Report of the 1962 Activity of Yakedake Volcano, Central Japan

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Introduction

After a period of quiescent period since 1939, Yakedake Volcano began an activity with a big explosion in the evening of June 17, 1962.

Yakedake is well-known because it is the only volcano now active in Japan Alps, and is located near Kamikochi, an entrance to the Japan Alps (**Fig. 2**), and because of its notable explosion of 1915, when the Azusa river was dammed up by the mud-flows to produce Taisho-ike (namely a small lake built in Taisho era in Japanese).

The results of geologic studies and the records of activities during historic time before 1932 were published by two authors (Kato 1912, and Kodaira 1932) and recently a study on chemical alteration having take place around fumaroles was also made (Ossaka 1961).

Immediately after the news of the first explosion reached us, we visited by turns Kamikochi for about ten days to watch the progress of activity since the first explosion. Although we went at times close to the volcano to make certain observations, we made no special research for the volcanological purposes.

We are only to report here the sequence of volcanic events of 1962 and at this time to re-examine the historical records of explosions.

The members who jointed in these surveys will be listed up in the following:

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and some students of geology of our Department; T. Kobayashi, H. Kagami, T. Nasu, T. Takada, K. Matsui, A. Nakagawa, and K. Minagawa.

Besides, we must record gratefully that we have been co-operated by T. Fujita.

I Geographic and Geologic Settings

Yakedake Volcano is situated about 35 km west of Matsumoto (**Fig. 1, 2**), and in a highly mountainous area, rising up to 2,455.4m above sea level. It adjoins Warudani Volcano (2,224m) on its NNE and Shiratani Volcano (2,182m) on its SSW. The latter two volcanoes, however, have been destroyed by dissection, whereas Yakedake Volcano has built up lava dome like a temple bell, and has been active.

The volcano is underlain by the Palaeozoic sediments composed of slate, chert, and sandstone with subordinate schalstein and limestone and such Mesozoic igneous rocks as granodiorite, granite porphyry, hornblende porphyrite and liparite. These Palaeozoic formations are generally striking NNE-SSW and dipping northwestward, and are exposed widely on eastern, southern, and western mountainous area. Mt. Hotaka and Mt. Yari etc. are precipitous high mountains made of porphyrite above-mentioned, whereas the main extent of distribution of granitic rocks is in far northern area where they built up many high peaks of northern part of the Japan Alps (Geological Map of Nagano Prefecture, scale 1:200,000, 1962).

Yakedake is a massive volcano and composed of several lava sheets and tuff-breccia. Kato (1912) divided these volcanic formations into three main formations, namely the lowest tuff-breccia formation, the lower lava formation, and the upper lava formation. Both the upper and the lower lava formations were divided respectively into two lava flows. Although some portion of these formations are exposed in high walls of gullies, the youngest lava, namely the upper lava of Yakedake, occurs around the summit of Yakedake. All of these are identified petrographically to biotite bearing hypersthene-hornblende andesite, especially biotite is rich in the upper lava.

The volcano belongs to the so-called the Norikura Volcanic Zone running along the central axis of the Japan Alps. On the southern part of this volcanic zone, there are two large volcanoes as Ontake and Norikura rising up to 3,063 m and 3,026.3 m respectively above the sea level. Other volcanoes belonging to this volcanic zone are Momisawa-dake, Washiba-dake, Warimo-dake, Jii-dake of Kumono-taira, Shirouma-norikura-dake, Kazafuki-yama, Ebira-dake, and Tateyama. All of these volcanoes

