

## 12. *A Brief Note on the Eruption of the Tokachi-dake Volcano of June 29 and 30, 1962.*

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### Introduction

The active volcano, Tokachi-dake, which lies on the south-western portion of the Daisetsu-Tokachi Volcanic Chain dominating the central part of Hokkaido, suddenly erupted on June 29, 1962. The Tokachi-dake Volcano is memorable for its characteristic eruption of May, 1926, when it burst out in an eruption that was the greatest and most disastrous volcanic catastrophe in several recent decades in Japan, causing fierce mud-flows which devastated forests, meadows, houses and the death of 144 persons on their course.

The eruptive activity which began in May of 1926 continued for two years and eight months with several surges and a general diminution of intensity until the small puffing in Dec. of 1928. Afterwards, the volcano had been only in a state of fumarolic activity, displaying a number of fumaroles in and around the newly formed explosion crater. Since 1952, the fumarolic activity on the south-western slope of the Suribachi crater has recurred. Since late April 1962 the eruptive activity of the volcano also seems to have recurred, and the fumarolic activity in the 1926 crater began increasing in intensity accompanied by many minor earthquakes and rumblings. At midnight of June 29, 1962, the volcano suddenly erupted with violent ejections of rock debris. During this outburst five men who were staying in the lodge of the Tokachi Sulphur Mine on the southern rim of the 1926 crater lost their lives and eleven men in the same lodge were injured by the ejected debris. In the morning of the next day, the second outburst began with the shooting up of huge mushroom-shaped eruptive clouds to a height of 12,000 m and ceaseless ejection of bombs. The eruption continued in discharge of ash and bombs for a week, after which it changed to emission of immense amount of steam and gas.

The writer had an opportunity of visiting the volcano immediately

after the beginning of the eruption. The result of his survey is presented in this report. The writer wishes to express his sincere thanks to Prof. Hiromichi Tsuya of the Earthquake Research Institute, Univ. of Tokyo, for his kindness in giving invaluable advice. He is indebted to Mr. Yoshichi Hosoya of the Komoro Branch of the same Institute for preparation of figures in this report. He is also indebted to many persons and public offices which provided numerous facilities for his survey on the spot and supplied valuable information and photographs of the eruption. He wishes to acknowledge with gratitude the newspaper offices and the Tokachi Sulphur Mine which supplied many photographs of the eruption.

### Geology and Morphology of the Volcano

The Tokachi-dake Volcano having an altitude of 2,077 m above sea level is the only active one among many volcanoes comprising the Daisetsu-Tokachi Volcanic Chain. The volcanic chain which belongs to the inner subzone of the Kurile Volcanic Zone runs in a NE-SW direction with a stretch of about 80 km, forming the central highland in Hokkaido. It consists of many volcanic cones having altitudes of 1,500 m to 2,300 m above sea level, and is divided into the three volcanic groups of Daisetsu, Sumanupuri and Tokachi. The Tokachi-dake Volcano is situated in the center of the Tokachi Volcanic Group which includes a main link running in a NE-SW direction from Urousube-san to Oputateshike-san and two subordinate links running in a NW-SE direction from Kami-horokamettoku-san to Shimo-horokamettoku-san and from Urousube-san to Dairoku-san. The volcanic cones of the Tokachi Volcanic Group are built up on the vast plateaux of ash-flow deposits (Fig. 2).

The Tokachi-dake Volcano is a composite conical volcano consisting of younger parasitic cones built up on the older volcanic bodies<sup>1)</sup> (Fig. 3). The lowest elements of the older volcanic activities of this volcanic group are lava flows of olivine-bearing hypersthene-augite basalt and hypersthene-bearing augite-olivine basalt, which might have effused out of fissures

1) F. TADA and H. TSUYA, "The Eruption of the Tokachi-dake Volcano, Hokkaido, on May 24th, 1962," *Bull. Earthq. Res. Inst.*, **2** (1962), 49-84. (in Japanese with English abstract)

T. TAKAHASHI, "Geology and petrology of the south-western part of the Daisetsu-Tokachi volcanic chain. I. Geology of the Tokachi volcanic group and its volcano-tectonic structure," *Bull. Geol. Comm. Hokkaido*, No. **39** (1960), 7-18. (in Japanese with English abstract)

Y. KATSUI and T. TAKAHASHI, "A note on the chemical composition of the lavas from the Daisetsu-Tokachi volcanic chain," *Jour. Jap. Ass. Min. Petr. Econ. Geol.*, **44** (1960), 142-151. (in Japanese with English abstract)

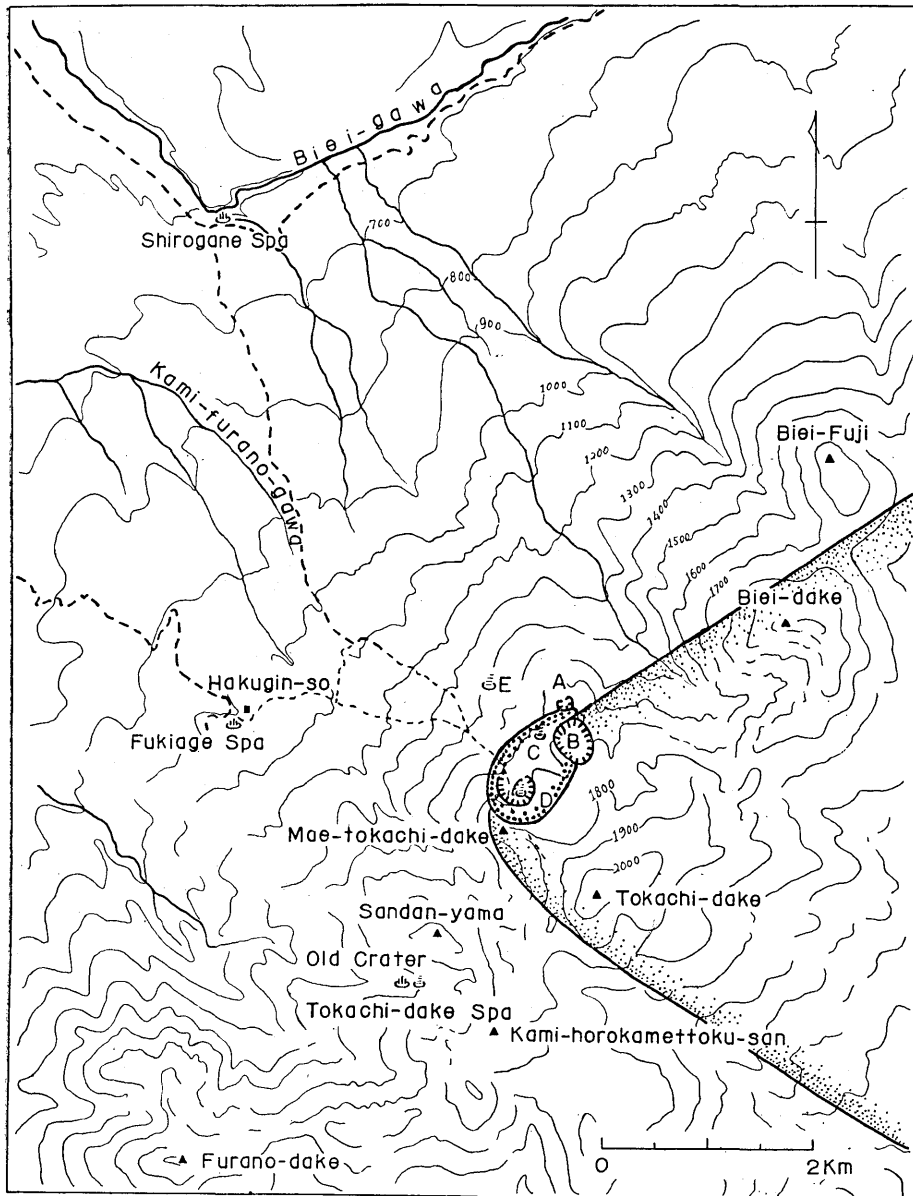


Fig. 1. Map of Tokachi-dake and the surrounding area. A: Kitamuki crater; B: Suribachi crater; C: Showa crater; D: Taisho crater; E: Kumanosawa. The circle fringed by large dots represents the area of ejecta fall, and the quadrant fringed by small dots represents the area of ash-fall.

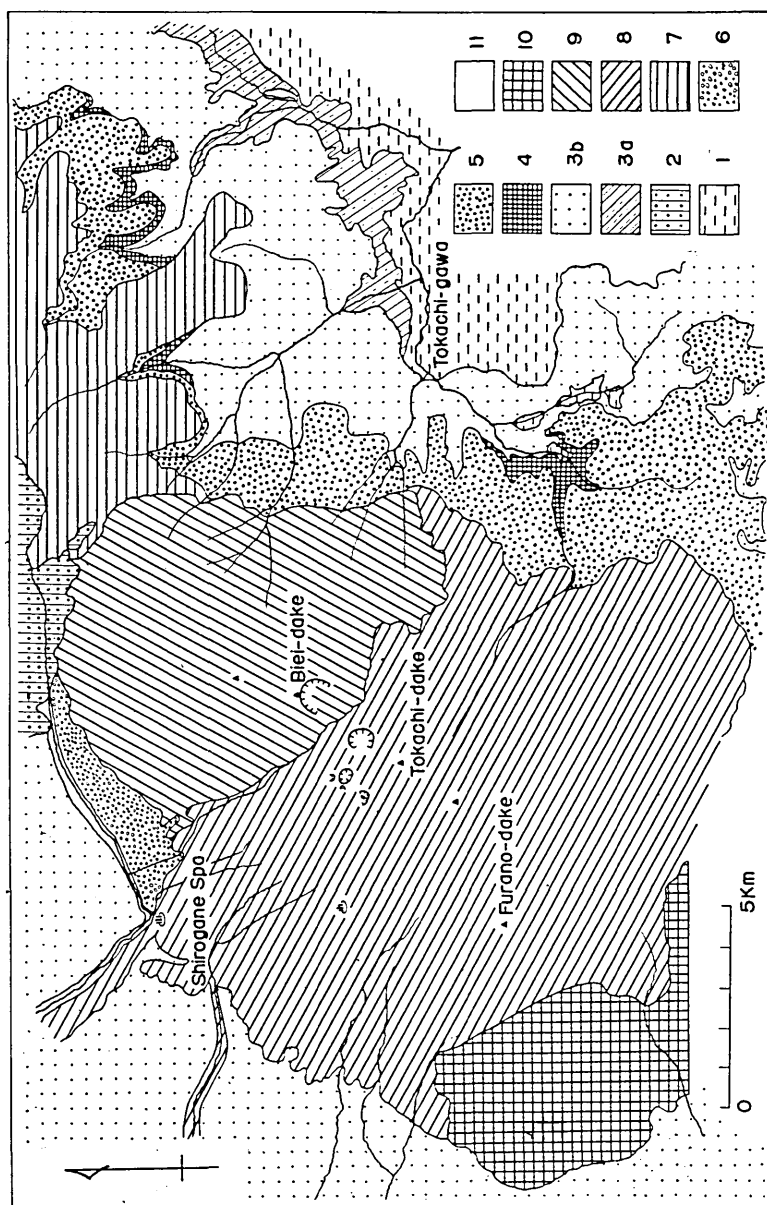


Fig. 2. Geological map of the Tokachi Volcanic Chain and the basement. (After Takahashi, 1960; Geological Sheet of Tokachigawajoryu, 1957; etc.) 1: Hidaka Group; 2: Biei Group; 3: Lower Ash-flows; 3a: Futamata Ash-flows; 3b: Tomuraushi and Biei Ash-flows; 4: Tonokari Tuffaceous Mudstone; 5: Upper Ash-flows; 6: Shirogane Bed; 7: Effusives of Sumanupuri Volcanic Group; 8: Effusives of Tokachi Volcanic Group; 9: Effusives of Oputateshike Volcanic Group; 10: Effusives of Urousube-san and Dairoku-san; 11: Alluvial deposits.

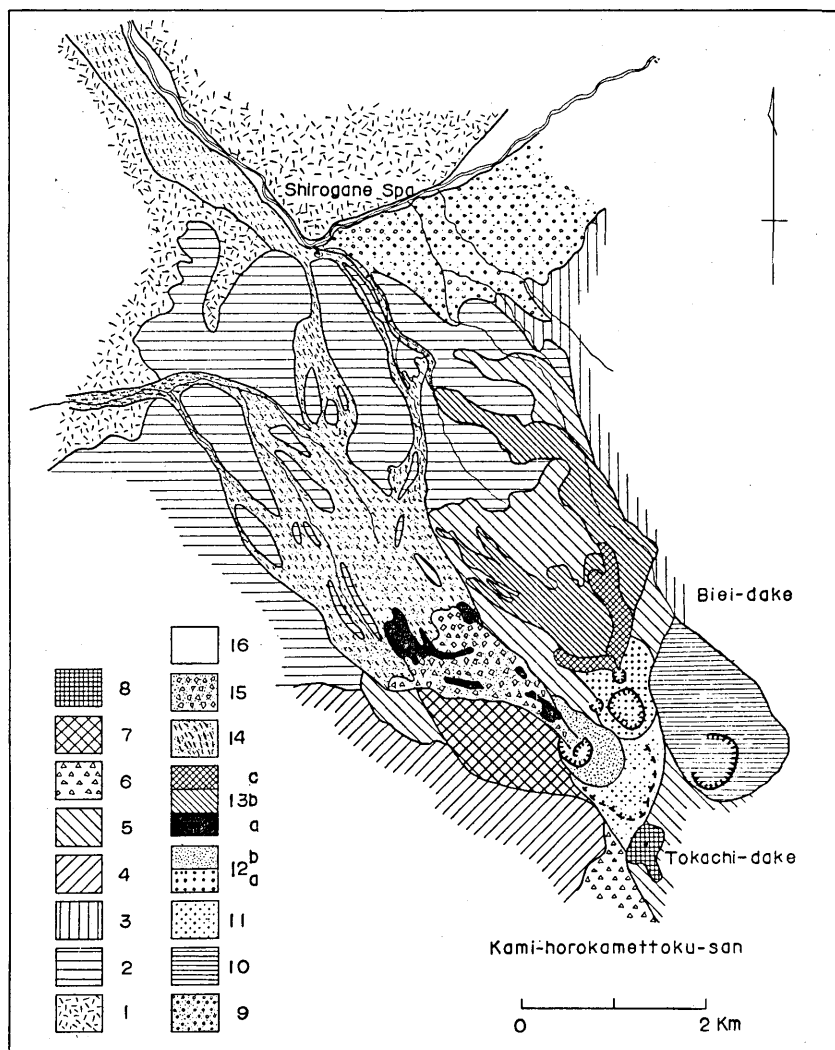


Fig. 3. Geological sketch map of the Tokachi-dake Volcano. 1: Tokachi Ash-flows; 2: Old Tokachi-dake basalt; 3: Effusives of Biei-dake; 4: Effusives of Kami-horokamettoku-san; 5: Effusives of Hira-ga-dake; 6: Agglomeratic rocks of Uma-no-se; 7: Effusives of Mae-tokachi-dake; 8: Lava dome of the summit of Tokachi-dake; 9: Shirogane Bed; 10: Effusives of Nokogiri-dake; 11: Somma cone; 12a: Suribachi cone; 12b: Central cone; 13a: Central cone lava; 13b: Suribachi cone lava; 13c: Kitamuki crater lava; 14: Pyroclastic flow deposits (partly covered by the mud-flow deposits of 1926); 15: Mud-flow deposits of 1926; 16: Alluvial deposits.

