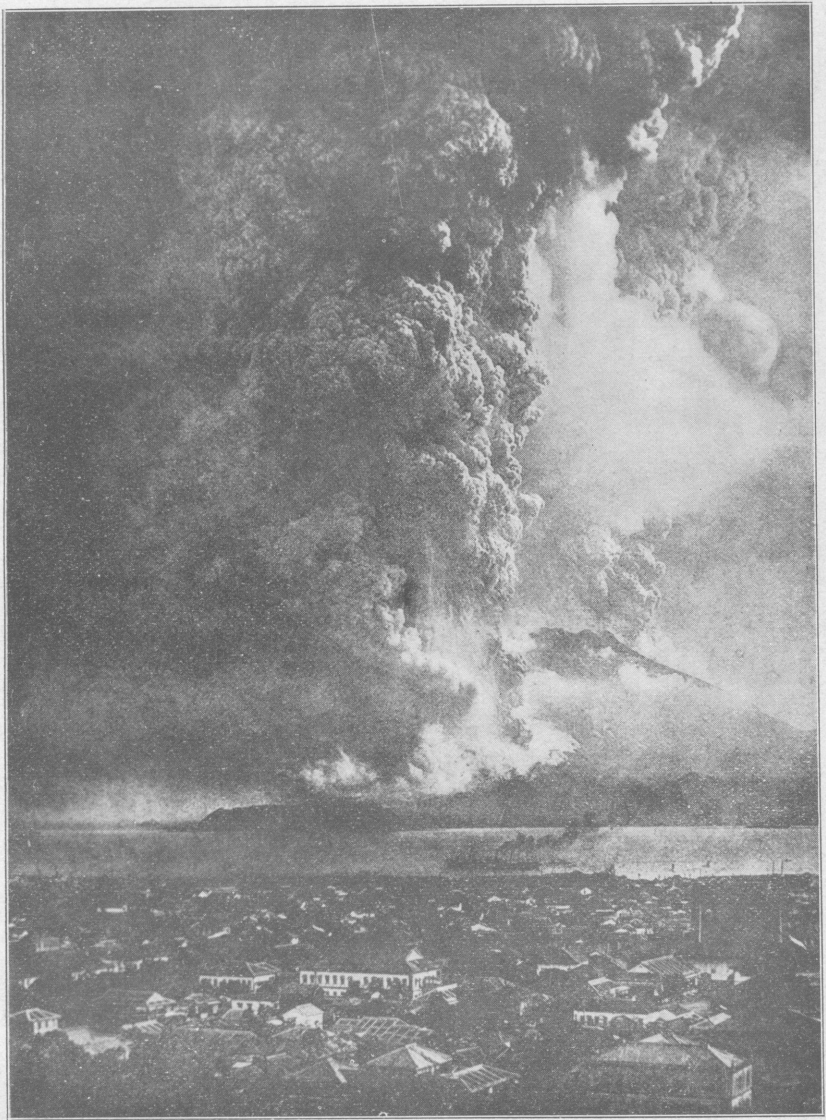


PAN-PACIFIC SCIENCE CONGRESS, 1926

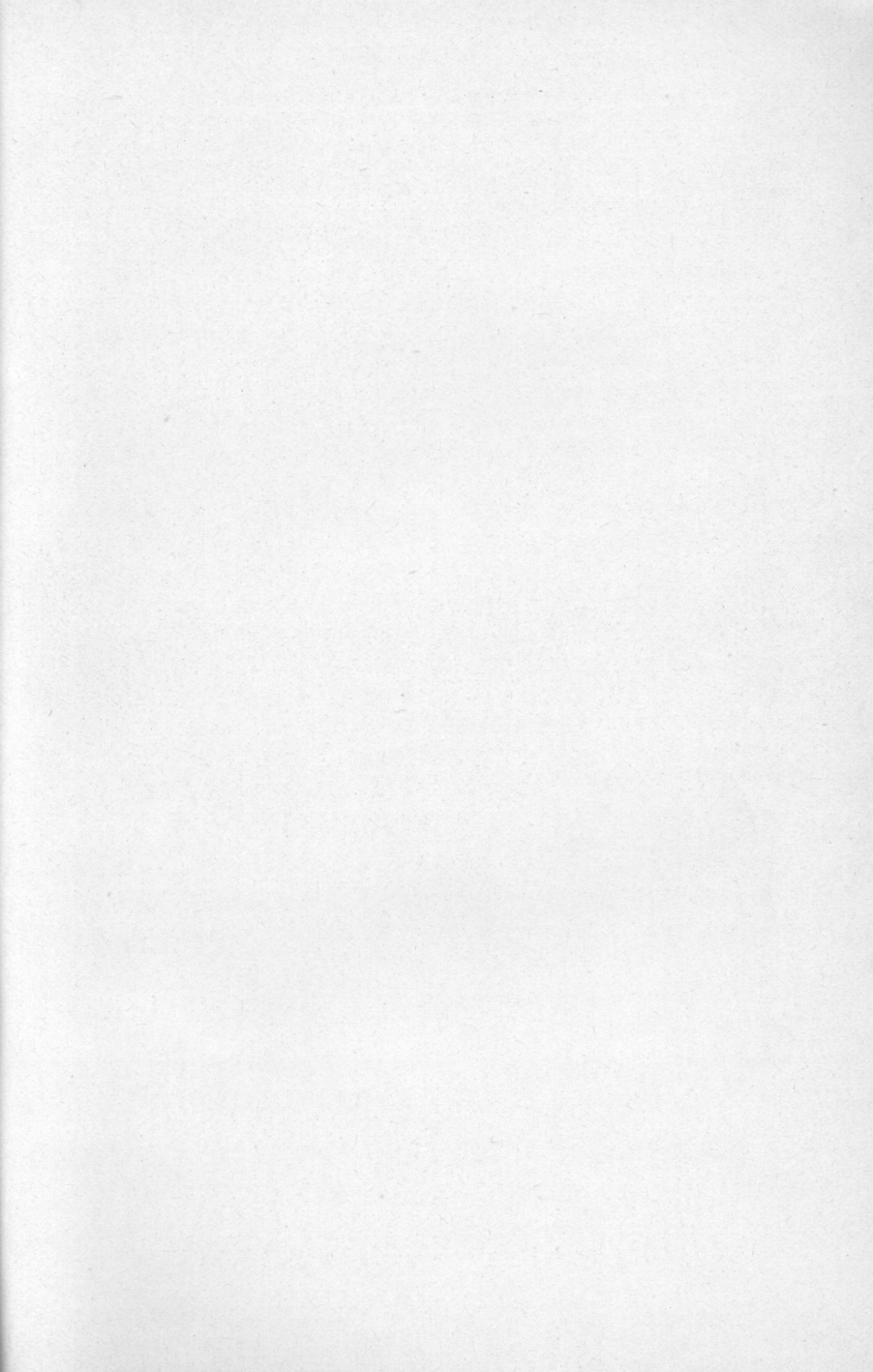
JAPAN



View of the First Eruption of Sakura-jima, seen from  
Shiro-yama Park, Kagoshima.