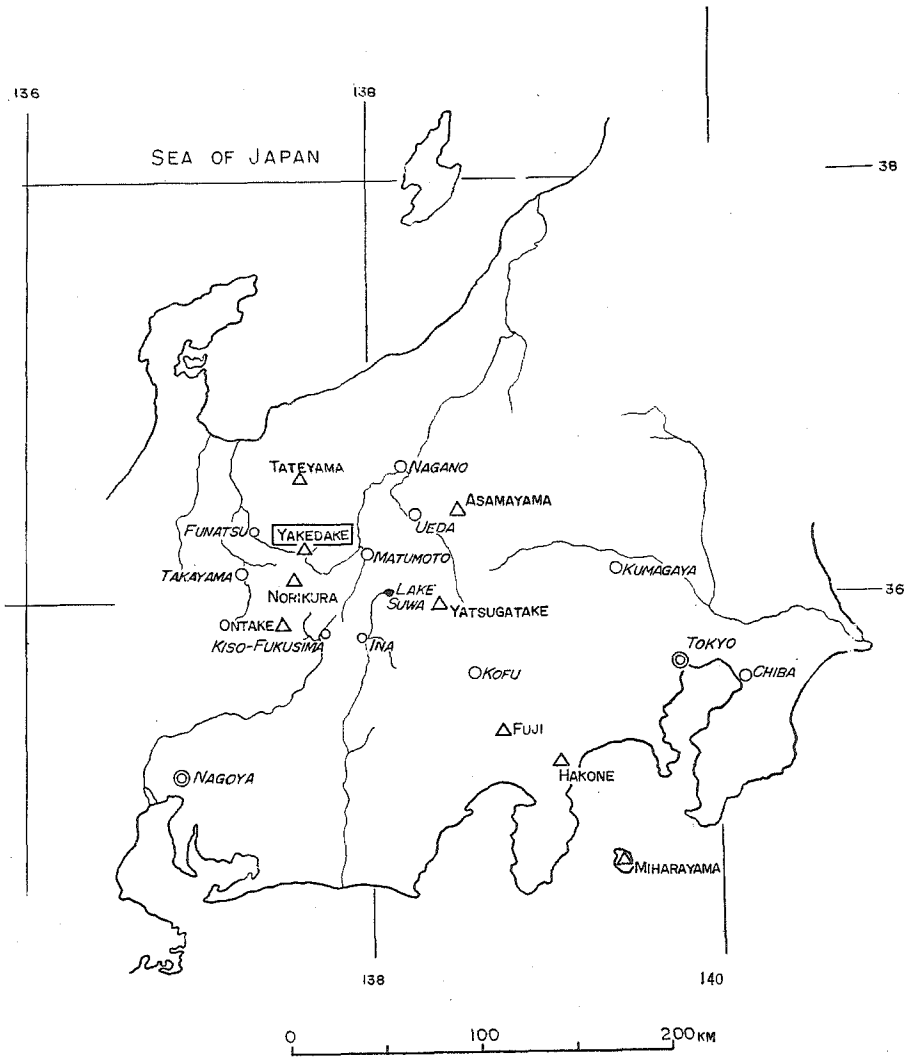

Fig. 1. Index map showing the position of Yakedake Volcano

are located on the north of Yakedake but are smaller and less higher than the Ontake and Norikura. (**Fig. 2**)

Characteristics of the Norikura Volcanic Zone from geologic view points are as follows.

1) These volcanoes are underlain by the Palaeozoic sediments, granitic intrusives and Mesozoic volcanic rocks erupted widely. Basement of these volcanoes forms high mountains, accordingly some volcanoes are perched upon the high surface of the basement.

2) Ejecta from these volcanoes is characterized by hypersthene-horn-

blende andesite and biotite bearing andesite.

3) Modern activities of the Norikura Volcanic Zone are recognized only as fumarolic activities taking place in Yakedake, Jigoku-dani of Tateyama and somewhere near Ontake volcano. The geologic time when those volcanoes erupted strongly to construct their main bodies of volcanic cones is supposed to be since the Middle Pleistocene. Ashes and pumices supplied from these volcanoes accumulated thickly in the eastern area and the deposits are called *Shinshu Loam* (K. Kobayashi, 1960)

4) Original forms of most of these volcanoes were later destroyed by the formation of some explosive craters.