or tectonic lines in this volcanic region, forming shield volcanoes. It is considered that these lava flows were discharged in the earlier stage of Alluvium, overlying the lacustrine deposits of the Shirogane Gravel Bed having a thickness of 30 m or more which was deposited in late Dilluvium in the vicinity of Shirogane Spa on the north-western foot of the volcano.<sup>2)</sup> During the earlier stages of volcanic activities of this volcanic group, the petrographic characteristics of lavas were converted from basalt to acidic andesite. At first, they were converted from olivine-augite-hypersthene basalt to olivine-bearing hypersthene-augite andesite, and then to augite-hypersthene andesite, and finally to biotite-hornblende-bearing augite-hypersthene andesite. Several younger parasitic cones were built up on the older volcanic bodies of basaltic shield volcanoes, andesitic stratovolcanoes and acidic andesitic lava domes. They are the small central cone with the 1926 explosion crater on its western side, the somma of the central cone, the Suribachi cone with the Kitamuki crater on its north-western slope and the Nokogiri-dake cone, all of which are composed exclusively of olivine-bearing hypersthene-augite andesite. The highest peak of Tokachi-dake, 2,077 m above sea level, is a lava dome of acidic andesite which was formed in the latest stage of the earlier volcanic activity.

After the formation of the lava dome of the summit and of the strato-cone of Nokogiri-dake, eruptions repeated mainly along the line from the summit to Shirogane Spa, and the centers of eruption shifted gradually south-east to north-west. These eruptive activities are characterized by the formation of cinder cones and the discharge of block lava flows. Recent lava flows have been found on the western and north-western slope of the volcano, which were discharged from the central cone, the Suribachi crater and from the Kitamuki crater. These lava flows are considered to have been discharged by the eruptions within about the last one hundred years, judging from the vegetation on their surfaces.<sup>3)</sup>

The eruptive activities of the Tokachi-dake Volcano are noteworthy for the peculiar eruptions which produced incandescent pyroclastic flows as well as those which caused devastating mud-flows. Some deposits of pyroclastic flows are distributed on the western slope of the volcano with the area of about 7 km<sup>2</sup>. They are inferred to have been discharged

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2) H. OSANAI, "Report on the hot spring Shirogane Onsen, in Biei town. Kamikawa Sub-prefecture," *Rep. Undergr. Res. Hokkaido*, No. 40 (1960), 67-72. (in Japanese)

3) S. WATASE, *Jour. Geogr.*, 38 (1926), 503-513. (in Japanese)

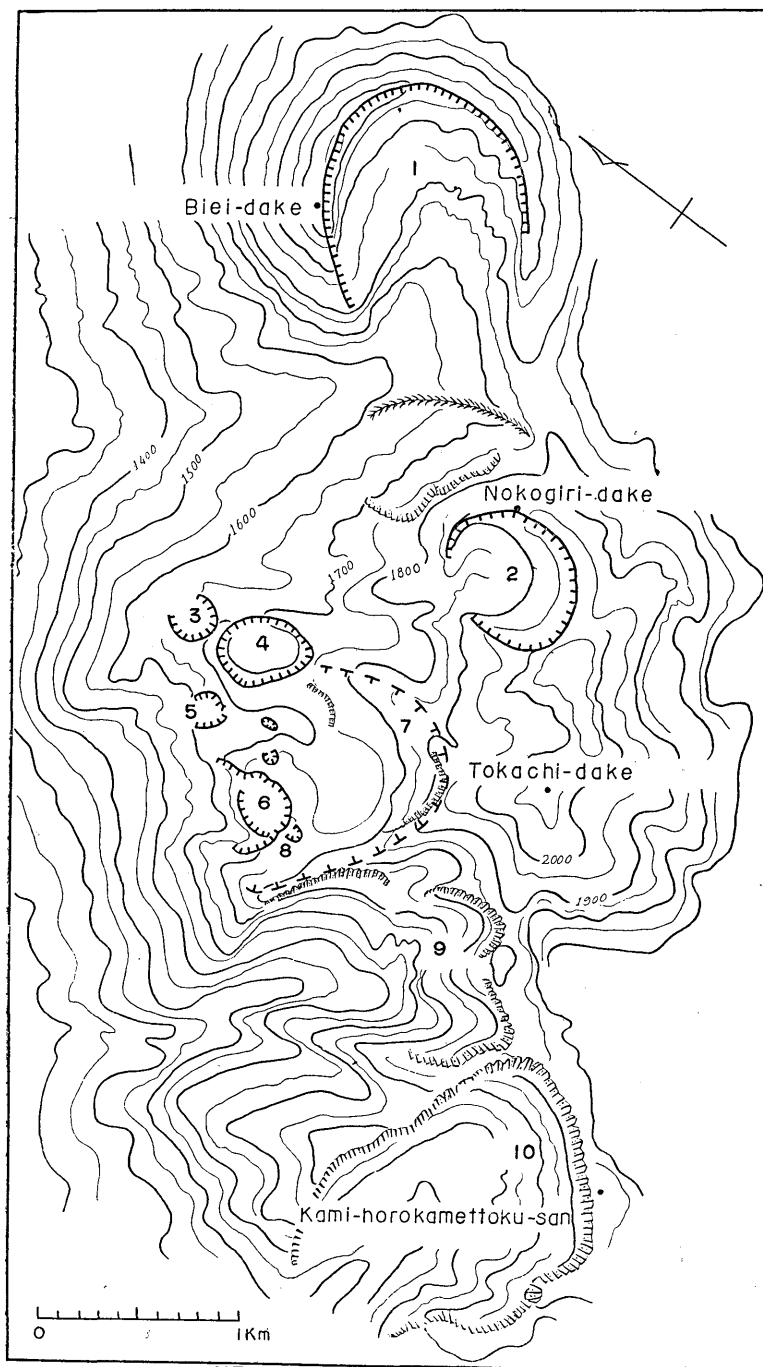


Fig. 4. Topography of the Tokachi-dake Volcano. 1: Explosion crater of Biei-dake; 2: Explosion crater of Nokogiri-dake; 3: Kitamuki crater; 4: Suribachi crater; 5: Showa crater; 6: Taisho crater; 7: Somma crater; 8: Yunuma pit; 9: Explosion crater of Uma-no-se; 10: Explosion crater of Kami-horokamettoku-san.

from the central cone, forming the flowage of the intermediate type pyroclastic flow, judging from their distribution restricted in hollows and valleys on the mountain-slope and characteristic features of texture and structure such as non-stratification, poorly sorted size distribution and welding. Several units of flows are recognized in their deposits, the lower unit is pumiceous with the volume of about  $15 \times 10^6 \text{ m}^3$ , and the upper units are scoriaceous with the volume of the same order. They are considered to have been discharged by some ancient eruptions of the central cone. It has been well known that the forcible mud-flows were caused by the 1926 eruption of the volcano. Their deposits are distributed on the western side of the central cone, resting on the pyroclastic flow deposits. The main part of their deposits occupy the area of about  $1 \text{ km}^2$  with the thickness of 2 m or more. Other deposits of mud-flows by the former eruptions are found under the pyroclastic flow deposits.<sup>4)</sup>

There are many explosion craters on the western side of the main ridge of the Tokachi Volcanic Group, all of which have asymmetrical forms opening westwards (Fig. 4). The recent active crater is one of these explosion craters. It was formed by the 1926 eruption on the western half of the central cone of Maruyama, being named "the Taisho crater" or "the new crater". The eruption on June 29 and 30, 1962, happened on the southern rim of this explosion crater.

As mentioned above, the volcanic cones of the Tokachi Volcanic Group are built up on the vast plateaux of ash-flow deposits. There are two members of the ash-flow deposits in this volcanic region, whose surfaces have the altitudes of 800 m to 1,000 m and 1,200 m above sea level respectively. The lower ash-flows of pyroxene-bearing hornblende-biotite rhyolite having a thickness of 200–300 m to 500 m were erupted out along the NE–SW tectonic line and its subordinate fractures perhaps in the early Pleistocene or Plio-Pleistocene epoch. The upper ones of hornblende-pyroxene dacite having a thickness of 80 m to 150 m were erupted perhaps in the middle Pleistocene epoch. Lacustrine deposits are intercalated between these two ash-flow sheets. These ash-flow

4) I. MURAI, "On the Mud-flows of the 1926 Eruption of Volcano Tokachi-dake, Central Hokkaido, Japan," *Bull. Earthq. Res. Inst.*, **38** (1960), 55–70.

These pyroclastic flow deposits were inferred to have been discharged during the 1926 eruption by the writer in this report. However, his latter survey clarified the fact that these deposits were overlain by the deposits of the 1926 mud-flow and the lava flows from the central cone. It may be possible to infer that they were discharged by the former several eruptions in ancient times.



deposits overlie the basal rocks consisting of the Hidaka Formation of Pre-Cretaceous ages and propylite with associated green tuff-breccia of the Biei Formation of Miocene.<sup>5)</sup>

### Former Activities of the Volcano

*Prior to the 1926 eruption* There are few historic records of violent eruptions of this volcano, because of its unexplored situation in former ages.<sup>6)</sup> However, it seems to have been active from ancient times. An explorer reported that he saw a supposedly eruptive cloud rising on the mountain-slope of the volcano on May 23, 1857. Some people at the foot of the volcano saw the rising of eruptive clouds with red reflections during the nights of early June, 1887. They recognized a new explosion pit formed on the western slope of the central cone. In 1889, some eruptive activity occurred perhaps at a spot at Yunuma which is a new pit formed by the eruption. After that the volcano seems to have been only in a state of fumarolic activity prior to the 1926 eruption.

*The 1926 eruption* During the period prior to the 1926 eruption, the volcano had continued in a dormant state, displaying many fumaroles in the crater, on the crater-rim and on the western slope of the central cone. From 1909 to 1913 and from 1918 to 1926 sulphur deposits were mined out of these fumaroles. The eruptive activity began on Dec. 23, 1925, when a small outburst occurred at the crater of the central cone, forming a new pit on the crater-wall. In 1926, the activity continued to increase in intensity, the amount of gases and sulphur deposits increased gradually and slight puffings occurred repeatedly. From the early days of May, 1926, the activity became more violent. On May 13, 14 and 15, puffings of smoke and intense rumblings occurred almost ceaselessly and many quakes and rumbling noises were felt at the villages at the foot of the volcano. On May 22 and 24, intense rumblings and puffings occurred. On May 24, the volcano was covered with thick clouds,

5) Y. SUZUKI and Y. KITAGAWA, "On the welded tuff in the vicinity of Mt. Tokachi," *Bull. Geol. Comm. Hokkaido*, No. 32 (1956), 12-21. (in Japanese with English abstract)

S. SAKO and K. HASEGAWA, "Explanatory text of the geological map of Japan, scale 1 : 50,000, 'Tokachigawajoryu'," Hokkaido Development Agency. (in Japanese with English abstract)

W. HASHIMOTO, "Explanatory text of the geological map of Japan, scale 1 : 50,000, 'Shimofurano'," Hokkaido Development Agency. (in Japanese with English abstract)

6) K. SHIBAHARA, *Chikyû* (The Globe), 6 (1962), 166-168. (in Japanese)

H. TANAKADATE, "General report on the explosion of Tokachi-dake," (Sapporo, 1926). (in Japanese)

but ceaseless rumblings were heard from the volcano. At 0:11 p.m. the first outburst occurred with an intense explosive noise. A mud-flow caused by this outburst swept over the north-western slope of the volcano, and three persons at the Maruyama Spa 3 km away from the crater of the central cone were killed. It was inferred that the explosion occurred on the western side of the central cone at an altitude of about 1,350 m above sea level, where many fumaroles had lain before the outburst. At about 2:00 p.m. violent rumbling noises were heard on the foot of the volcano, which are inferred to have accompanied some outbursts. At 4:18 p.m. of the same day, the second major outburst occurred at the top of the central cone. The greater half of the north-western side of the central cone was destroyed by the intense outburst. Collapsed materials were shot out laterally causing forcible mud-flows which rushed down with unexpected rapidity over the western slope of the cone. Within one minute after the outburst, mud-flows extended to the office of the sulphur mine, about 2.5 km away from the crater. The writer estimated the volume of the collapsed mass at about  $4 \times 10^6 \text{ m}^3$  or more. Such an immense amount of rock fragments mainly derived from crumbly rocks attacked by the fumarolic action on the upper part of the cone, accompanied by large quantities of steam, gas and possibly hot water, formed hot mud-flows commingling together. The deposits of mud-flows were spread on the western side of the central cone. The snow which had accumulated on the upper half of the mountain-slope melted at once by the heat of these deposits and consequently this water flooded into the valleys on the lower skirts of the volcano, and finally flooded over the basin at the foot of the volcano. About 25 minutes after the outburst, muddy water filled with drift-wood brought from the forest on the course flowed into the town of Kami-furano at a distance of 24 km from the crater. About 29 km<sup>2</sup> of land was washed away, forest, meadows and farms were swept down, 5,080 houses were laid in ruin and 141 persons were killed. The new explosion crater of 420 × 380 m widths and 150 m depth was formed by the outburst. After these major outbursts, some discharge of ash followed and then the ejection of bombs of about 3,000 m<sup>3</sup> occurred.<sup>7)</sup>

After the heavy explosions of May 24, 1926, the eruptive activity diminished gradually, and in late June the eruption consisted only of

7) F. TADA and H. TSUYA, *op. cit.*, (1927).