Taken about one hour after the Commencement of the Eruption, or approximately  
at 11 a.m., Jan. 12th, 1914. (After F. Ōmori).





# SAKURA-JIMA VOLCANO

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## NOTES ON THE GREAT ERUPTION OF SAKURA-JIMA VOLCANO IN 1914

BY TSUNENAKA IKI AND SEITARO TSUBOI

### INTRODUCTION

Sakura-jima is a volcanic island rising in the Bay of Kagoshima in Kyūshū. The great eruption which took place on January 12th, 1914, has made it noted. Since the eruption the island has been thoroughly investigated by various authorities from different scientific standpoints. The following description is greatly indebted to the elaborate papers published during the years 1915 and 1916 by Professor Kotō<sup>1)</sup> and the late Professor Ōmori.<sup>2)</sup>

Geologically speaking, the Bay of Kagoshima is a depression trough in the ash-plateau of southern Kyūshū, formed probably during the Pleistocene Period. In the bay are found some remnants of land blocks, such as Okoga-shima and Hakama-goshi, which consist of ash or lapilli beds. In the northern part of the bay, the volcano of Sakura-jima has been built up to the height of 1,110 m. above the sea-level. At a distance of about 50 km. to the north of Sakura-jima, above the ash-plateau, stands the volcanic group of Kirishima one of the cones of which, called Takachiho-mine, constantly emits smoke. At an equal distance in the opposite direction near the entrance to Kagoshima Bay, rises the beautiful cone of Kaimon. Kaimon is widely known under the name of Satsuma-Fuji<sup>3)</sup> on account of its similarity to Mt. Fuji in appearance.

1) B. Kotō, The Great Eruption of Sakura-jima in 1914. Jour. Coll. sc. Tokyo Imp. Univ. Vol. XXXVIII. Art. 3.

2) F. Ōmori, Bull. Imp. Earthquake Committe. Vol. VIII, No. I, II and III.

3) *Satsuma* is the name of the province in which the mountain is located.

The three volcanoes above mentioned are arranged in a straight line running in the direction of NNE-SSW, and the line is extended further south to the volcanic chain of Ryūkyū, which consists of several volcanic islands, viz., Iwō-jima, Kuchinoerabu-jima, Suwanose-jima, Tori-shima and Agumi.

### TOPOGRAPHY

The volcanic cone of Sakura-jima rises about 1,100 m. above the sea-level, having a roughly circular base 8 km. in diameter. When viewed from the west or east, it has a graceful slope with a curvature of 30°-5°, gradually decreasing towards the base; but from the north or south, it appears perfectly conical. It is truncated on the top, and also more or less serrated. A small portion of the island is in the form of a coastal flat, but most of it consists of a rugged lava field, which is especially notable in the southeastern half. Although the volcano appears to be a single cone, a morphological examination of the mountain top shows that it is a triple volcano. There are three apical cones, viz., Kita-dake (North peak), Naka-dake (Middle peak) and Minami-dake (South peak), arranged in the meridional direction, each cone provided with a crater from which lava-streams have poured out forming the main body of the island of Sakura-jima. The crater of Kita-dake has a diameter of about 450 m. and a depth of 100 m., and its wall, with an altitude of 1,133 m. above the sea-level, is the highest point in the island. The crater of Naka-dake is elliptical in shape, having longer and shorter diameters of about 300 m. and 175 m. respectively, and is a shallow basin with an ash-covered bottom. The southern-most crater of Minami-dake is the largest, having an average diameter of 550 m. and a depth of about 250 m., and its wall forms precipitous cliffs. Faint sulphurous fumes issue from the vents around the crater, which is for this reason known as Moye-dake (Burning peak). After the formation of the main body of Sakura-jima, frequent eruptions from fissures on the mountain flank occurred, accompanied by outflows of immense volumes of lava which naturally modified the original topography of the island.

On the western foot of the island, the rectangular flat-topped hill of Hakama-goshi rises to the height of 72 m. above the sea-level. It is so called from its resemblance, when sighted from Kagoshima, to the waistband at the back of the Japanese "Hakama" (a divided skirt worn by men). It seems to be one of the original land blocks,

and is composed of pumiceous ash. This is the only sedimentary rock exposed in Sakura-jima. Hakama-goshi was formerly isolated but is now connected with Sakura-jima by an accumulation of talus. Among the parasitic cones, Nabe-yama (Kettle hill) on the southeastern flank, having a height of 328 m., is the most conspicuous. Its horseshoe-shaped crater is 100 m. in diameter and has an opening to the east. The dome-like mound of Hikinohira, 553 m. high, on the western side, is also attractive.

On the south, Sakura-jima was formerly separated from the mainland by a narrow channel called Seto with a breadth of about 400 m., but this channel was completely choked up by lavaflows during the recent eruption in 1914. The island has thus become a peninsula in the Province of Ōsumi, and bears considerable resemblance to the Shimabara Peninsula which was built up by the Unzen volcanoes.

The islets of Moye-jima (Burning island) and Shin-jima (New island) together with others still smaller, lying about 2-4 km. off the northeast coast of Sakura-jima, were formed by submarine outbursts which followed the great eruption of the An-ei era (1779). Okogashima off the southwest coast appears, like Hakama-goshi, to be a remnant of the original ash plateau.

In Sakura-jima there are several hot springs, namely, Kurokami on the southeastern coast, and Yunohama, Furusato and Arimura on the southern coast. Arimura was entirely buried by the recent lava-flow. The island of Sakura-jima was inhabited all along the coast and there was a total population of about 25,000 before the eruption in 1914, but the chief villages, including Yokoyama, Akamidzu and Arimura, were annihilated by the recent eruption and their inhabitants have removed to other provinces. The island is famous for the production of various kinds of oranges and of giant radishes of about 0.6 m. in diameter.

#### HISTORICAL RECORDS OF THE ERUPTIONS OF SAKURA-JIMA

Authentic records of the volcanic eruptions of Sakura-jima begin in 1468. During the four and a half centuries since then, there have been 26 eruptions, of which the two, occurring one in the period from 1468 to 1476 and the other in 1779, are the most remarkable.

The eruptions of the first period began in 1468 with a moderate explosion from the southern top-crater "Moye-dake." Another strong eruption occurred in 1471 above Kurokami on the eastern side of the island, accompanied by the ejection of ashes and stones. The outflow of lava at this time formed the cape of "Moye-zaki" (Burning cape). The violent eruption of 1476 was preceded by strong earthquakes and was followed by an out-pouring of lava, which formed another cape also called "Moye-zaki" at the southwestern end of the island.