Yakedake has several explosive craters (Plate 12 and **Fig. 3**). Kato (1912) and Kodaira (1932) described already these craters in details. One of these is found on the northern side of the highest point of Yakedake, about 200 m long (E–W) and 150 m wide (N–S) surrounded by crater walls partly 100 m in height. There is an evidence for that the crater was covered by vegitations before the explosion of the Meiji era. The trunks of pine-trees damaged at this occasion indicated that the growth of pine-trees lasted more than 200

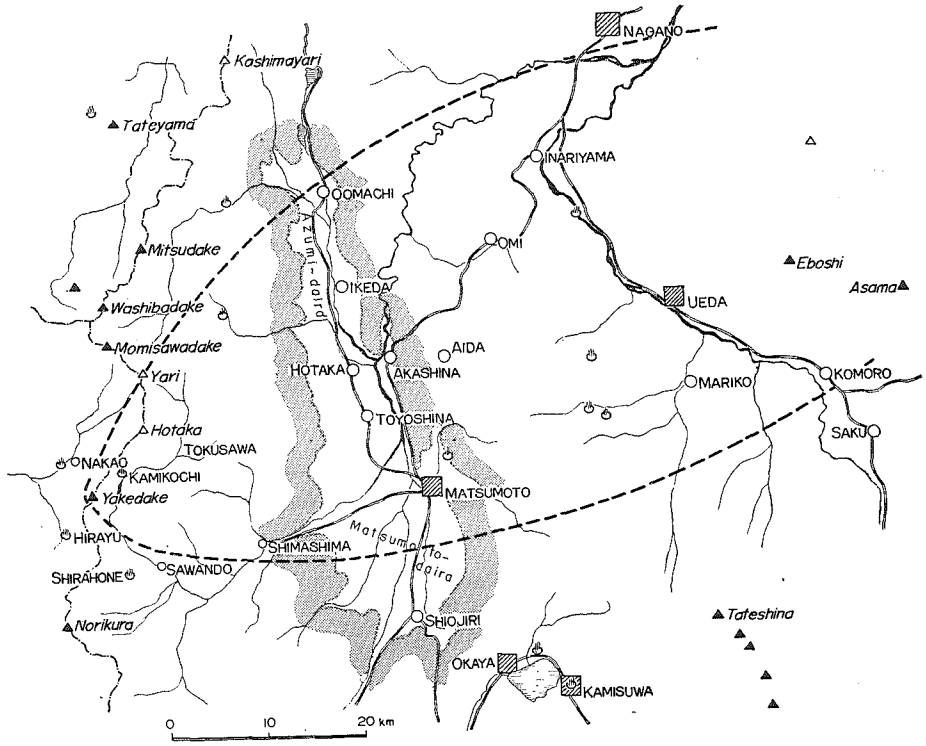

Fig. 2. Map showing the locations of the volcanoes of Quarternary (▲), and towns in the northern Nagano Prefecture, and the ash area by the explosion of June 17, 1962 (enclosed by blocken line)

years. Therefore, it seems that this volcano might have domant period of more than 200 years before the explosion of the Meiji era.

Owing to the explosion of 1911, an explosive crater in small size, about 100 m long (E–W) and 50 m wide (N–S), was formed on the northern margin of the old crater, and the newly formed craterlet is called Inkyo-ana. The bottom of the old crater has been buried with ashes and rock-fragments supplied by later explosions and by collapses of crater walls.