H. TANAKADATE, *op. cit.*, (1926).

H. TANAKADATE, "Explosive eruption of Tokachi-dake, Hokkaido, Japan," *Bull. Volc., Napoli*, **13-14** (1927), 11-14.

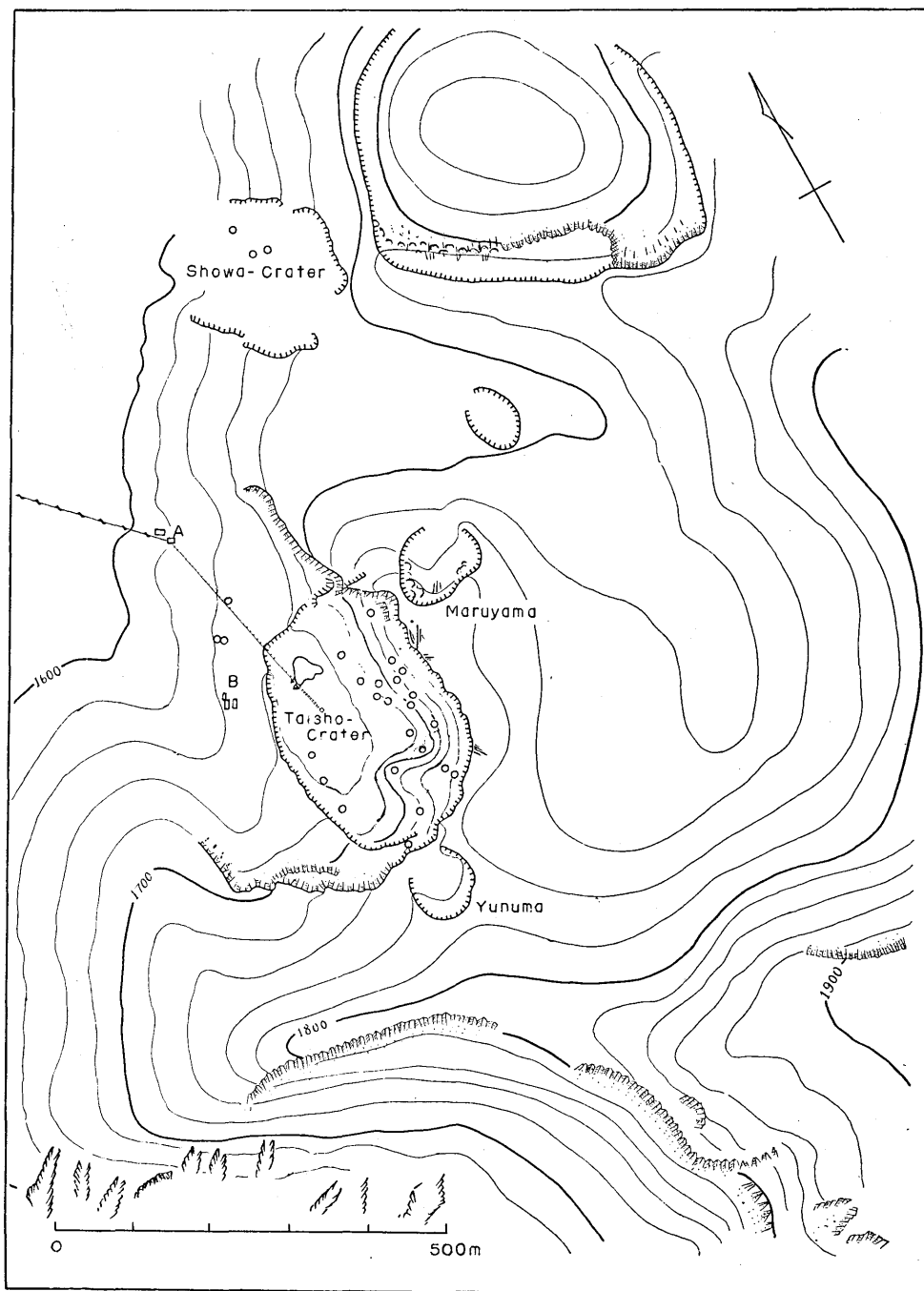


Fig. 5. Topographical sketch map of the Taisho crater and the surrounding area, before the eruption. Open circles are fumaroles. A is the lodge of the sulphur mine where many persons were killed and injured during the eruption of June 29, 1962. B is another lodge.

emissions of white vapour clouds. On Sep. 8, 1926, a heavy outburst occurred again in the newly-formed explosion crater. After that, the eruptive activity continued for three years until the last puffing on Dec. 4, 1928, with minor surges occurring repeatedly at intervals of about three or four months.<sup>8)</sup>

*Recent activities* Since the last puffing in 1928, the eruptive activity of the volcano entirely ceased. Only steam and gas were emitted ceaselessly from the fumaroles at the foot of the eastern wall of the new explosion crater (Fig. 5). In 1933, 1936, 1937, 1946 and 1947, the fumarolic activity in the 1926 crater increased in intensity in a short time. In 1936 and since 1951, the mining of sulphur from these fumaroles was in operation. On Aug. 17, 1952, the activity of the volcano seems to have recurred, when the fumarolic activity on the southern slope of the Suribachi crater recommenced and some fumarolic pits were formed. These pits were named as "the Showa crater". Since then, the activity of the volcano seems to have increased. At the new fumaroles of the Showa crater some puffings occurred frequently, i.e. in Sept. of 1956, Aug. of 1957, Oct. of 1958, Aug. and Nov. of 1959. The fumarolic activity in the 1926 crater seems to have increased gradually since 1952.<sup>9)</sup>

#### Eruption of June 29 and 30, 1962

*Premonitory symptoms* Since April 23, 1962, when a distinct earthquake was felt in the central district of Hokkaido, the activity of the volcano became remarkable. It was reported that the epicenter lies off Hiroo on the south-eastern coast of Hokkaido. In the 1926 crater, the fumarolic activity increased remarkably and rock falls happened frequently on the wall of the crater. Minor local earthquakes whose epicenters were considered to lie beneath the area around the volcano began to occur frequently. They were felt at Shirogane Spa, Fukiage Spa, Tokachi-dake Spa, etc. in the area around the volcano. On May 4, 9, 23, 27 and 28, minor quakes were felt in this area. On April 29, May 21 and 25, rock falls occurred on the eastern wall of the 1926 crater. On May 30, some rumbling noises were heard in the vicinity of the crater. At

8) K. NOBUHARA, *Jour. Geogr.*, **39** (1927), 204-213. (in Japanese)

K. NOBUHARA, *Jour. Geogr.*, **40** (1928), 365-366. (in Japanese)

9) S. SAKUMA and T. MURASE, "Geophysical studies of volcanoes in Hokkaido, in Japan. Part 2, The Tokachi volcano in 1955," *Geophys. Bull. Hokkaido Univ.*, **4** (1956), 25-30. (in Japanese with English abstract)

Observation Division of Jap. Meteorol. Agency, Sapporo Meteorol. Obs. and Asahikawa Local Meteorol. Obs., *Quartary Jour. Seism.*, **23** (1958), 23-30. (in Japanese)

almost the same time, the emission of smoke from every fumarole in the Showa crater, Taisho crater and in the old crater at the bottom of the Horokamettoku explosion crater increased in intensity altogether in a short time. On May 31, several quakes were felt at Shirogane Spa, Tokachi-dake Spa, etc. at 2:23, 2:29, 2:32 p.m. and at 4:30 p.m. etc., some of which having the magnitudes of 3.3 and 3.6. After that, the fumarolic activity in the Taisho crater became increasingly intense, and the temperature and the gas content of emitted steam from the fumaroles gradually increased.<sup>10)</sup> In the early days of June, quakes continued to be felt frequently, and rock falls also occurred frequently. People in the area around the volcano noticed these symptoms which might suggest an imminent eruption. Officeholders of Biei-machi and Kami-furano-machi on the western foot of the volcano and staffs of the sulphur mine became seriously worried about the possibility of an imminent eruption and considered how to take proper measures for such an eventuality. On June 2, 4, 8, 9 and 16, quakes were felt, and on June 5, 9, 15, 17, 18, 19 and 24, rock falls occurred in the Taisho crater. On June 12, muddy water issued from the foot of the eastern wall of the Taisho crater. On June 13 and 14, the temperature of emitted steam from the fumaroles in the Taisho crater increased remarkably. The volume of sulphur deposits sublimated on the artificial tubes which were attached to natural fumaroles to give rise to sulphur ore also increased remarkably. During the latter days of June, activities remained rather tranquil except for an increase of temperature and a quantity of emitted steam from the fumaroles that was observed. The volume of emitted steam was reported to have probably reached 5,000 m<sup>3</sup>/min or more. On June 27, a quake was felt at Tokachi-dake Spa. On the same day, staffs of the sulphur mine found new fissures additionally formed on the top of the eastern crater-rim, where distinct fissures had opened since observations of several years ago. White vapour of 86°C was recognized as issuing from one of these fissures. The temperature of steam at the mouths of some artificial tunnels in the Taisho crater was measured as 220° to 260°C, which had been previously recorded as 125°C in March, 1962. The temperature of the ground of 20 cm depth at Yunuma of the eastern crater-rim was measured as 76°C, which was recorded as 45°C in May, 1960. On June 28, a minor quake was felt at Shirogane Spa, and rock-falls occurred in the Taisho crater. Some persons noticed that hot muddy water gushed out

10) At some fumaroles in the Taisho crater the temperature was recorded as 120°-180°C, the volume of emitted steam was recorded as 650 m<sup>3</sup>-1,500 m<sup>3</sup>/min., and the gas content was recorded as 4.00-7.09% in August, 1954.

of a fumarole in Kumanosawa, a gully on the north-western slope of the central cone. Muddy water also gushed out in a gully on the western side of the central cone. On June 29, some persons noticed a new fissure of about 4 m length opening on the ridge of Mae-tokachi-dake, when many fissures had opened since observations of eight years ago.

Seismographs of a magnification of 350 were set up at a spot 800 m away from the western crater-rim of the Taisho crater in order to register preliminary quakes. They recorded microseisms of 2 to 50 or more a day during the period from April 23 to the outburst of June 29. In early May the number of microseisms recorded on them increased remarkably. Since June 24, there has also been a conspicuous increase.

*Situation of the eruption* On June 29, 1962, the quantity of emitted steam from the fumaroles in the Taisho crater decreased and no quake was felt on the volcano. However, the fissures on the top of the crater-rim became more distinct. At midnight of the same day an intense outburst occurred. At about 10:15 p.m., some low noises like a whirr of jet planes were heard from the volcano, and a white smoke column was seen rising from the Taisho crater. At about 10:30 p.m., the noises became louder. It is inferred that the eruption had started and the ejection of rock debris had begun by that time. At 10:24 and 10:47 p.m., a column of eruptive cloud with red reflections and lightning was shot out from the southern rim of the Taisho crater. Explosive noises and airshocks were reported to have been felt at Hakugin-so, about 3 km away from the crater. At the town of Kami-furano, 24 km away from the crater, no explosive noise nor airshock was felt. It was also reported that some noises were heard at Otaru, Date, Abuta, Rusuttsu, Soya and other places, about 140 km to 230 km away from the volcano. It may be possible to consider that such phenomenon of abnormal audibility may be due to refraction of sound waves by a layered atmosphere.<sup>11)</sup> Curiously, the seismographs on the western slope of the central cone showed no explosion earthquake nor any other shock. The seismographs registered a microseism at 10:34 p.m., and recorded many microtremors from about 10:45 p.m. on June 29 to 0:55 a.m. on June 30. From about 10:45 p.m. until about 11:30 p.m. on June 29, the eruption reached its climax. Several columns of eruptive clouds were shot into the air from the southern rim of the Taisho crater, whose height could not be determined exactly, because of the darkness of night.

11) At Abuta, Date and Rusuttsu, many airshocks were felt from about 10:30 p.m. on June 29 until about 0:10 a.m. on June 30. Several panes were broken by these airshocks at Rusuttsu.

Some people said that it was about 4,000 m at the climax phase of the eruption, but other people believed it to be only several hundred metres. Large amounts of rock debris were ejected continuously, falling on the crater bottom and around the crater. During this climax phase, five men who were staying in the lodge of the sulphur mine, only 400 m away from the eruption spot, were killed by ejected debris and eleven men were injured. The entirety of ejected debris consisted of rock fragments derived from the crater-wall. They were ejected at rather low temperatures, so that the injured persons suffered no burns except for one man who suffered a very small burn on his finger. People at Shirogane Spa became so frightened by the sudden eruption that they moved down from the Spa immediately, worrying about possible occurrence of mud-flows. At about 0:30 a.m. on June 30, the eruption ceased except for the emission of white smoke raised to a height of about 300 m above the top of the crater-rim. After that the discharge of smoke diminished gradually until about 1:00 a.m. when no smoke from the crater could be seen. The accurate position of eruption spots could not be determined because of the darkness of night. It may be inferred that the eruption occurred along a line running in a NW-SE direction on the southern rim of the Taisho crater below the ridge of Mae-tokachidake, as in the following outbursts. Some people said that the first outburst occurred at the northern part of this line, but other people said it happened at the southern part. The writer considers that the eruption started at several points along this line ejecting a large amount of rock debris, judging from the distribution of the ejecta.

At 2:43 a.m. on June 30, the second outburst began with intense rumbling noise, shooting mushroom clouds of ash up to a height of about 10,000 m and ceaseless ejection of bombs and debris. The seismographs on the western slope of the central cone also recorded no explosion quake nor another shock at this time. The rising of clouds continued successively with a gradual increase of their height. At about 3:45 a.m., the eruption reached a climax phase, and the height of the ash columns rose to about 12,000 m or more. After that, shooting of ash clouds and ejection of bombs continued ceaselessly. At about 10:00 a.m. the height of eruptive clouds still reached about 10,000 m. From about 11:00 a.m., the intensity of eruption diminished gradually, decreasing the height of ash clouds. At about 2:45 p.m., the eruption produced a surge increasing the height of ash clouds, but by 3:30 p.m. the height of eruptive clouds decreased again to about 3,000 m. At 5:30 p.m. on June 30, the erup-

tion produced another surge.