The eruption in 1779 was the most active and terrible one ever recorded. Strong earthquakes accompanied the volcanic outburst. The eruption began on November 8th with emission of white smoke from the top-crater of Minami-dake or Moye-dake and then followed tremendous outbreaks occurring simultaneously at two places, one at the southern flank of Minami-dake above the village of Furusato and the other on the eastern slope of Kita-dake above the village of Kōmen. A column of black smoke ascended vertically to an extraordinary height and then spread out in the shape of an open umbrella. The island of Sakura-jima was soon enveloped in dark smoke with frequent flashes of lightning and ejections of red-hot stones, followed by violent quakes and roarings. The smoke spread over the city of Kagoshima and caused the accumulation of ashes and sand. The eruption was most active on November 9th and 10th, after which followed the epoch of lava out-flow. A large volume of lava-flow poured down on the northeastern side of the island to Kurokami and Kōmen, while another lava-stream flowed out from a large hollow on An-ei-zan on the southern side, forming the cape of Tatsu-saki. During this eruption 153 human lives were lost, besides large numbers of horses and oxen. Five hundred houses and vast areas of cultivated fields were damaged and the old village of Kōmen was entirely buried under the lava-stream. Thus the volcanic convulsions lasted for about twenty years and frequently caused damage in the island, though they gradually declined in violence.

Five days after the eruption of November 8th, a submarine outburst occurred from the sea bottom, 70-80 fathoms deep, at a little distance off the northeastern coast of the island. Stones, pumice and mud were ejected, forming shallow banks and several small islands of which Moye-jima (Burning island) is the largest. This eruption caused also *Tsunami* (Sea-waves) on the neighboring coasts.

Besides the eruptions above mentioned, it is also recorded that in 1749 a violent eruption took place from Ōhira-yama on the west side of the island and that lava flowed out to the south of Hikinohira.

### THE ERUPTION IN 1914

The recent eruption in 1914 seems, in general, to have been very similar to that of 1779. The eruption was preceded by earthquakes which began in the early morning of January 10th, gradually increasing in frequency as well as in intensity. Earthquakes occurred frequently, accompanied by sounds like a cannonade. Threatened with the coming terrible event, the majority of the islanders had already begun to flee to the neighboring mainland by the 11th, while the remainder spent a restless night in the open fields. It is said that, at Arimura on the southern coast of the island, hot water of a high temperature began to issue from several places in the early morning of the 12th, while the hot spring itself threw jets into the air about one meter high. Similar phenomena took place on the opposite side of the island, namely at Saïdo, where the flow of a natural cold spring considerably increased in the morning of the 12th. At about 8 a.m. on the 12th, a column of white smoke was suddenly thrown up from the top of Minami-dake. These phenomena were direct premonitory signs of the approaching eruption of the volcano, which remained for some time in a quiet state except for feeble emissions of white vapour.

The great eruption occurred at 10 a.m. on January 12th, but fortunately all the inhabitants, over 25,000 in number, were safely brought out of danger, with the exception of only a few persons. The first outbreak took place from the west side of the island at a point 400 m. high directly above the village of Yokoyama, and was followed about 10 minutes later by an outburst from the southern shoulder of Nabe-yama on the southeastern slope of the island. From the western vent, dense black smoke traversed by lightning was thrown up to a height of about 6,000 m. and thick showers of lava fragments and blocks were observed with tails of steam and gases. In the afternoon, the whole island was enveloped in smoke, the eruption becoming more and more intense with terrible detonations. After a strong earthquake, which occurred at half-past six o'clock, the explosive phase became markedly stronger and reached its climax



at midnight on the 12th. On this occasion, a local hurricane blew causing some damage in the neighborhood of Yokoyama. Threatened by the danger of this terrible eruption and by the earthquakes, the people of Kagoshima were stricken by a great panic and the majority of the citizens began to flee as far as possible from the city.

By the next morning, the explosions had greatly decreased in violence and, about noon, a lava-stream appeared between the clouds near Yunohira on the west side, flowing down the slope toward Yokoyama. At about 7 a.m. on the 14th, the lava-stream had approached within a distance of 500 m. from the shore, having a front 2 km. wide. On the morning of the 16th, it reached the shore almost entirely burying the villages of Yokoyama and Akamidzu. The lava-stream continued its movement into the sea, giving out great quantities of white vapour and, at noon on the 18th, reached an islet called Karasu-jima, which was situated 600 m. off the coast and had a height of 20 m. On the 19th, the islet disappeared under the lava, which was moving forward at the rate of 5.6 m. per hour. On the 22nd, the lateral margin of the lava was still in motion at the southern base of Hakama-goshi with a velocity of 0.3 m. per hour. On the 25th, the lava front was found to have advanced about 400 m. It was not until the 27th that the lava-stream came to a standstill, forming a new lava-field which extended 950 m. from the shore with a breadth of about  $1\frac{1}{2}$  km.

Concerning the velocity of the lava-stream, Prof. Kotō states, "The lava-stream reached the flat shore, a distance of 3 km. from the vent, after three days, crawling at the rate of 3 m. per hour at this moment." According to the late Prof. Ōmori, the mean velocities of the lava-stream during the different epochs were as follows:—

8 a.m., 13th—7 a.m., 14th . . . . .	245.4 m/h
7 a.m., 14th—noon, 18th . . . . .	10.9 ,,
noon, 18th—noon, 25th . . . . .	2.4 ,,

On the western side of Sakura-jima, there were a series of vents arranged in a zone running in the ESE-WNW direction. The uppermost vent was formed to the north of Hikinohira, a parasitic cone (?), at an altitude of 570 m. above the sea-level. Other vents appeared about 220 m. below the first and these constituted the main source of the great lava-stream on the west. Still another series of vents, having a length of more than 400 m., occurs at a height of 100-160 m. above the sea-level. The fissure zone above mentioned extends to



the Nabe-yama vent on the opposite side of the island, and crosses the main line which connects the top-craters in the N-S direction, at about  $60^{\circ}$ .

Particulars of the eruption on the eastern side are not known in so much detail as in the case of the western side. The outbreak occurred a little later than that of the west at the southern shoulder of the parasitic cone of Nabe-yama. Here are five vent-holes arranged on a line running ESE for a distance of about 2 km. This fissure line is probably the eastern extension of the western. The eruption was in general similar to that of the western side, and was not less active, explosions and tremblings continuing even longer than in the west. On the 15th, a lava-stream which was forced out from the vent, came down to the coast burying the villages of Arimura, Waki and Seto, and on the 16th it had already pushed out into the sea, exhaling dense clouds of white smoke. The channel, which separated the island of Sakura-jima from the mainland of Ōsumi with a breadth of 400 m. and a depth of 72 m., was completely blocked up on the 29th, the island being converted into a peninsula. The lava mass in this channel formed a hill of 50 m. or more in height. The lava-stream advanced into the sea to about 3 km. from the original coast line with a width of nearly 3 km., three-fourths of it being submerged in the sea. It is said that the lava-stream in the channel of Seto continued its eastward progression till April, 1915, at the slow rate of about 0.9 m. during the later period.