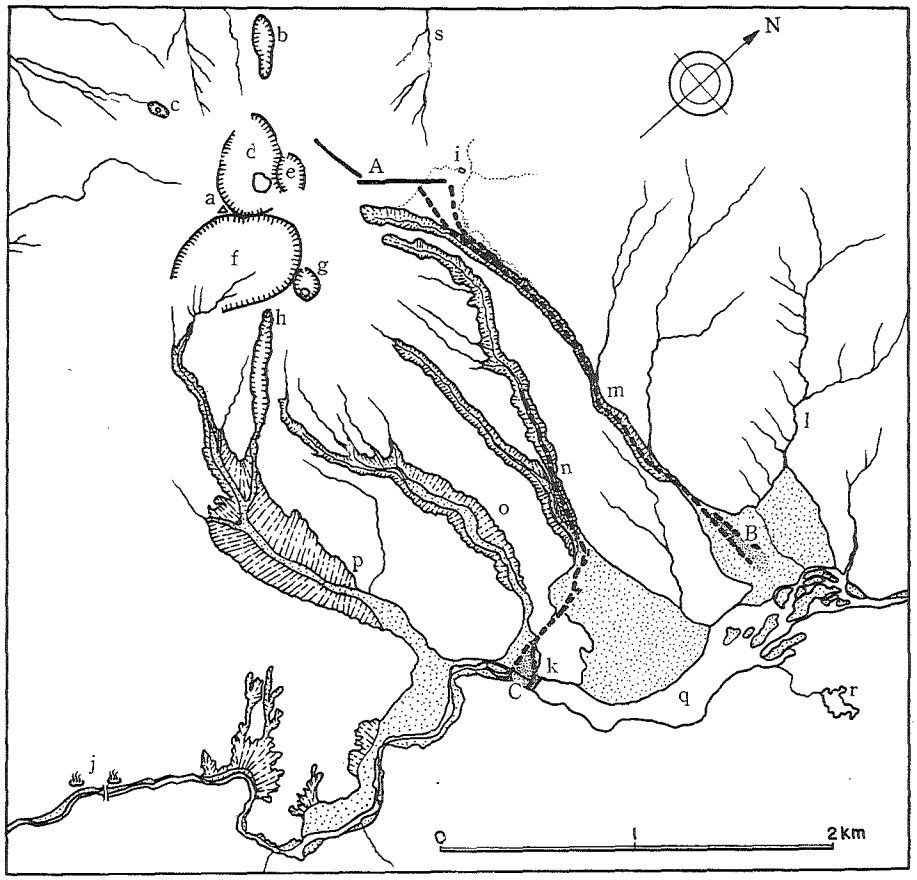

Fig. 3. Map showing the distributions of explosion craters, fissure, mud-flows, and surrounding area

a: Summit of Yakedake, b: Kurodani craterlet c: Shuga-ike, d: Old crater and Shoga-ike, e: Inkyo-ana, f: Shimobori crater, g: Samega-ike crater, h: Taisho crater, i: Nakao pass and a rest house, j: Nakanoyu, k: dam of electric power station, l: Yunosawa, m: Toge valley, n: Kamibori valley, o: Nakabori valley, p: Shimobori valley, q: Taisho-ike, r: Tashiro-ike, s: Shiramizu valley. A: newly opened explosive fissure, B: Toge-zawa mud-flows (June 19, 1962, and later). C: Kamibori mud-flows (June 22, 1962 and later).

After the end of the Meiji era, fumarolic activity in the old crater was ceased, and a water pool has been formed on its bottom.

By the explosion of 1915, a large explosive fissure was formed. The fissure runs for about 1,000m from the southeastern side of the summit to an even surface at the height of 1,900m above sea level and being between the Shimobori and Nakabori valleys in a direction WWN-EES. Ejected ashes and rock fragments rushed down through both Shimobori and Nakabori gullies and dammed up the stream course of the Azusa river. The explosive fissure at this time is called the Taisho crater.

Another craterlet, about 40 m (E-W) and 30 m (N-S) in diameters, is located on the western flank, about 150 m downward from the summit. It is formed by the explosion of 1919 and is called the Kurodani crater. This craterlet is situated on the extension line of the explosive fissure of 1915. It is suggestive that the Kurodani craterlet and the explosive fissure are connected with the same weak line of the volcano.

Besides the craters above-mentioned, there are several explosive craters and certain indications of scars of explosion of unknown ages. Among them, well-formed ones are seen near the summit, namely the Shimobori, the Kamibori, and the Samega-ike explosive craters. (**Fig. 3**)

Although the volcano had been in rather dormant state after the intensive activities during the Taisho era, leaving the fumarolic activities around the summit, and small activities. Volcanic rocks near the fumaroles have been fairly altered by fumarolic gases and high temperature vapour (Ossaka 1961).

On the eastern and northern flanks, runoff water erroded the slope of volcano, and occasional streams are cutting deep gullies about 20 m in depth and with the width of 20~30 m and more (**Fig. 3**).

II History of Volcanic Activity of Yakedake

The records of eruptions of Yakedake Volcano during historical time are few. Volcanic activities being much the same in character have been repeated through the past half century.