The eruption occurred at several points on the southern rim of the Taisho crater along the line running NW to SE. Three cinder cones were built up with an intense ejection of bombs (Fig. 6). The cinder

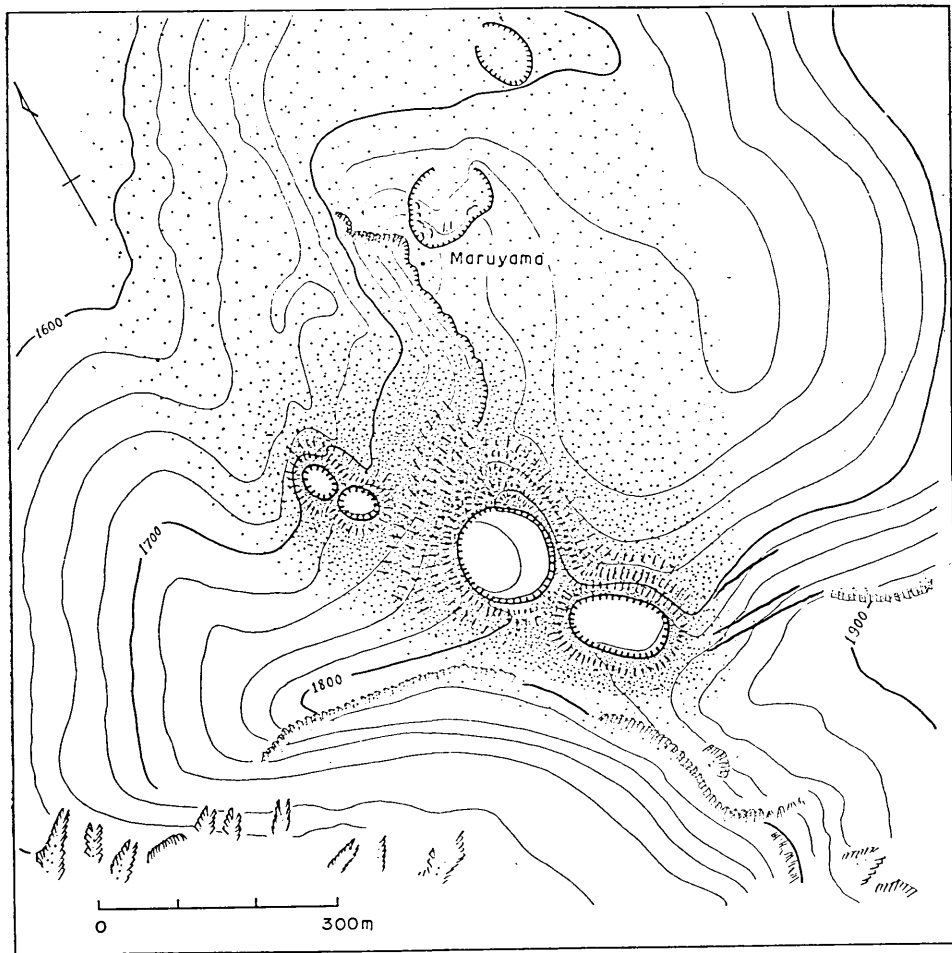


Fig. 6. Topographical sketch map of the Taisho crater and the surrounding area, after the eruption. Three cinder cones were formed on the southern rim of the Taisho crater.

cone in the middle was the largest and main one, which continued its activity to the last among the three. The cinder cone in the north was the smallest and ceased its activity first. Rock debris and bombs were shot out of the pits northwards, falling most heavily in the area



between the Showa crater and the ridge of Mae-tokachi-dake. The ash clouds thrown up into the air were carried to NNE by winds over the volcano, and then turned their direction immediately to ENE to E. About  $3 \times 10^7$  t or  $5 \times 10^7$  m<sup>3</sup> (as the density of ash is presumed 1.6) of ash was blown into the air by the eruption on June 29 and 30, with additional eruptions on the following days. This ash was carried by winds into an eastern quadrant, smoothing the vegetation over the land of about

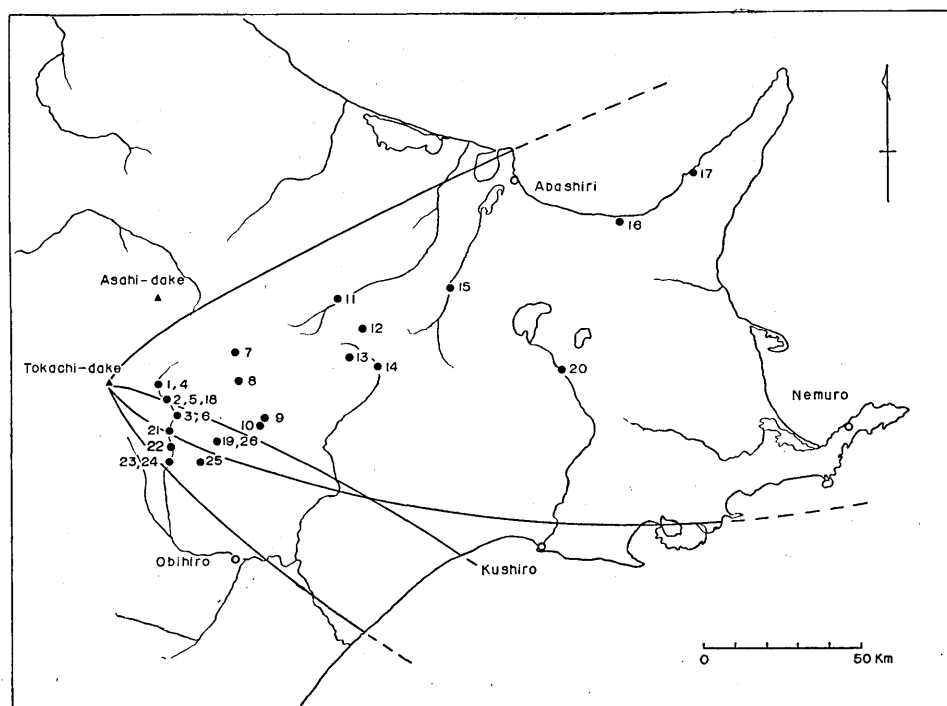


Fig. 7. Map showing the distribution of the ash-falls from the eruption of Tokachi-dake. Solid circles show the localities of collected specimens of ash-falls for mechanical analyses. The upper large distribution represents the ash-falls of June 29 and 30, 1962, and the lower small distribution represents the ash-falls of July 3, 1962.

$1.8 \times 10^4$  km<sup>2</sup> in the eastern district of Hokkaido, causing some damage to crops (Fig. 7). Heavy ash-falls fell on the eastern slope of the volcano. People in villages along the upper course of the Tokachi-gawa began to move southwards in order to avoid the ash-fall and sulphurous gases from the volcano. Some persons in this district began to have headaches and sore throats. Very few domestic animals were reported to have

died in the area of ash-falls. Some parts of ash clouds, especially those thrown up by the first outburst on June 29, fell on the area to the south of Mae-tokachi-dake, where the upper course of the Furano-gawa lies. The water of the Furano-gawa became remarkably acidic by the dissolving of sulphurous components in the ash-falls.

The heaviest ash-falls followed along the line having a direction of about  $N 65^{\circ} E$  from the volcano. They were brought mainly during the climax phase of the second eruption on the morning of June 30. At the northern part of Rikubetsu-machi, 105 km away from the volcano, the ash was falling heavily from 4:00 a.m. to 11:00 a.m. on June 30, and about  $150\text{--}300\text{ g/m}^2$  of ash was deposited until 11:00 a.m. on June 30.<sup>12)</sup> At Oketo-machi, 80 km from the volcano, the ash began falling at about 8:20 a.m. on June 30, and continued falling heavily from 10:00 a.m. to 8:10 p.m., and from 7:30 a.m. to 1:20 p.m. on July 1 the ash-fall recurred. At Shari-machi, 170 km away from the volcano, the ash began falling at about 10:00 a.m. on June 30, and from 2:00 p.m. to 3:30 p.m. fell most heavily, depositing about  $125\text{ g/m}^2$  of ash. It is considered that the ash created by the first eruption was carried to a position  $N 80^{\circ} E$ , while the ash ejected during the climax phase of the second eruption was carried mainly to a position  $N 65^{\circ} E$ , judging from the distribution of the ash-fall deposits and the reports on the situation of ash-falls. On July 3, another minor ash-fall followed along a line at about  $S 55^{\circ} E$  from the volcano. At Urimaku, Shikaoi-mura, 25 km away from the volcano,  $50\text{ g/m}^2$  of ash was deposited. The total mass of the ash-fall from the eruption of June 3 was calculated as  $1.5 \times 10^5\text{ t}$  and the volume as  $2.5 \times 10^5\text{ m}^3$  by the writer.

The eruption continued for several days with minor surges from July 1. Emission of ash and ejection of bombs continued ceaselessly chiefly from the middle cinder cone, which increased in intensity at 9:45 a.m. and 5:00 p.m. of July 1, and at 1:30 a.m. and 4:45 p.m. on July 2, etc. However, there followed a general diminution of the intensity of eruption. The amount of white vapour in the eruptive clouds began to increase from the afternoon of June 30, and the discharge of ash from the north cinder cone ceased on July 1. On July 2, the discharge of ash from the south cinder cone also ceased. On July 6, the discharge of ash from the last active cinder cone at the middle ceased, after which the eruption consisted only of emission of yellowish white vapour clouds

12) According to the report of the Rikubetsu-machi Public Office, the total mass of the ash-falls from the eruptions on June 29, 30, and July 1, with additional eruptions on the following days, reached about  $300\text{ g--}600\text{ g/m}^2$  in the northern part of the town.

instead of blackish ash clouds.

*Ejected materials* Almost the entirety of the ejected materials from the first eruption of June 29, 1962, did not belong to juvenile or

Table 1. The results of mechanical analyses of ash-fall deposits.

The result of a given specimen is noted in the column beneath its specimen number with weight per cent of each fraction.

$\phi$	1	2	3	4	5	6	7	8	9	10	11	12	13
~-1		1.5											
-1 ~ -0.5	5.5												
-0.5 ~ 0	20.0												
0 ~ 0.5	33.8	18.5											
0.5 ~ 1	28.0	34.2		0.6	1.2		3.0	0.1			1.7		
1 ~ 1.5	5.5	16.8			6.0		27.3						
1.5 ~ 2		9.5	10.0	8.4	11.3	5.0	39.5	2.6	0.3	0.1	19.8	10.0	0.4
2 ~ 2.5	2.5	5.2	13.0	19.3	20.5		21.7	13.3				53.3	27.4
2.5 ~ 3			12.5	18.9	19.0	17.0	5.8	17.8	14.2	3.8		15.5	40.1
3 ~ 3.5	1.5	0.8	9.8	31.7	11.5	10.0		11.0	18.5	7.7	9.7		22.5
3.5 ~ 4			9.7	9.7	9.3	10.8	1.6	10.3	18.5	15.4		14.5	17.5
4 ~ 4.5	1.0		8.7		7.7	13.8	1.1	10.2	19.5	16.5			12.0
4.5 ~ 5			9.0	5.9	6.8	13.1		10.2	18.0	17.0		6.8	8.2
5 ~ 6	2.2		15.1	5.5	6.7	23.8		18.0	9.3	30.7		5.7	9.6
6 ~ 7			12.2					6.5	1.7	7.5		4.5	7.2
7 ~										1.3			

$\phi$	14	15	16	17	18	19	20	21	22	23	24	25	26
~ 0		0.2											
0 ~ 0.5													
0.5 ~ 1					0.7							0.9	
1 ~ 1.5													
1.5 ~ 2	0.3	1.2		2.0	9.3	0.3		5.2	0.3			1.4	0.5
2 ~ 2.5	9.7	10.8			12.5		0.3						
2.5 ~ 3	20.1	61.2	8.3	11.8	11.0	10.9	5.3	15.7	5.7			2.6	4.0
3 ~ 3.5	22.9	15.0	19.7	43.4	10.8	14.8	25.8	16.9	18.2	18.7	17.3	16.4	15.6
3.5 ~ 4	13.5	4.2	16.8	21.8	9.9	19.3	19.6	25.9	26.0	18.2	19.0	28.7	20.7
4 ~ 4.5	10.2		14.6	9.7	9.3	21.2	11.7	17.8	17.8	14.5	19.2	20.0	14.4
4.5 ~ 5	7.8	2.5	11.9	5.6	8.9	23.3	9.6	10.3	23.1	12.4	17.0	11.0	12.1
5 ~ 6	10.5	1.5	18.2	5.7	15.3	10.2	15.0	7.4	11.5	14.4	14.0	10.3	16.7
6 ~ 7	5.0	1.5	10.5		12.3		9.0	0.8	5.4	7.9	4.2	8.7	9.3
7 ~		1.3					3.7			3.0	0.8		6.7

essential ones brought directly from the molten magma. The eruption is considered to have consisted of steam explosions which only threw out rock fragments around the eruption pits. Ejected debris was brought from the pre-existing rocks composing the top of the central cone. Most of them are decomposed andesitic rocks attacked by the fumarolic activity. They were thrown out with low temperature at the outbursts.

During the eruption of June 30 and for many days following, a large amount of bombs was discharged with some accessory and accidental ejecta, covering the area of about  $7 \times 10^5 \text{ m}^2$  to the north of Mae-tokachidake. The writer estimated the total volume of these ejecta as about  $1 \times 10^6 \text{ m}^3$ . There were many variations of shape and structure among the ejected bombs, from dense blocky ones to porous slaggy ones. It

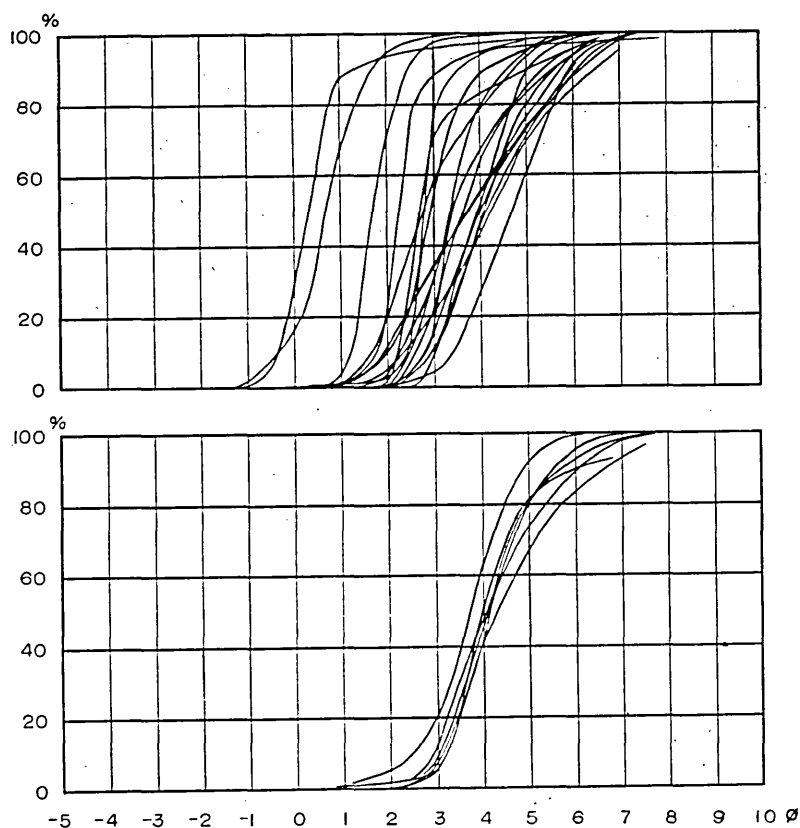


Fig. 8. Size distribution curves of the ash-fall deposits. Upper: Sp. nos. 1-20. Lower: Sp. nos. 21-26, ash-falls from the eruption of July 3.

may be inferred that the dense blocky ones were ejected at the initial and climax phase of the eruption, while the porous ones were ejected at the latter phase, judging from their distribution and sequence of deposition. The writer collected several specimens of ejected materials and examined the petrographic characteristics of them. Essential ejecta is composed of olivine-bearing hypersthene-augite andesite, although there are wide variations as regards the characteristics of constituent minerals from specimen to specimen. One specimen of flattened bomb consists of phenocrysts of bytownite ( $Ab_{28} An_{72}$ ,  $n_1=1.567$ ), augite, hypersthene, olivine and magnetite, and groundmass of pale brown glass ( $n=1.545$ ) with microlites. Another specimen consists of phenocrysts of labradorite

Table 2. Data on parameters of particle size distribution.