Between the end of March and the beginning of April, 1915, i.e. fourteen months after the great eruption, a secondary lava-stream was forced out from a few crevices in the lava-field on the southern coast. This was a molten mass pressed up from below the still unconsolidated portion of the lava-stream of the preceding year. The new lava, which is black in color, flowed over the gray lava of the first period in the form of ramifying leaves. Thus, molten portions being pushed onward, lava-tunnels or channels were frequently formed.

The phase of maximum activity of the recent eruption in 1914 extended from the 12th to the 20th of January, eruptions taking place from both the western and the eastern vents. After the 21st the western side came to rest, the outbursts being limited in the main to the eastern side. From the 28th the activity showed a marked reduction, though occasional weak explosions were observed as late as the next spring.

The dimensions and volumes of the lava-streams may be tabulated as follows:—

Western lava-stream from the Yunohira vents.

Author	Area	thickness	volume
Kotō . . . .	7.20 Sq. km.	40 m.	0.288 c. km.
Ōmori . . . .	8.33 ,,	40 ,,	0.333 ,,

Eastern lava-stream from the Nabe-yama vents.

Author	Area	thickness	volume		
Kotō	5.40 Sq. km. lava-field on land	11.139	40 m.	0.2160 c. km.	
	1.886 ,, ,, in sea		100 ,,		0.1886 ,,
	2.738 ,, Submarine flow on S		100 ,,		0.2738 ,,
	1.115 ,, ,, E		50 ,,		0.0558 ,,
	4.238 ,, Outer mud shoal		28 ,,		0.1187 ,,
Ōmori	5.25 Sq. km. lava-field on land	15.41	40 m.	0.210 c. km.	
	2.19 ,, in sea above sea-level		100 ,,		0.219 ,,
	7.97 ,, ,, below ,,		100 ,,		0.797 ,,

	Kotō	Ōmori
Western lava-stream . . .	0.288 c. km.	0.333 c. km.
Eastern ,, . . .	0.852 ,,	1.226 ,,
Total . . . . .	1.140 ,,	1.559 ,,

The thickest deposit of ash and pumice thrown out during the eruption of 1914 was found in the environs of Nabe-yama, measuring from 2 to 4 m. To the southeast, at the opposite side of the old channel of Seto, the deposit was found to be 69 cm. thick. To the northeast, on the slope of Kita-dake, its thickness was a little less than 1 m. The southern side of the island, on the other hand, was but thinly covered with pumice, black soil remaining exposed in some places. In the vicinity of Hakama-goshi the ejectamenta were very slight, less than 20 cm. in thickness, consisting of ashes only. This, together with a few localities on the northwestern coast of the island, is the only district where the vegetation was not seriously affected by the eruption.

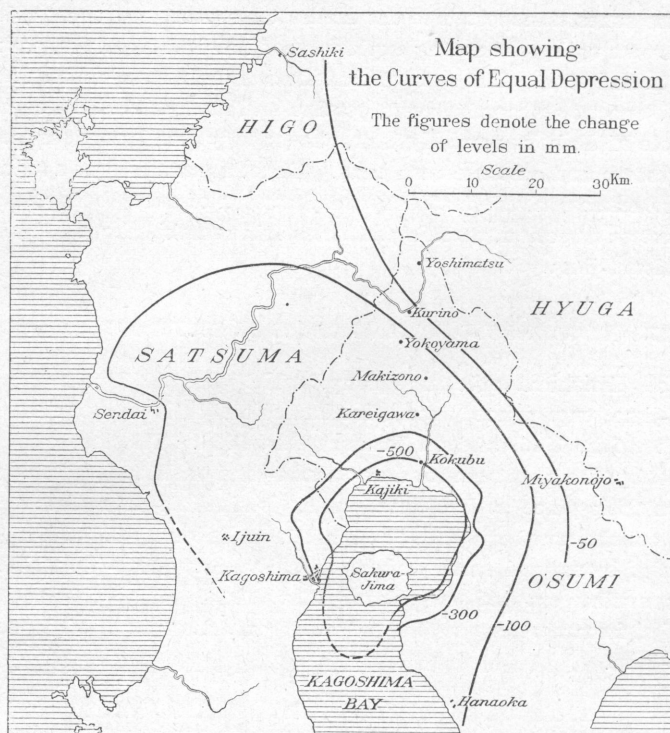
The ashes transported to the farthest distances are those which were thrown up by the strong explosions of the first two days, namely Jan. 12th and 13th. The area of distribution includes Honshū (Main Island), except its northeastern portion and its southeastern corner; the whole of Shikoku; and Kyūshū, except very small portions at its southwestern and northwestern ends. Thus, the area shows a marked eastward extension, the farthest transportation of ashes being in the northeastern direction, reaching as far as Ishinomaki, about 1,230 km. from Sakura-jima.

### ACTIVITY AMONG THE VOLCANIC CHAINS OF SOUTHERN KYŪSHŪ

The Kirishima volcanic group, which lies 50 km. north of Sakura-jima, experienced successive explosions on November 8th and December 9th, 1913, and on January 8th, 1914. The last one was followed by the great eruption of Sakura-jima on January 12th. An eruption took place at Iwō-jima, which is situated at a distance of 50 km. off the southern end of Kyūshū, on February 13th, 1914, accompanied by several earthquakes. Finally, Suwanose-jima, 97 km. farther south, erupted on March 21st, 1914. Thus the activity proceeded from north to south, presenting its maximum violence at Sakura-jima.

### DEPRESSION OF THE GROUND, CAUSED BY THE ERUPTION

After the Sakura-jima eruption in 1914, it was reported that the environs of the island had undergone some changes of sea-level, the low flat-land on the Kagoshima side being invaded to some extent by the sea-water, and also that the ground on the northern coast of Sakura-jima had been lowered 0.6-0.9 m. Precise level measurements of the bench-marks were carried out by the Military Survey during the years 1914 and 1915 and compared with those made before the eruption. The results are shown in the annexed figure with the curves of equal depression. The curves of 300 and 500 mm. run rather close to the northern coastline of Kagoshima Bay, describing a circle which is roughly concentric. The greatest depression on the mainland is 894 mm. at about 10 km. north of Kagoshima, where the curves have a comparatively larger landward extension to the west. The depression line of 100 mm. shows far greater extension to the west than to the east. At Shirahama on the northern coast of



After F. Ōmori.

Sakura-jima, the maximum depression of 1,700 mm. was measured and on the islet of Heda-kojima near the opposite coast of the mainland, the depression of 1,000 mm. was observed. Thus the centre of depression is considered to be located under the sea at about 3 km. off the coast of Shirahama, and the total area affected to be an irregular circle with a radius of approximately 52 km.