Now we will examine historic records of volcanic activities of Yakedake, especially basing the chronologic table compiled by S. Todoroki and Kato (1912), we are to reproduce better records of activities of Yakedake Volcano.

For convenience, certain explanation will be made to symbols and abbreviation used in the following list.

1) Time of the beginning of eruption is described first. [Example : 1960, (*Showa 32*) VI 17, 1200, respectively corresponding to the year (Japanese term), month, date, and hour].

2) Character of the common type of the eruption is denoted by following symbols.

(Explanation) △ Eruption accompanied by earthquake.

◎ Explosion accompanied by ash-fall. Name of area with considerable extent where ash-fall was certified,

is indicate in [ ], and local place-names are indicated in ( ) by Japanese letters.

○ Explosion accompanied by detonation.

→ Explosion accompanied by mud-flows.

= Fissure eruption

3) Intensity of eruption is classified relatively into three magnitudes: small (s), medium (m), and great (g).

4) Short comments may be added to describe the events.

1585 (*Tensho 13*) date unknown, → According to local tradation, mud-flows ran down along the Shiramizu valley and formed the flat terrace of Nakao village at the western foot.

1736 (*Genbun 1*) date unknown, Outburst of Warudani Volcano, mud-flows by landslide reached to the west of Kamikochi spa.

1858 (*Ansei 5*) date unknown, Violent earthquake. Several villages were buried under landslide. Casualties were over three hundreds.

1907 (*Meiji 40*) XII 8, 1400, ◎ [Takayama, Funatsu], (s).

XII 11, 0900-1100, ◎ [around Matsumoto and Shimashima (波多, 山形, 和田, 神林, 島立, 島々, 大野川)], (m). Volcanic rumblings were heard at the foot. New craterlet was formed in the old crater.

XII 21, 1500, ◎ [south-eastern side (奈川)], (s).

1908 (*Meiji 41*) III 8, 1500, ◎ [Takayama, Funatsu], (s).

VII 28, ◎ (s).

XI 23, Morning ◎ [around Matsumoto, Azumi-daira], (m). Damaged forest by ejected materials reached up to 8 km square around the crater.

1909 (*Meiji 42*) I 20, 1900, ○ [Azumi-daira, around Nagano (穂高, 七貴, 長野, 須坂, 山の内, 陸郷, 坂北)], (m). Volcanic rumblings were heard at western foot (田頃家), 6 km distant from the summit, and shocks with rumblings were felt at Nakao.

III 10, ◎ (s).

III 12, ◎ [western foot (中尾)], (s).

III 13, 2300, △ [around Azumi-daira, Matsumoto, and Lake Suwa], (m).

III 23, 1300, △ [Azumi-daira, around Nagano (豊科, 穂高, 松川, 大町, 麻績, 稲荷山, 長野, 須坂, 中野)], (g).

A large amount of ejecta was thrown out and the former crater on the summit was extremely changed (a craterlet was formed on the eastern wall of the old crater). Large blocks (more than 1 m in diameter) fell down around the crater, and the maximum diameter of the fallen materials were 100 mm at Nakao pass, 5 mm at Kamikochi, and 2 mm at Kappa-bashi respectively. Accumulation of ash reached about 6 mm thick at Azumi-daira (穂高, 池田). In the vicinity of Nagano, pedestrians in the street should to put umbrellas.

It was doubtful whether the essential ejecta were thrown out or not. Inhabitants of the western foot of the volcano said that red hot blocks like shooted handballs were seen in black ash clouds whenever heard the explosive roars, but others judged that it was the gitter by the clashing among shooted blocks.

III 29, 0700, ◎ [southern Azumi-daira (豊科, 明科)], (s).

IV 9, 1000, ◎ (s).

IV 26, 0930, ○ [around Shimashima (島々, 朝日)], (s). New craterlet was formed on the western margin of old crater.
V 7, ◎ [Mt. Chyo-ga-take], (s).
V 13, 2300, ○ [30 km west from the volcano (上宝, 神原峠, 船津),] (s).
V 15, 2100, △ [northern Azumi-daira (大町)], (g). Red-cloud of ashes which might have caught red hot glow of lava flow was seen from the western foot (上宝村).
V 28, 0500, ◎ [Azumi-daira and around Nagano], (s).
VI 1, 1815, ○ [western foot (一重ケ根)], (s).