Sp. no.	$Md_\phi$	$Q'$	$Q''$	$M_\phi$	$\sigma_\phi$	$\alpha_\phi$	$\alpha_{2\phi}$	$\beta_\phi$	Date of sampling
1	0.40	0.33	-0.28	0.36	0.52	0.09	1.24	2.03	June 30, noon
2	0.75	0.44	-0.07	0.76	0.73	0.07	0.09	0.81	June 30, noon
3	3.74	1.27	0.20	3.97	1.74	0.13	0.27	0.38	June 30, noon
4	2.05	0.47	-0.11	1.98	0.70	-0.10	0.46	1.42	June 30, p. m.
5	2.76	0.81	0.53	3.12	1.21	0.30	0.43	0.58	June 30, p. m.
6	4.27	1.01	-0.20	4.12	1.42	0.11	-0.14	0.45	June 30, p. m.
7	1.75	0.35	0.06	1.78	0.53	0.05	0.28	0.61	July 1
8	3.76	1.12	0.19	3.98	1.48	0.15	0.25	0.52	July 1
9	3.96	0.67	-0.02	3.94	0.89	-0.03	0.07	0.66	July 1
10	4.70	0.76	-0.03	4.70	1.03	0.00	-0.03	0.52	July 1
11	2.27	0.24	0.04	2.30	0.41	0.06	0.30	1.37	June 30
12	2.77	0.45	0.70	3.23	0.91	0.50	1.35	1.09	June 30, a. m.
13	3.62	0.74	0.39	3.95	1.13	0.29	0.72	0.78	June 30, a. m.
14	3.43	0.75	0.53	3.82	1.15	0.34	0.63	0.62	June 30, a. m.
15	2.82	0.20	0.10	2.91	0.35	0.26	1.84	2.33	June 30
16	4.17	0.87	0.30	4.45	1.23	0.22	0.42	0.51	June 30, p. m.
17	3.42	0.42	0.10	3.52	0.72	0.13	0.39	0.96	July 1
18	3.80	1.27	0.15	3.99	1.75	0.11	0.23	0.42	July 2, p. m.
19	4.12	0.60	0.17	4.02	0.84	-0.13	-0.16	0.75	July 2
20	3.97	0.90	0.68	4.49	1.29	0.40	0.72	0.49	July 3
21	3.76	0.58	-0.21	3.69	0.91	-0.08	-0.15	0.81	July 4
22	3.99	0.63	0.46	3.27	0.97	0.74	0.69	0.88	"
23	4.09	0.81	0.30	4.37	1.23	0.23	0.55	0.59	"
24	4.14	0.67	-0.02	4.20	0.87	0.07	0.33	0.81	"
25	4.00	0.57	0.46	4.32	0.94	0.34	0.81	0.87	"
26	4.30	0.89	0.49	4.71	1.30	0.31	0.66	0.64	"

( $\text{Ab}_{35}\text{An}_{65}$ ,  $n_1=1.562$ ), augite, hypersthene, olivine and magnetite, and groundmass of pale-brown to coloreless glass ( $n=1.514$ ). The writer collected several kinds of accidental ejecta, those considered to have been brought from welded rhyolitic ash-flow deposits, those brought from sedimentary formations, and those brought from Tertiary andesitic rocks. They are considered to have been brought up from the basal rocks of the volcano, which are distributed up to an altitude of about 1,000 to 1,500 m above sea level.

The deposits of ash-falls had the same petrographic characteristics as those of the ejected bombs. The writer carried out mechanical analyses of some specimens collected from the ash-fall area. The localities of the specimens are shown in the map of ash-fall distribution (Fig. 7). The results of the mechanical analyses are shown in Table 1, where figures listed in the column represent the weight per cent of each fraction evaluated by the mechanical analyses. Fig. 8 shows the particle

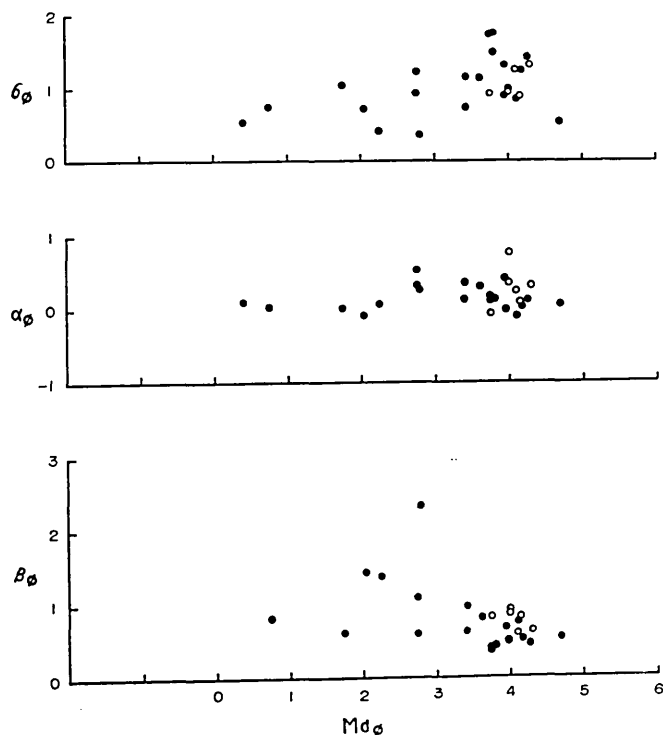


Fig. 9. Diagram showing the relation of the values of  $\sigma_\phi$ ,  $\alpha_\phi$  and  $\beta_\phi$  to the values of  $Md_\phi$ . Solid circles represent the values of Sp. nos. 1-20, and open circles represent the values of Sp. nos. 21-26.

size distribution of the specimens by cumulative curves. The diameter of particles in millimetres  $\xi$  are replaced here by  $\phi$  as expressed  $\phi = -\log_2 \xi$  for convenience. The values of parameters of size distribution curves are listed in Table 2. Here,  $Md_\phi$ ,  $Q'$  and  $Q''$  are median, deviation or sorting coefficient and skewness respectively, which are obtained by the quartile method, and  $M_\phi$ ,  $\sigma_\phi$ ,  $\alpha_\phi$  and  $\alpha_{2\phi}$ , and  $\beta_\phi$  are mean, deviation, skewness and kurtosis of the Inman's phi measure system (Inman, 1952).<sup>13)</sup> All of the specimens show the typical size characteristics of ash-falls. They show the regular grading of coarseness according to the distance from the volcano. Values of  $Md_\phi$  of collected specimens of the ash-falls of Jun 30 varied from 0.4 to 4.7. The deposits along a line N 65° E from the volcano showed smaller values of  $Md_\phi$  than those along other directions. This may indicate that the ash-falls during the climax phase of the eruption might have followed this direction. The ash-fall deposits of July 3 were more fine-grained. The  $Md_\phi$  values of these deposits in the near vicinity of the volcano were 3.7 to 4.3, far larger than those of the ash-falls of June 30. All specimens showed well-sorted size distribution. The values of  $\sigma_\phi$  are in a range of 0.52 to 1.75, all belonging in a range below 2. The values of  $\alpha_\phi$  and  $\alpha_{2\phi}$  tend to fall in the positive area. This represents the fact that the modal fraction of size distribution tends to lie on the coarser side than the median. The value of  $\beta_\phi$  varies widely around the value of the normal distribution of 0.65.

### Summary

The activity of the volcano seems to have increased in intensity since 1952, when the fumarolic activity on the southern slope of the Suribachi crater recurred. In 1962, the fumarolic activity in the Taisho crater increased remarkably, and since late April preliminary earthquakes have occurred frequently in the area around the volcano. The first outburst of June 29, 1962, is considered to have consisted of steam explosion, which ejected rock debris from the southern rim of the Taisho crater. During the period prior to the outburst, the amount of ground water beneath the volcano had increased by the melting of snow due to the warm climate of May and June. This was suggested by the gush of muddy water at the foot of the eastern wall of the Taisho crater, on the southern slope of the Suribachi crater and on the western side of the

13) D. L. INMAN, "Measures of describing the distribution of sediments," *Jour. Sed. Petr.*, **22** (1952), 125-145.

central cone. It may be possible to consider that such filling of water in the ground might induce the steam explosion. After the first outbursts of steam, a rapid rising of magma column followed resulting in the second eruption of June 30 and several days following, which consisted of intense discharge of ash and bombs with many accessory and accidental ejecta.

## 12. 昭和 37 年 6 月 29, 30 日の十勝岳火山の噴火について

地震研究所 村 井 勇

十勝岳火山は大正 15 年 (1926 年) の大爆発以降しばらくの間噴火を続け、昭和 3 年 (1928 年) 12 月の小噴火を最後にして活動を休止していた。それ以後は新たに生じた爆裂火口 (大正火口または新噴火口と名づけられた) 内に多数の噴気孔が生じ、噴気活動を続けていた。昭和 27 年 (1952 年) に摺鉢山南側斜面上の古い噴気孔が活動を再び開始していら (昭和火口または新々噴火口と呼ばれた)、大正火口の噴気活動はしだいに活発化する傾向を示してきた。昭和 37 年 (1962 年) に入つて、大正火口の噴気は強まり、特に 5 月 23 日の広尾沖地震以来、その温度は上昇し、ガス含有量も増加してきた。また火口附近や山麓一帯で地震を頻繁に感じるようになった。大正火口の南壁上に昭和 30 年 (1955 年) 頃より亀裂を生じていたが、今回の噴火の直前にはその中から  $86^{\circ}\text{C}$  の噴気が認められ、またその附近に新たにいくつもの亀裂が生じた、大正火口の噴気孔の噴気量は噴火直前にこれまでの 3 倍以上になったといわれている。

噴火は 6 月 29 日午後 10 時 15 分頃より始まつた。最初低い鳴動が聞えはじめ、白煙が立ちはじめた。10 時 30 分頃には鳴動は大きくなり、岩塊を飛ばしはじめた。10 時 42 分頃烈しい鳴動、火柱、電光を伴つて噴火はますます烈しくなつた。噴火の起つた地点は大正火口南壁上であるが、夜間のため正確な位置は判明しなかつた。10 時 45 分頃より 11 時 30 分頃までは烈しい噴火が続き、その間大正火口附近の硫黄鉱山宿泊所では、落下してきた岩塊に打たれ 5 名が死亡し 11 名が負傷した。6 月 30 日午前 0 時すぎには噴火はほとんどおさまリ、わずかに白煙が立つのみとなつたが、午前 1 時頃にはその噴煙もおさまつた。

6 月 30 日午前 2 時 43 分再び烈しい噴火が始まつた。噴煙は 10,000 m に達し午前 3 時 45 分頃には更に 12,000 m あるいはそれ以上に達した。噴煙は絶えまなく吹き上げられ、同時に多量の火山弾が抛出されて、噴火地点には 3 個の噴石丘が形成された。噴火口は大正火口南壁上、前十勝岳の後線の下にほぼ一線上に並び、それらが時には同時にまたは交互に噴煙を吹き上げた。午前 11 時以後、噴煙の高さはしだいに低まり、白煙がしだいに量を減してきた。しかし噴煙の上昇と火山弾の抛出は依然として続いた。午後 2 時 45 分噴火は再び勢力を増したが、すぐに衰え、その後も噴煙の上昇と火山弾の抛出は絶え間なく続き、30 日午後 5 時 30 分、7 月 1 日午前 9 時 45 分および午後 5 時、7 月 2 日午後 1 時 30 分および 4 時 45 分などに勢力を再び増したが、7 月 6 日まで続いて止んだ。

抛出された火山弾と岩塊は前十勝岳の後線より北方、昭和火口に至る間に厚く堆積し、大正火口底のくぼみはほとんど埋つてしまつた。3 個の噴石丘のうち中央のものは最も大きく成長し、最後まで噴煙をあげていた。上空高く吹き上げられた火山灰は、風にのつて東方ないし東北東方へ運ばれ、北海道東部の諸地方をおつた。その総量は  $3 \times 10^7 \text{ t}$  または  $5 \times 10^7 \text{ m}^3$  (比重を 1.6 として) と計算された。

6 月 29 日夜の第 1 回目の噴火の際に抛出された岩塊はすべて大正火口南壁上の岩石より由来したもので、温度は低く、このため負傷者の内ただ 1 人が指に小さな火傷を受けたほかは、全く火傷はなかつた。この噴火は水蒸気爆発で、新しい物質を抛出しなかつたと考えられる。十勝岳では 5 月、6 月の季節に融雪のため地下水が非常に多くなる。今回の噴火の直前にも、大正火口の内部および周囲から泥水の湧出が認められている。このような地下水の増加が、この噴火の誘因の 1 つになつたと考えられる。6 月 30 日朝の第 2 回目の噴火は、火山灰、火山弾の烈しい噴出によつて始まつた。多孔質の粘性の比較的低い火山弾が絶え間なく抛出された。これらはいずれも橄欖石含有複輝石安山岩であり、中には極めて多孔質なものも認められた。多量の類質および異質抛出物を伴い、異質抛出物の中には、この火山の基盤を構成する堆積岩、火砕流堆積物や第三紀火山岩より由来したと認められるものが多量に見い出された。