The triangulation surveys also revealed the horizontal shifting of the trigonometrical points. Three points in the southwestern part of Sakura-jima were shifted about 2-3.6 m. toward the south, while those in the northwestern part showed a displacement toward the north varying from 1 m. to 4.5 m. Thus the northern and southern parts of the island were displaced outward in contrary directions, and it is noteworthy that the neutral zone roughly coincides with

the fissure line of the recent eruption on the western side. Topographical measurements have also shown that the central part of Sakurajima was elevated to some extent, 9 m. at Hikinohira and 10.4 m. at Gongen-yama near Nabe-yama.

### STATISTICS OF DAMAGE IN SAKURA-JIMA

	Houses before eruption	Houses buried under lava	Houses burnt	People lost & killed	Cattle lost
West side	2,222	919	420	5	
East side	1,112	410	196	25	
Total	3,334	1,329	616	30	2,875

### PETROGRAPHIC SKETCH OF THE SAKURA-JIMA LAVAS

The following descriptions are based on Prof. Kotō's work on this volcano.<sup>1)</sup>

#### I PREHISTORIC LAVAS

##### 1) Kita-dake Lava. Hypersthene-andesite.

Slightly slaggy, dopatic, light coloured.

*Phenocrysts*: Plagioclase (labradorite) fairly abundant, usually zonal-structured. Pyroxenes scarce. Secretory patches of micronorite form phenocrysts, being composed of an ophitic aggregate of plagioclase and pyroxene. Hornblende extremely rare. Apatite very scarce.

*Groundmass*: Pilotaxitic and hyalopilitic, consisting of plagioclase, augite, magnetite, and glassy base.

##### 2) Kabano Lava. Pyroxene-andesite.

Black, dohyaline, dopatic.

*Phenocrysts*: Plagioclase abundant, zonal-structured.

Pyroxenes (hypersthene > augite) few. Magnetite in small quantity.

*Groundmass*: Largely made up of brown glass, variously kneaded and streaked as if after a pattern of damask, with abundant augite needles and relatively few plagioclase skeletons in glassy base.

##### 3) Minami-dake and Naka-dake Lavas. Pyroxene-andesite.

i) Southeast slope between 300 and 800 m. above sea-level.

(1) B. Kotō, The Great Eruption of Sakurajima in 1914, *Jour. Coll. Sci., Tokyo Imp. Univ.*, Vol. XXXVIII, Art. 3, 1916.

Black, dopatic.

*Phenocrysts*: Plagioclase, 1-1.5 mm. in diameter, tabular, abundant, simple or polysynthetically twinned, zonal-structured. Pyroxenes (hypersthene > augite) scarce.

*Groundmass*: Hyalopilitic, with augite needles, feldspar laths, magnetite grains in brown glassy base.

ii) Kannonzaki area.

Black, vitreous, owing to the abundancy of glass in which microlites of augite and feldspar are found. Olivine extremely rare. Contains micronorite patches.

iii) Naka-dake.

Slaggy, vitreous, pitch-black or dull-black. Characterized by abundancy of brown glass, with augite needles, sometimes with feldspar microlites as well, in a glassy base.

## II HISTORIC LAVAS

4) **Bummei Lava, 1471-'76.** Pyroxene-andesite.

Slightly slaggy, pitch-black, dopatic.

*Phenocrysts*: Plagioclase abundant. Pyroxenes (hypersthene > augite) scarce.

*Groundmass*: Rich in brown glass, with augite microlites and plagioclase skeletons in fluidal arrangement.

5) **Byōbuhira Lava, 1475-'76.** Pyroxene-andesite.

Dopatic or sempatatic. The land lava is pitch-black and vitreous, while the shore lava is dull and cloddy.

*Phenocrysts*: Plagioclase, 1-3 mm. across ' abundant. Pyroxenes (hypersthene > augite) only sparsely represented.

6) **Ōhirayama Lava, 1749.**

Dopatic, dark-coloured, rather compact.

*Phenocrysts*: Plagioclase, 2-3 mm. across ' abundant. Pyroxene usually very scarce.

*Groundmass*: Dull, lustreless gray, due to a large amount of feldspar in a light brown glass.

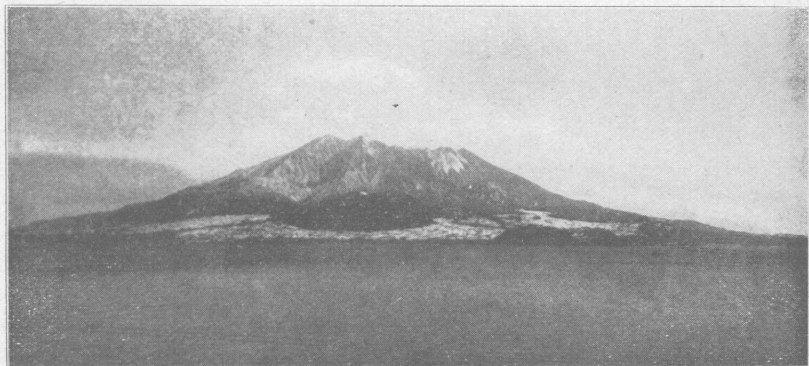
This lava contains micronoritic secretory patches.

7) **An-ei Lava, 1779-'81.** Olivine-bearing pyroxene-andesite.

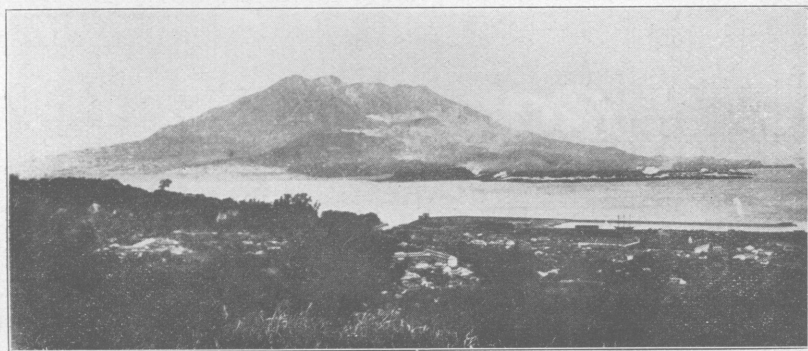
*Land lava*: Black, slaggy, sempatatic.

*Shore lava*: Dark gray, somewhat slaggy, weakly vitreous, dopatic.



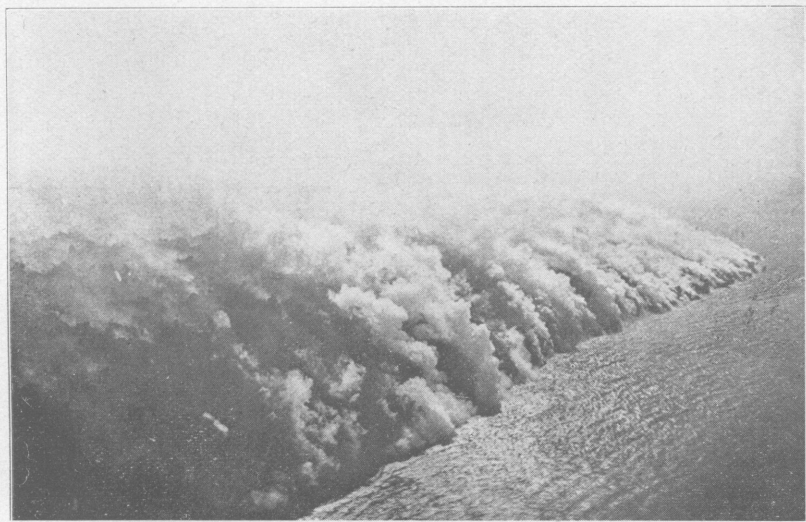


Western views of Sakura-jima prior to the great eruption in 1914,  
seen from Kagoshima. (After B. Koto)

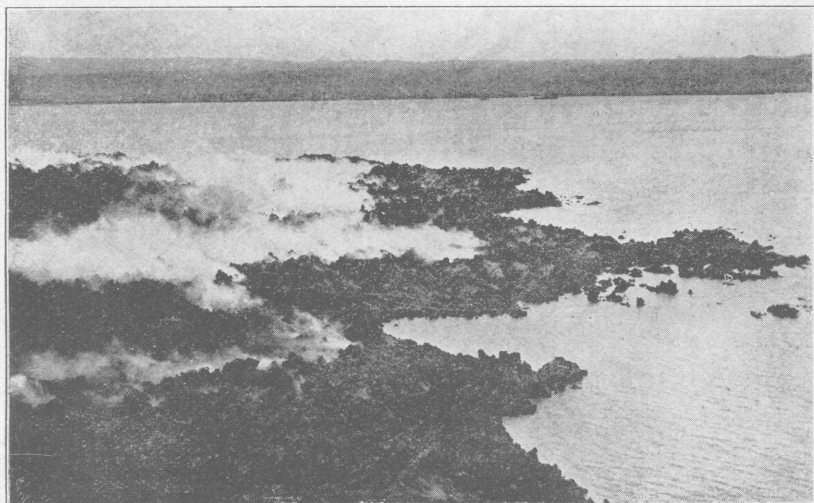


View of the western lava-streams, seen from the Meteorological  
Observatory in Kagoshima. (After B. Koto)



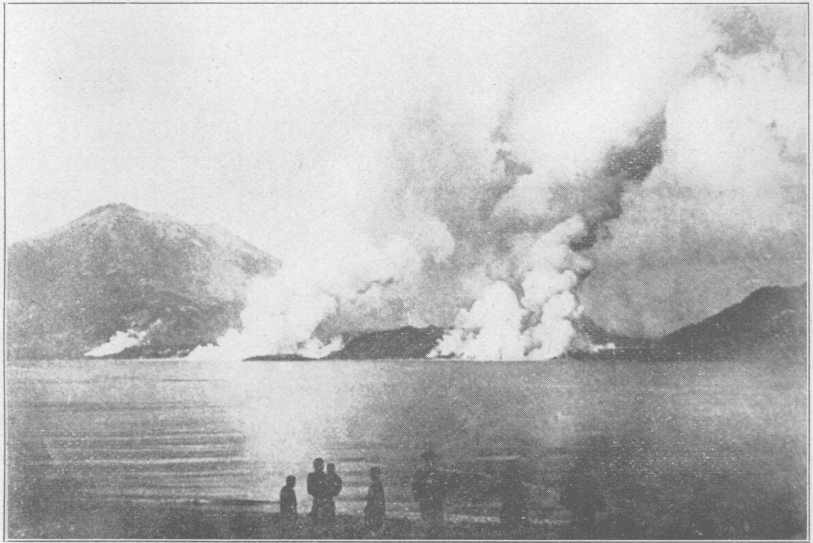


View of the Western Lava-front in the sea, looking southwards  
from the top of Hakamagoshi. (After B. Koto.)

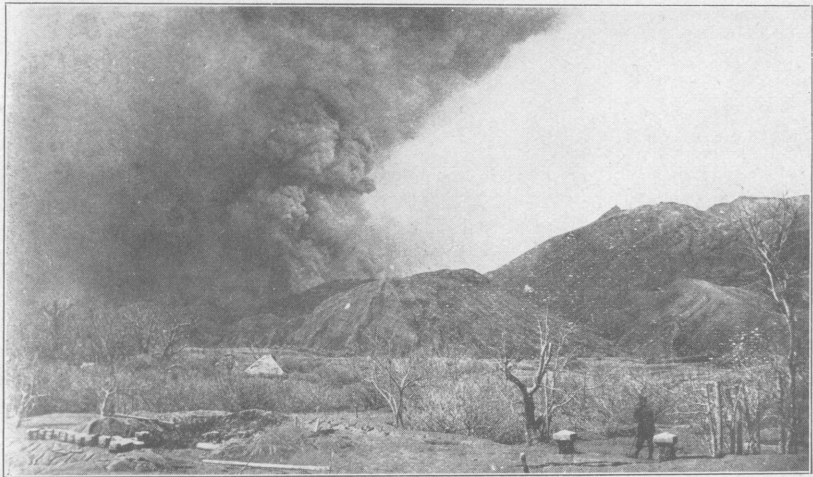


End of the Western Lava.





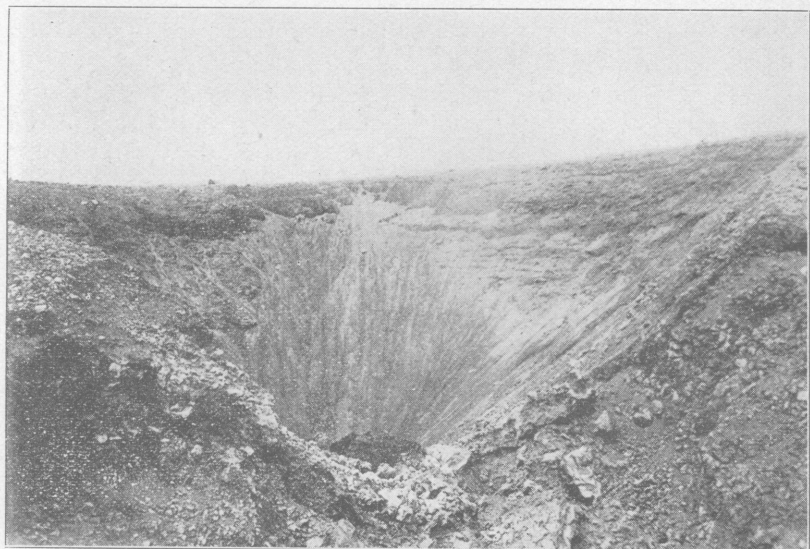
Eastern Lava-flow blocked up the Channel of Seto. An islet (Arimura-jima) is in existence in front of the left hand vapour column. (Feb. 4th, 1914. R. Higo, Photo).