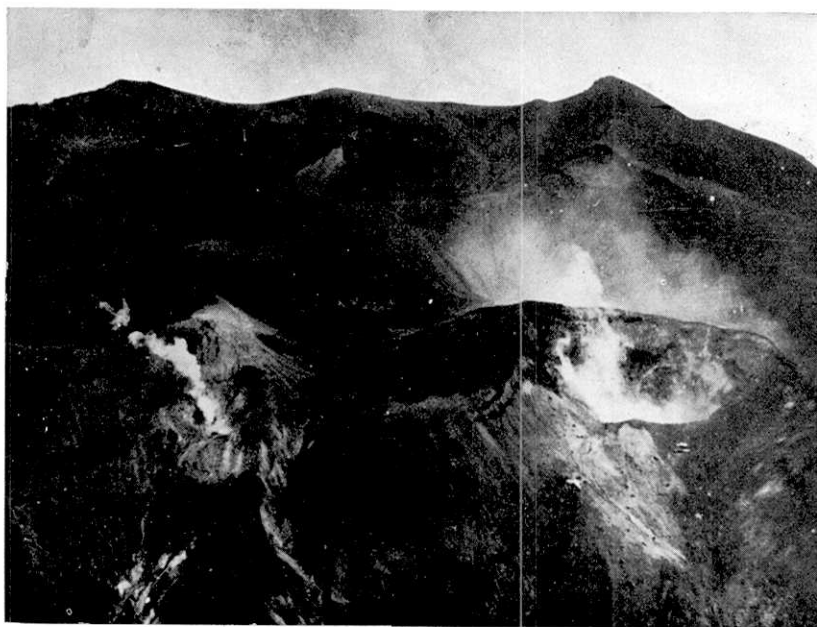


Fig. 10. Aerial view of the volcano before the eruption of June 29, 1962, taken from the west. (Photo. by The Yomiuri)

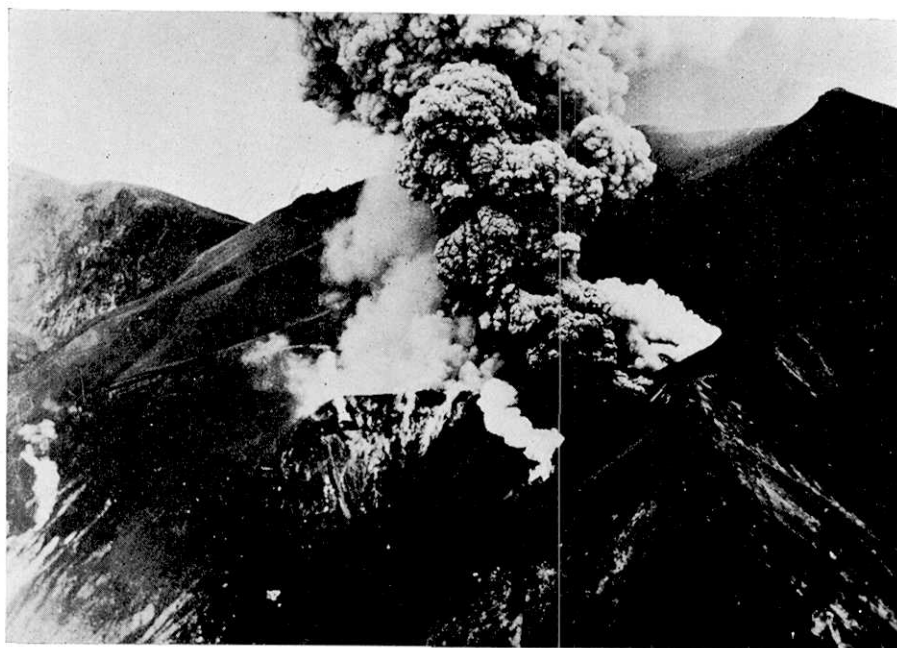


Fig. 11. Aerial view of the volcano on June 3, 1962, taken from the west. (Photo. by the Self Defence Force)

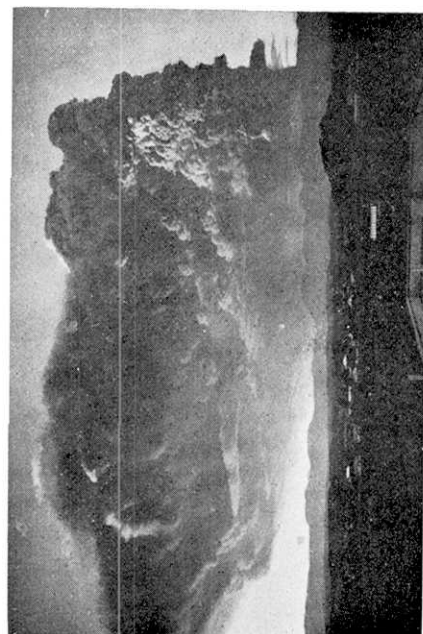
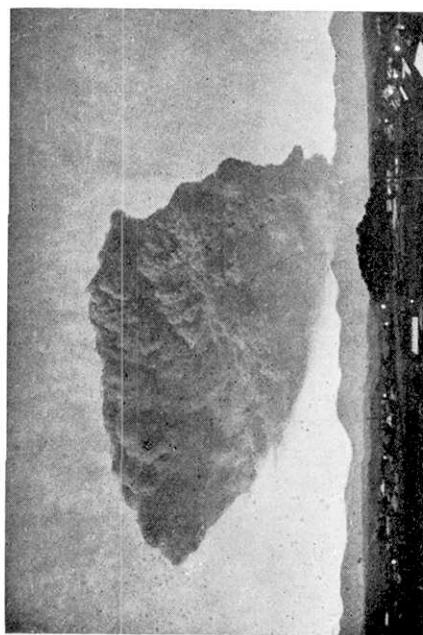
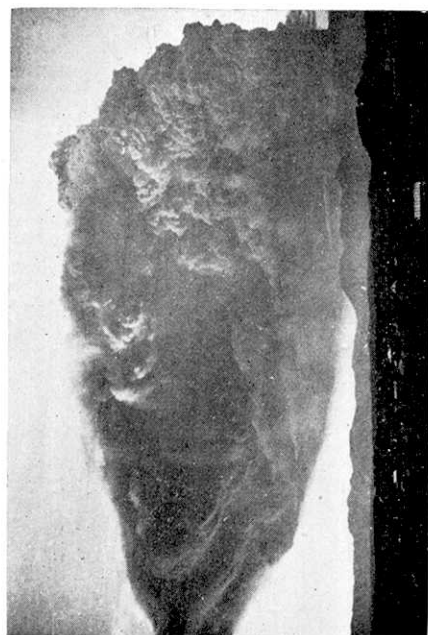
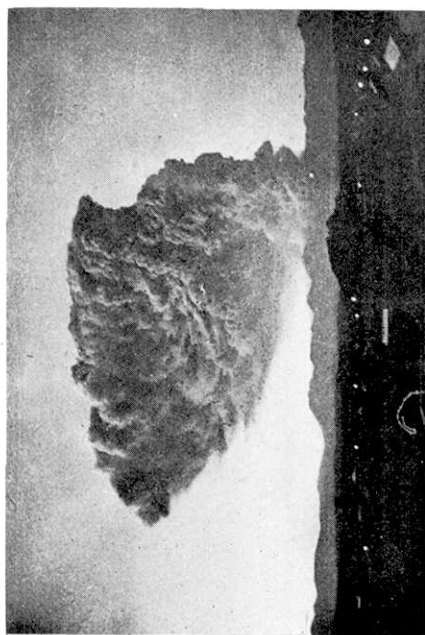


Fig. 12. Successive views of the second eruption that began at 2:43 a.m. on June 30, 1962, taken from the town of Kami-furano. (Photo. by The Hokkai Times)

[I. MURAI]

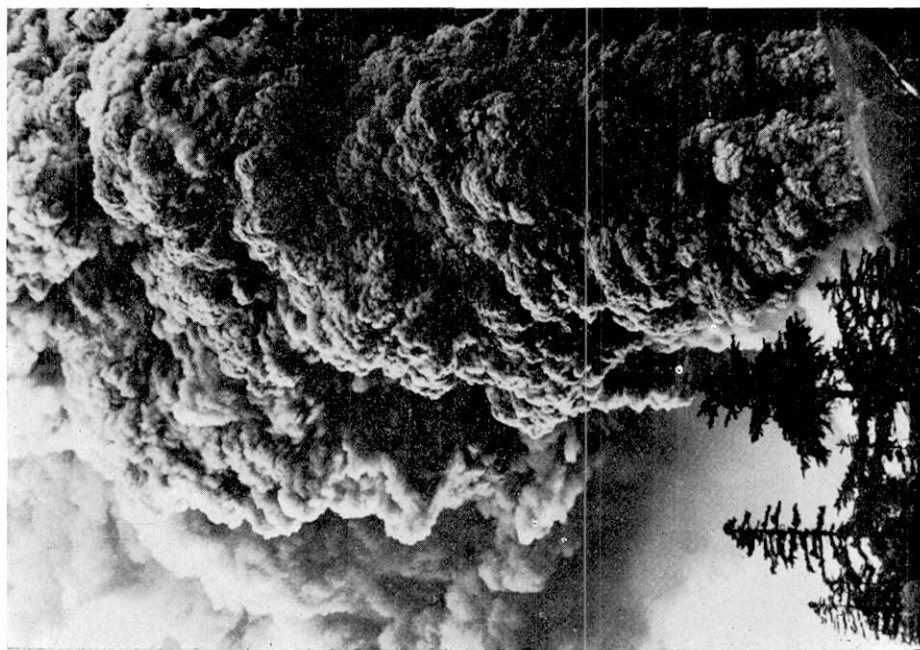


Fig. 13. Eruptive clouds at about 4:00 a.m. on June 30, 1962, viewed from Hakugin-so. (Photo. by Mr. Aida)

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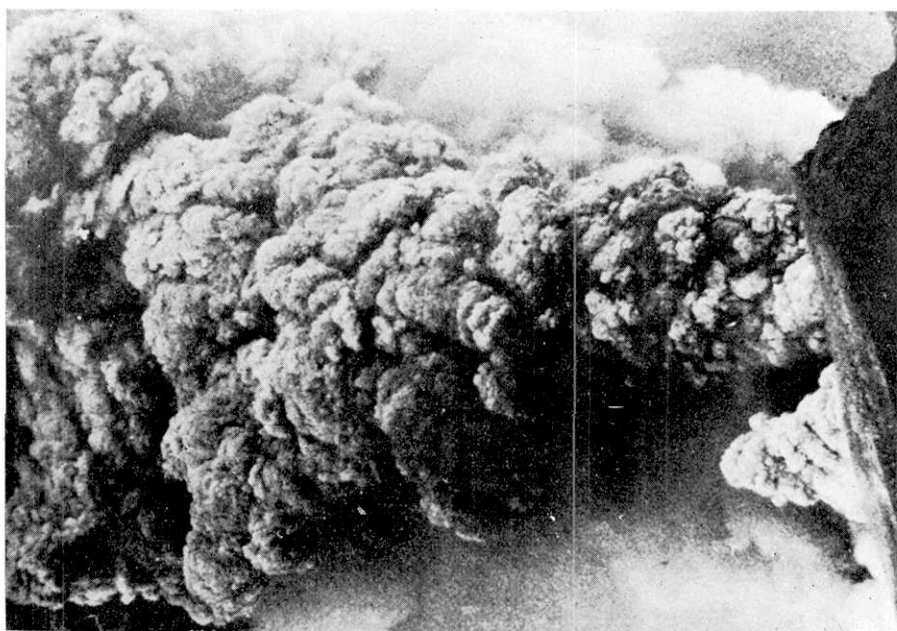


Fig. 14. Eruptive clouds at about 8:00 a.m. on June 30, 1962, viewed from Sandan-yama. (Photo. by Mr. Aida)

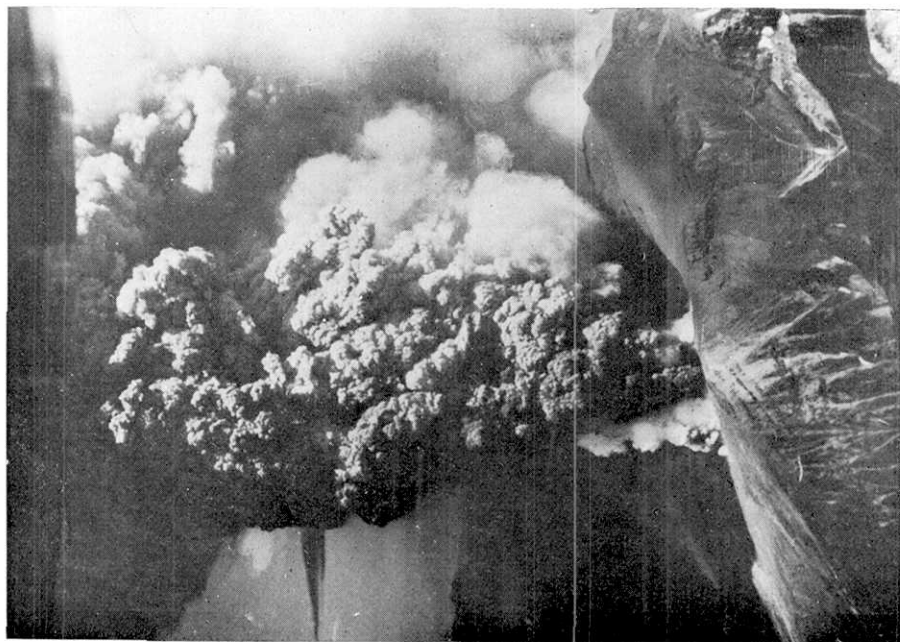


Fig. 15, Aerial view of the eruption at 4:20 p.m. on June 30, 1962, taken from the south. (Photo, by The Yomiuri)