Nabe-yama (at centre of figure) seen from the plateau ground of Krokami, with the smoke columns rising principally from the No. 4 and the more eastern craterlets. The central and southern peaks of Sakura-jima are shown at the right-hand side. The heads of two stone gate posts, near which a man is standing, are shown out of the accumulated layer of pumice and ash. (April 1914. After F. Ōmori.)







Craterlet No. 4, A loose-looking mass of lava at the bottom.  
(F. Ōmori, photo)



General view of the Eastern Eruption Field taken from the upper rim of the No. 1 craterlet (1). From the latter a depression zone or Eruption Canal (X—X) leads toward the Nabe-yama Crack. (April, 1915) (N), Highest point of Nabe yama. (1), A small craterlet. (2), Craterlet No. 2. (F. Ōmori, photo.)



*Phenocrysts*: Plagioclase abundant. Pyroxenes (hypersthene > augite) comparatively few. Olivine sporadically found.

*Groundmass*: Hyalopilitic, consisting of augite needles, mixed with feldspar laths in a light-brownish glass.

8) **Taishō Lava, 1914.** Olivine-bearing pyroxene-andesite.

*Land lava*: Black, more or less slaggy, semipatic to dopatic.

*Phenocrysts*: Plagioclase, 2 mm. in diameter, zonal-structured. Pyroxenes (hypersthene > augite) relatively few. Olivine anhedral, sometimes single, but habitually forming nuclei of glomerophyric masses surrounded by hypersthene with amoeboid iron ore as a transitional zone; also in association with feldspar and pyroxene, building up secretory patches.

*Groundmass*: Hyalopilitic, composed of augite, feldspar, magnetite, and brown glass.

In the C. I. P. W. System this rock belongs to II 4 4 4, *bandose*.

*Submarine lava*: Dull-grayish black, cavernous, coccolithic or lumpy, due to chilling under water, dopatic to semipatic.

*Phenocrysts*: Plagioclase, mostly 2 mm., rarely 4 mm. in diameter, full of brown glass inclusions, zonal-structured. Olivine anhedral, almost always present, though small in quantity, often as nuclei of the cumuloxyric patches. Pyroxenes (hypersthene > augite) scarce. Two kinds of pyroxenes often in parallel growth. Magnetite sporadically in clumps.

*Groundmass*: Brownish and hyalopilitic, mainly composed of augite microlites mixed with a subordinate quantity of feldspar in a light-brownish globulitic base.

## BOTANICAL NOTES ON SAKURA-JIMA

BY KWAN KORIBA AND ZENTARO TASHIRO

As Sakura-jima is covered by various kinds of lava, new and old, so likewise does it display a varied vegetation. While the ash plains in general are favourable to plant growth, even though they are newly formed, the lava flows are extremely resistant. Thus there appears a marked difference of vegetation according to the age of the lava flow. The prehistoric lava is already covered by humous soil mixed with tuff, 1/3 m. or more in depth, with a fairly dense growth

of trees and undergrowth. The lava beds of the recent eruption are still almost bare, veritable deserts, so to speak, while the Bummei (1475-6) and An-ei (1779) lavas, representing an intermediate stage, are not unlike savannahs. Besides these edaphic factors, the volcano also shows zones of vegetation, extending from the coast up to a height of 1,100 m., though the upper portion is now extremely wasted.

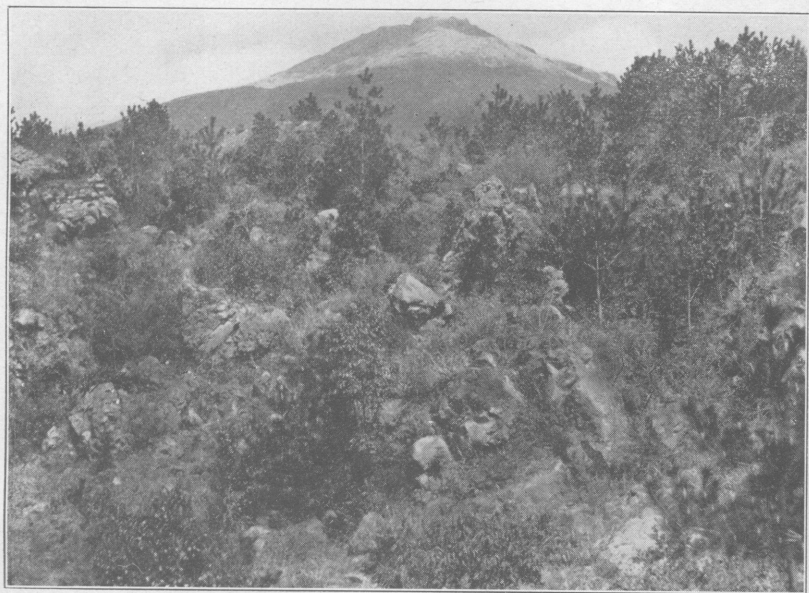
Landing on the shore, we meet with *Lathyrus maritimus*, *Canavalia lineata*, *Tetragonia expansa*, *Angelica kiusiana*, *Calystegia soldanella*, and *Vitex trifoliata* var. *ovata*. Of trees there are *Listera japonica* and *Ficus Wightiana*. A little further inland we see *Arundo Donax*, *Urtica Thunbergiana*, *Boehmeria holoserisea*, *Panicum repens*, *Bidens bipinnata*, *Polygonum chinense*, and among trees, *Erythronium japonicum*, *Celtis sinensis*, *Viburnum Awabuchi* and *Pittosporum Tobira*.

On the recent lava, at first in hollow spots, mosses and lichens grow quite sparsely. On the marginal portion of the beds, however, there appear occasionally *Polygonum Reynoutria*, *Miscanthus sinensis*, *Erigeron canadensis*, *Polygonum sinense*, *Inula denticulata*, and *Ligularia Tussilaginea*; rarely also, *Buddleia curviflora*, *Lespedeza cyrtobotrya*, *Deutzia Sieboldiana*, *Rosa Luciae*, *Rubus dulcis*, and *Pinus Thunbergii*.