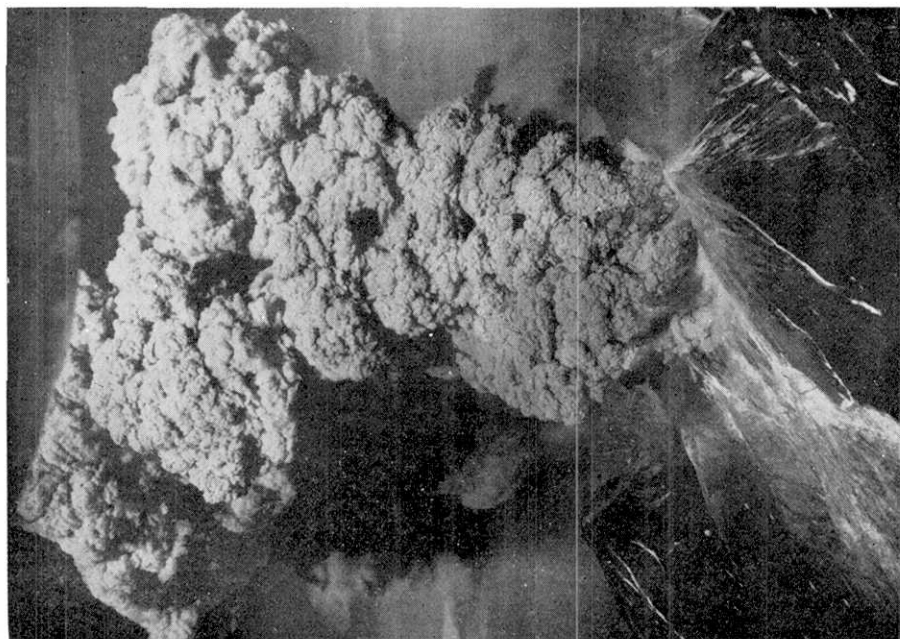


Fig. 16, Aerial view of the eruption at 11:30 a.m. on June 30, 1962, taken from the south-west. (Photo, by The Yomiuri)

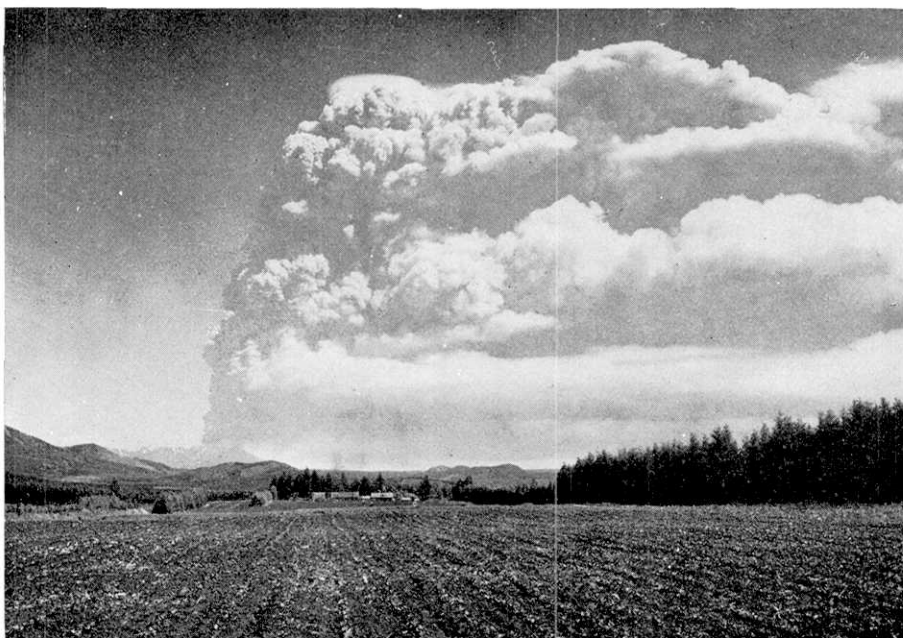


Fig. 17. Eruptive clouds at the climax phase, at about 10:00 a.m. on June 30, 1962, looking from the town of Shintoku. (Photo by Mr. Ozeki)



Fig. 18. Eruptive clouds in the afternoon of June 30, looking from the west.



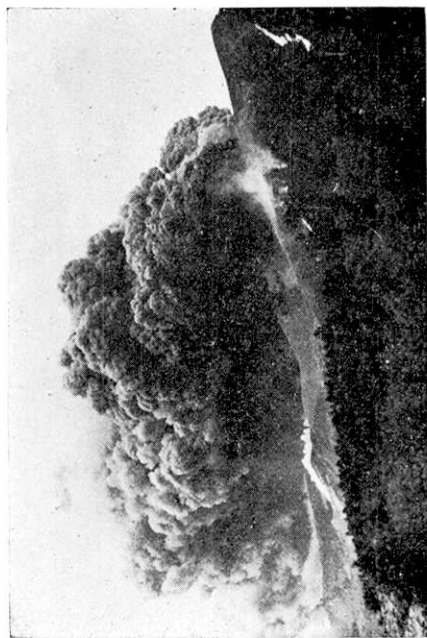


Fig. 19. The eruptive clouds on the morning of July 1, 1962, looking from Hakugin-so. Trees on the western side of Mae-tokachi-dake were burned by the falling of bombs. (Photo. by The Hokkai Times)

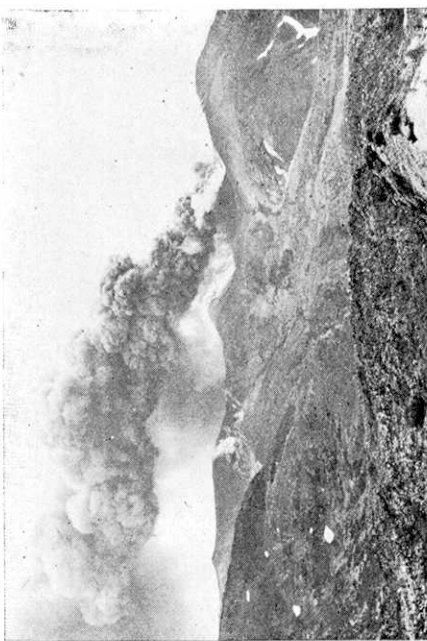


Fig. 21. The eruptive clouds at 11:00 a.m. of July 3, looking from Bogaku-dai, on the north-western slope of the volcano.



Fig. 20. A night scene of ejection of bombs, looking from Kiyotomi to the west of Shirogane Spa at 9:30 p.m. on July 2.

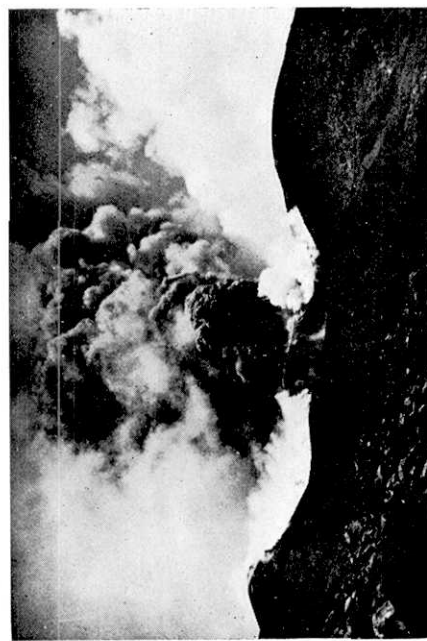
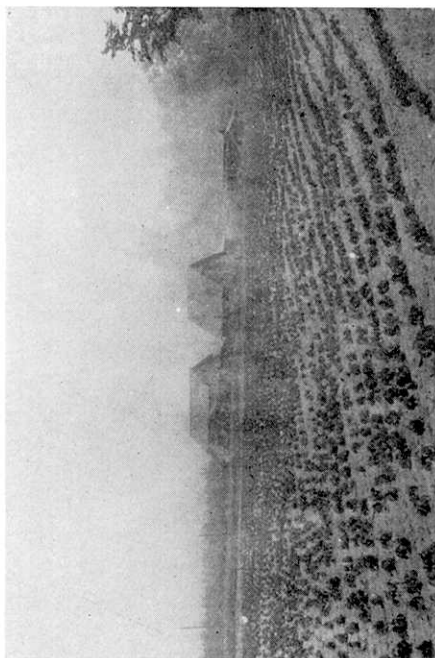


Fig. 22. The eruptive clouds on the morning of July 4, looking from the western slope of the central cone. (Photo. by the Tokachi Sulphur Mine)

[I. MURAI]



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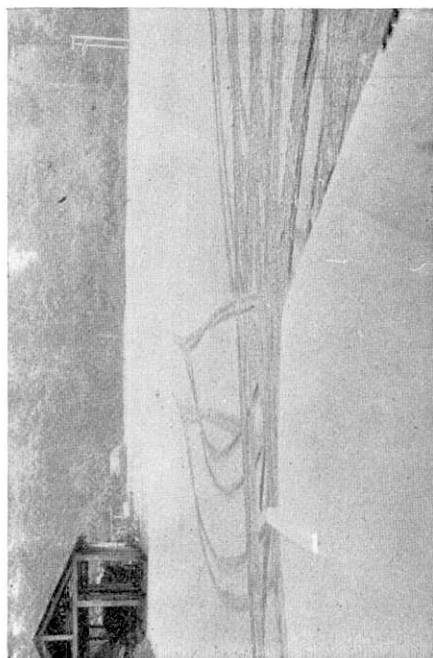


Fig. 23. Ash-falls at Tomuraushi in Shintoku-machi, to the east of the volcano, on June 30, 1962.  
People began to move southwards in order to avoid the ash-falls.

(震研彙報 第四十一号 図版 村井)



Fig. 24. The eastern wall of the Taisho crater half-buried by new ejecta.

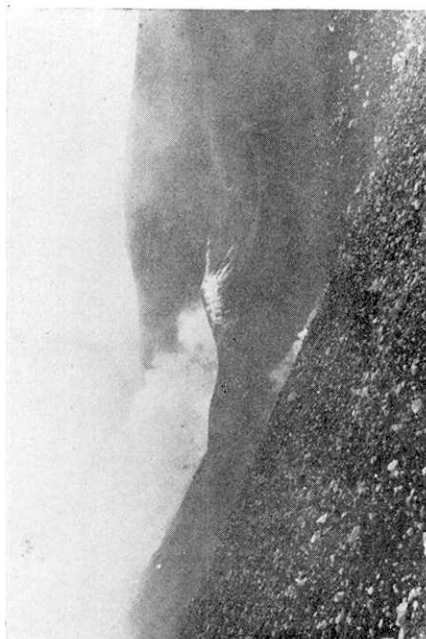


Fig. 26. The new cinder cone formed on the southern rim of the Taisho crater.

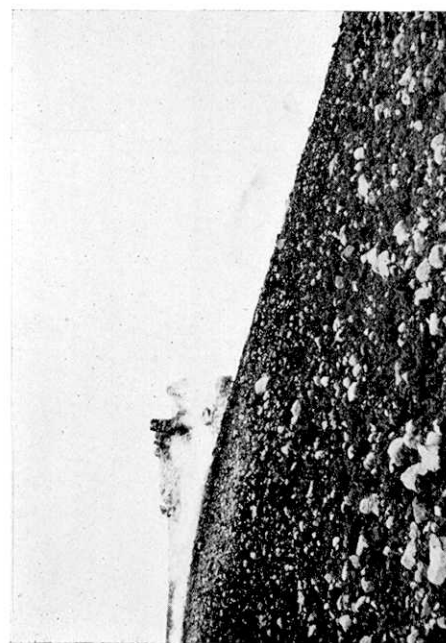


Fig. 25. The northern rim of the Taisho crater.

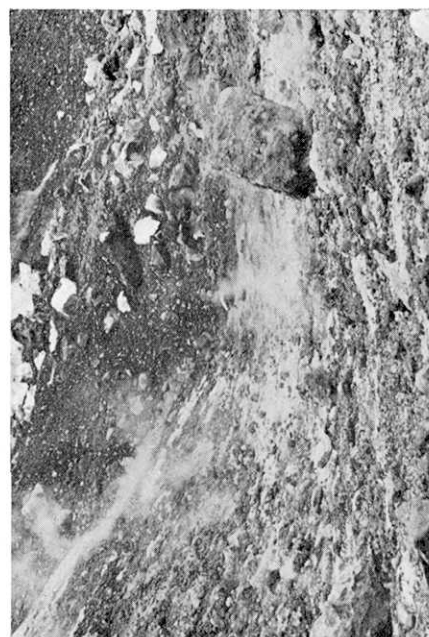


Fig. 27. The bottom of the Taisho crater buried by new ejecta.





Fig. 28. New cinder cones formed on the southern rim of the Taisho crater. (Photo. by the Tokachi Sulphur Mine)



Fig. 30. Ejecta accumulated on the northern slope of the central cone. (Photo. by the Tokachi Sulphur Mine)

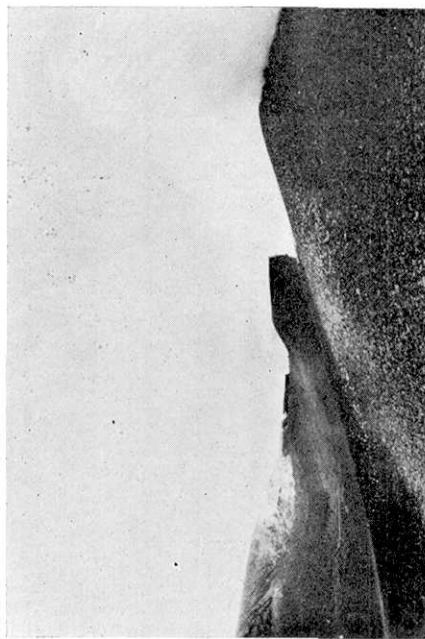


Fig. 29. Ditto. (Photo. by the Tokachi Sulphur Mine)

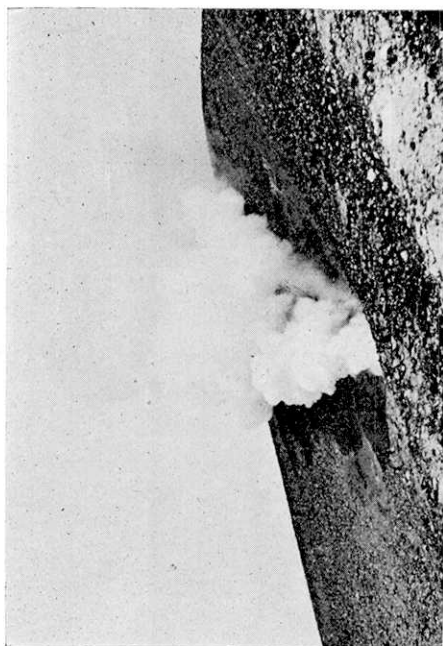


Fig. 31. The fumarole of the Showa crater, after the eruption.



Fig. 32. Ejected bombs on the western side of the central cone.



Fig. 34. Ejected bombs and debris beneath the western rim of the Taisho crater, at the position of the lodge where five men were killed by ejected debris.



Fig. 33. Ditto.



Fig. 35. Ditto. A rope-way support was destroyed by ejected debris.

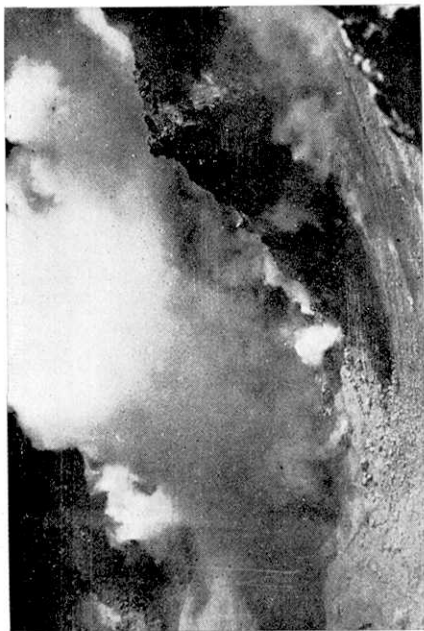


Fig. 36. The mining field of the sulphur mine on the bottom of the Taisho crater at about 10 : 30 a.m. on June 29, 1962, looking from the southern rim of the crater. (Photo. by the Tokachi Sulphur Mine)

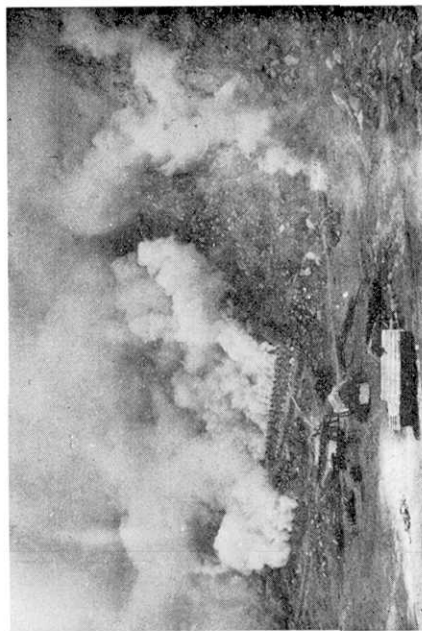


Fig. 37. Ditto. (Photo. by the Tokachi Sulphur Mine)

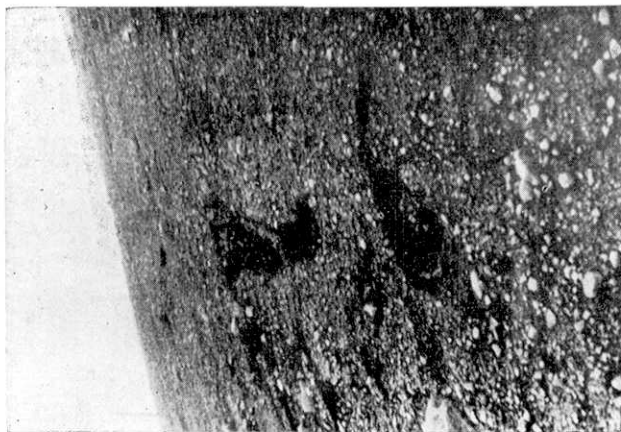


Fig. 38. A new fissure on the eastern rim of the Taisho crater, on June 29, 1962. (Photo. by the Tokachi Sulphur Mine)

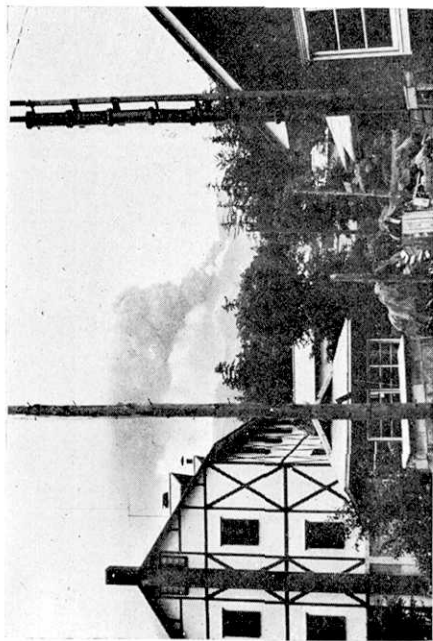


Fig. 39. Eruptive clouds looking from Shirogane Spa, where people moved out westwards anticipating an attack of mud-flows which never occurred during the eruption of June and July, 1962.

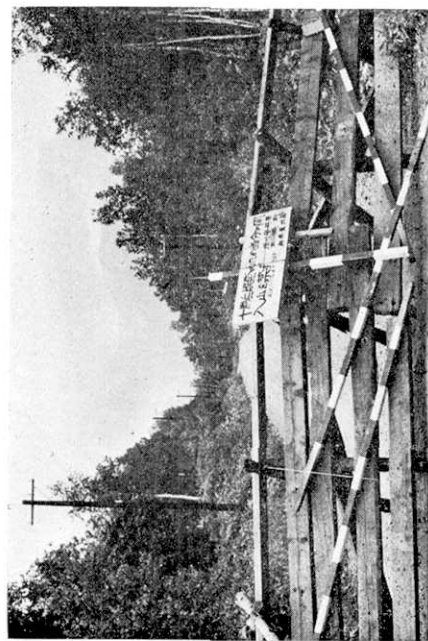


Fig. 40. Fence built up in order to shut out the traffic on the route to the volcano, near Shirogane Spa.

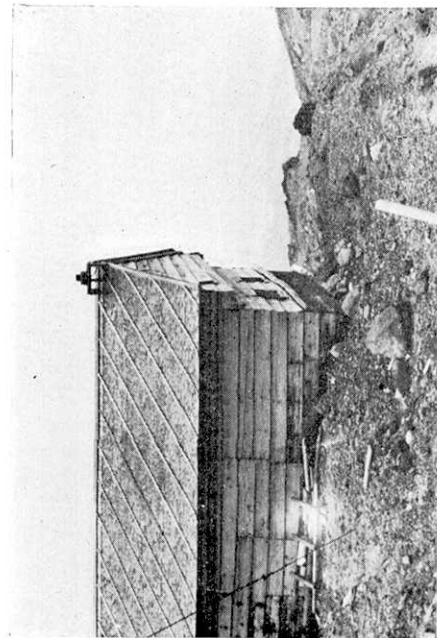


Fig. 41. Seismograph station on the western slope of the central cone, about 800 m away from the Taisho crater.

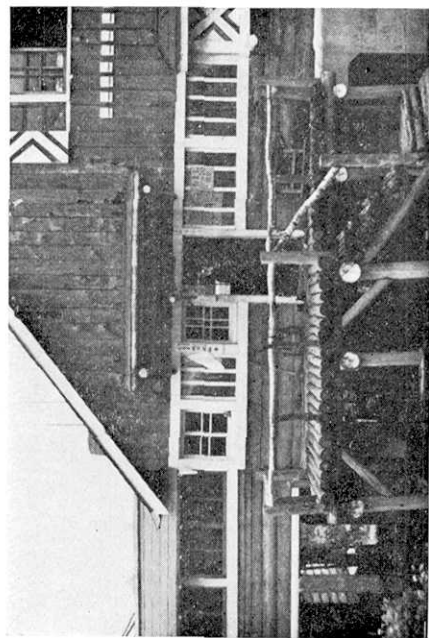


Fig. 42. Hakugin-so, a lodge lying on the western slope of the volcano, about 3 km away from the Taisho crater. Here the volcanologists of the University of Hokkaido continued seismometrical observation immediately after the eruption.

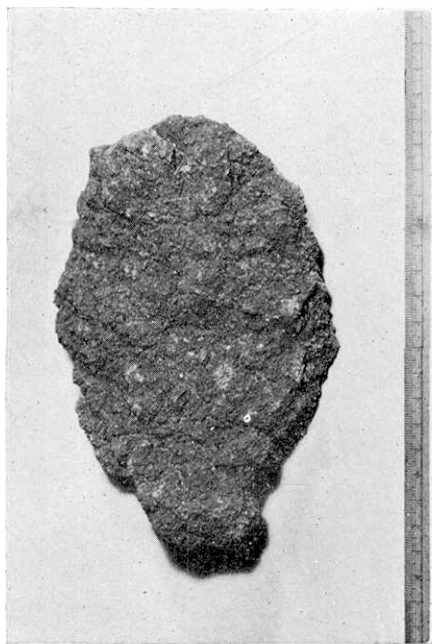


Fig. 43. Flattened bomb.

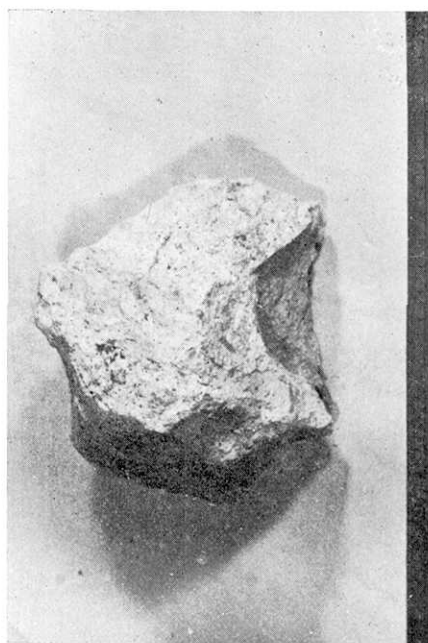


Fig. 45. White accidental ejecta derived from sedimentary rock.

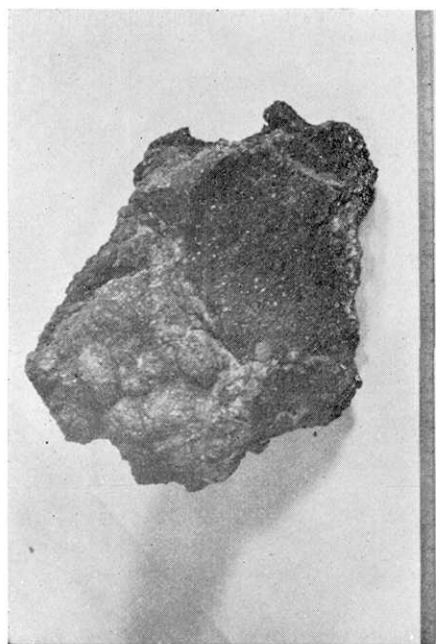


Fig. 44. Dense blocky bomb.

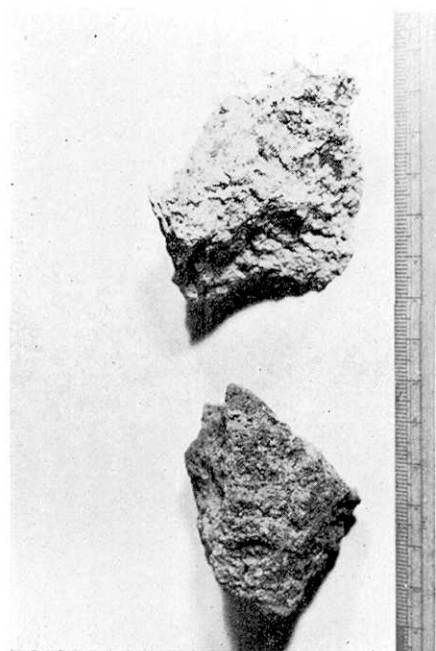


Fig. 46. Porous xenolithic ejecta (left) and white porous accidental ejecta derived from ash-flow deposits (right).



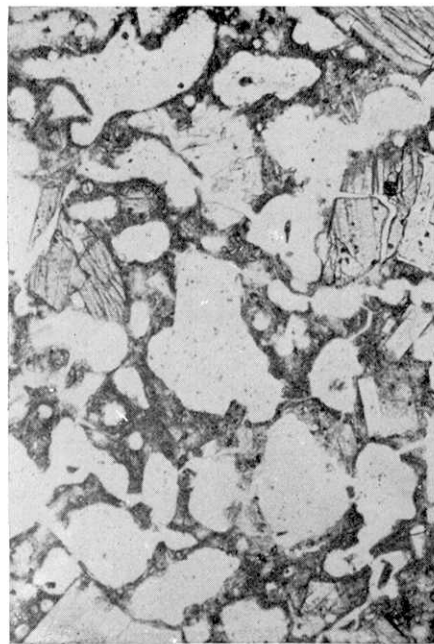


Fig. 47. Microscopic photograph of flattened bomb.  
( $\times 70$ )

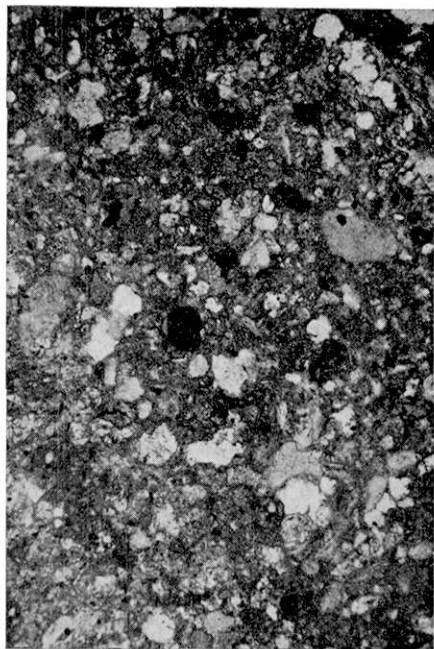


Fig. 49. Microscopic photograph of white accidental ejecta.  
( $\times 70$ )



Fig. 48. Microscopic photograph of dense blocky bomb.  
( $\times 70$ )

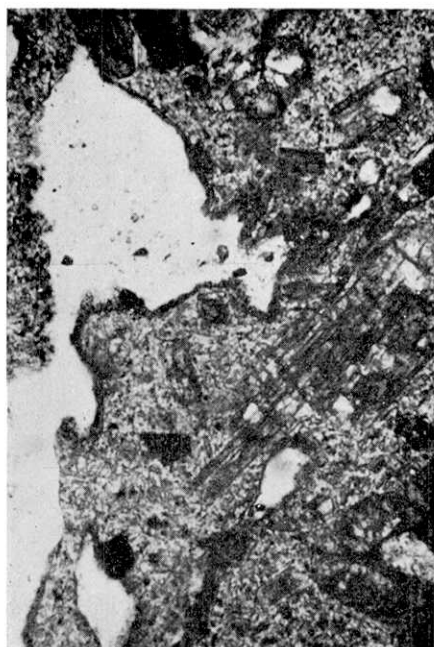


Fig. 50. Microscopic photograph of porous xenolithic ejecta.  
( $\times 70$ )