On the An-ei and Bummei lavas, the black pine predominates, mixed with some other trees such as *Quercus glauca*, *Rhus succedanea*, *Eurya japonica*, *Rhaphiolepis umbellata*, and occasionally also *Machilus Thunbergii*, *Ilex Oldhami*, *Camellia japonica* var. *spontanea*, *Macaranga japonica*, and others. Of shrubs, there are *Deutzia Sieboldiana*, *Lespedeza cyrtobotrya*, *Elaeagnus umbellata*, and *E. pungens*; of lianas, *Parthenocissus tricuspidata*, *Paederia tomentosa*, *Lonicera japonica*, *Trachelospermum asiaticum*, and *Stauntonia hexaphylla*. Of grasses and herbs, besides those already mentioned on the new lava, there frequently occur *Eragrostis atrovirens*, *Bulbostyris capillaris*, *Cyperus polystachyus*, *Solidago virgaurea*, *Lilioden graminifolia*, *Artemisia vulgaris* var. *indica*, *Rumex japonicus*, and of ferns, *Nephrolepis cordifolia*, *Polypodium hastatum*, and *Cyclophorus lingua* are found.

On the prehistoric lava, as well as on the wash-plain in general, there are found *Pinus Thunbergii*, *Cinnamomum Camphor*, *C. pedunculatum*, *Machilus Thunbergii*, *Hydrangea paniculata*, *Rhododendron Kaempferi*, *Ligustrum japonicum*, *Fatsia japonica*, *Symplocos lucida*, and some of those trees and plants noted above.

Ascending from the plain to a height of 250-500 m., we find that the vegetation tends to become shrubby, and associated with that



A savanna-like vegetation on An-ei-lava.





observed on the low plain, there occur as new elements, *Salix Saidaana*, *Ardisia japonica*, *Rubus Buergeri*, *Ampelopsis heterophylla*, and of ferns, *Dryopteris uniformis*, *Blechnum nipponicum*, *Gleichenia linialis*, *G. glauca*, and *Pteridium aquilinum*, though they are not frequent. From 500-900 m. there occur also *Ilex crenata* var. *Fukusawana* and *Sambucus Sieboldiana*; and over 900 m., on the barren grounds built up of lapilli, occur, but only sporadically, *Alnus firma*, *Ligustrum japonicum*, *Ilex Fukusawana*, *Plantago major*, *Cnidium longeradiatum*, *Cerastium vulgatum* and a few others. *Miscanthus sinensis* and *Polygonum Reynoutria* predominate in all these zones.

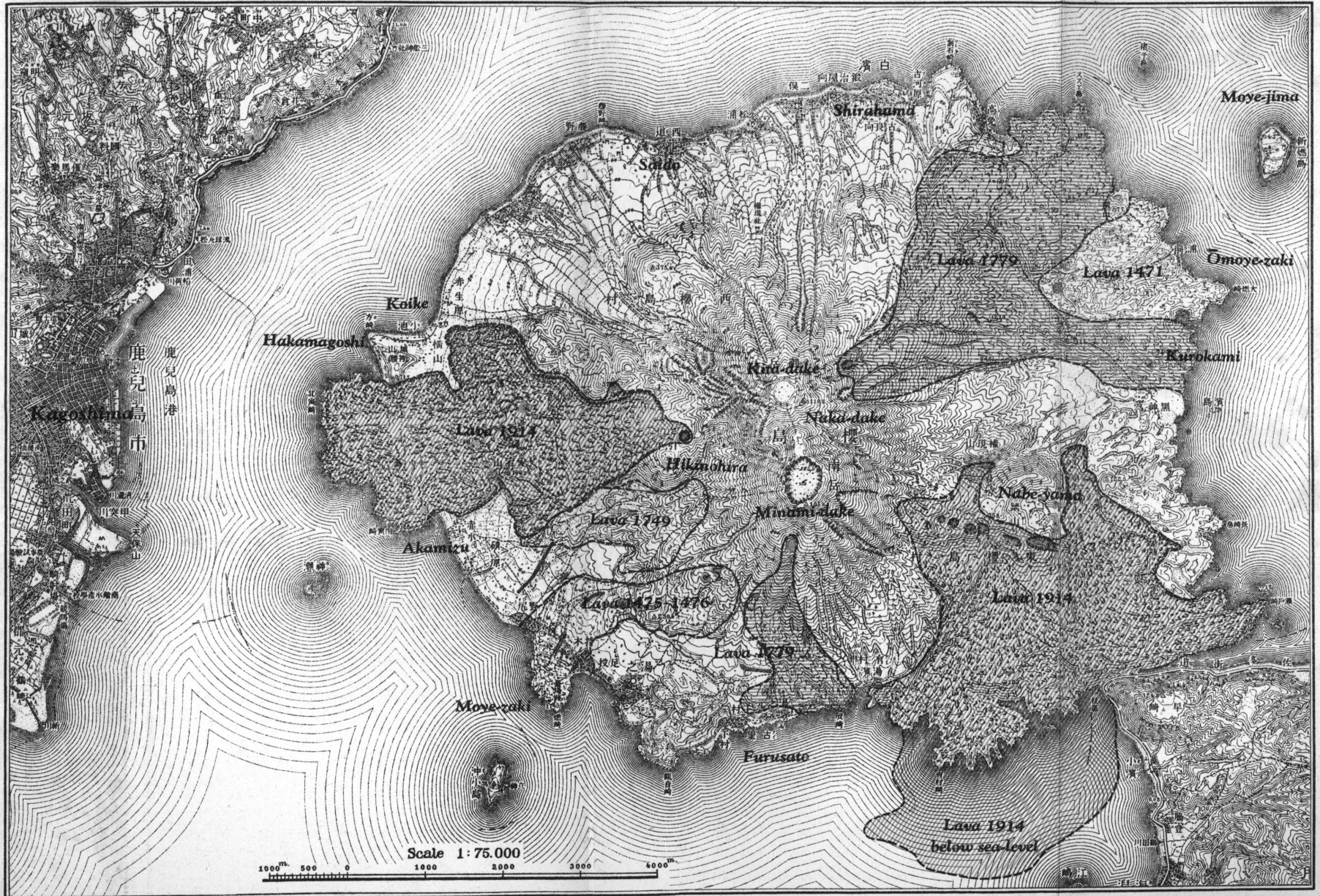
As Sakura-jima has an exceedingly mild climate, it produces various delicious fruits including varieties of *Citrus*. Even sugarcane is cultivated. Especially worthy of notice is the famous Sakura-jima radish, which is produced on the tuffy soil and often attains a weight of 30 kg. or more.

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# MAP SHOWING THE LAVA-FLOWS OF VOLCANO SAKURA-JIMA

PL. I



Compiled from Professors Koto and Omori's Maps.

大正十五年十二月二十日印行  
大正十五年十二月二十五日發行

第三回汎太平洋學術會議

印刷者 木 下 憲  
東京市日本橋區兜町二番地  
印刷所 東京印刷株式會社  
東京市日本橋區兜町二番地  
發賣所 東京地學協會  
東京市京橋區木挽町九丁目二十九番地



**Executive Office: Rooms of the National Research Council,  
Department of Education, Tokyo**

**CABLE ADDRESS:—KENKYU, TOKYO.**