1910 (*Meiji 43*) XI 11, 0500 ○ [around Matsumoto], (s).
XI 29, 2200, ◎ [Shimashima], (s).
XI 30, 0600, ○ [Azumi-daira, around Lake Suwa (南安曇郡, 稲荷山, 上諏訪, 岡谷辰野)], (m).

1911 (*Meiji 44*) V 6, ◎ [Shimashima] (s).
V 11, 0730, ◎ [Nagano], (s).
VI 13, 2010, ○ [Azumi-daira, around Ueda (梓川, 三郷, 堀金, 豊科, 穂高, 松本, 屋代, 上田, 塩田), (g). Gitter like lightnings accompanied by roarings were several times observed around the crater. Accumulation of ashes was 0.7 m thick around the summit. At Kamikochi spa, ash-fall continued for 25 minutes with irritative sulfurous stinking, and an amount of fallen ash was 34 g on a sheet of newspaper.
VI 14, 2100, ◎ [Kamikochi], (s).
VI 16, 0030, and 1425, ○◎ [Kamikochi], (s).
VI 17, 1340, ◎ [Shimashima (島々, 波田)], (s).
VI 22, 1910, ○ [southern foot (平湯, 白骨)], (s).
VI 24, 0440, ◎ [Kiso-Fukushima (白骨, 王滝, 開田, 三岳, 梓川)], (s).
VI 25～VI 29, ◎ everydays, (s).
VII 7, 1315, ○ [Azumi-daira (八坂, 広津, 松川, 池田, 七貴, 陸郷)], (s).
VII 10, 1120, ○ [Azumi-daira (穂高, 豊科, 三郷, 梓川, 明科) and near Nagano (松代, 屋代, 上田)], (m)
VII 12, 1940, ○[Azumi-daira (豊科, 梓川, 三郷), Komoro, and Kumagaya, Tokyo], (g). New spindle-shaped crater (60m×120m in diameters) was formed on the northern border of an old crater. The quantities of fallen ash on a sheet of newspaper were about 110 cc at Azusa, and 180 cc at Toyoshina respectively.
VII 13, ◎ [Shimashima], (s).
VII 17, 0230 ○ [southern Azumi-daira (安曇, 梓川, 三郷)], (s).
VII 19, ◎ [around Shiojiri (広丘, 洗馬, 塩尻)], (s).
VII 20, ◎ [〃 (筑摩地)], (s).
VII 22, ◎ [southern Azumi-daira (豊科, 梓川) and Matsumoto], (s).
VIII 18, 0330, ○ [southern Azumi-daira (梓川, 三郷, 豊科)], (m).
VIII 21, ◎ (s).
VIII 23, ◎ [Azumi-daira, around Matsumoto (梓川, 豊科, 坂井, 麻績, 会田, 明科, 松本, 塩尻, 山形, 洗馬)], (m).

1912 (*Meiji 45*) II 11, 2000 ◎ [Matsumoto and Shiojiri (寿, 神林, 広丘, 片丘)], (m).
II 13, 1930, ◎ [Toyoshina (豊科, 和田)], (s).
II 16, ◎ [Shimashima], (s).
II 18, ◎ [Shiojiri (洗馬, 塩尻)], (s).
II 19, 1300, ◎ [Shiojiri (洗馬, 朝日, 塩尻, 片丘, 筑摩地)], (s).
II 21, ◎ [southern Azumi-daira], (s).

II 23, 1300, ◎ [around Shiojiri (安曇, 洗馬, 広丘, 神林, 塩尻) and Tokyo, Chiba], (m).
II 26, 1700, ◎ (s).
IV 21, 1300, ◎ [southern Azumi-daira and Matsumoto], (s).
V 6, 0200, ◎ [around Toyoshina], (s).
V 7, ◎ [〃], (s).

1913 (*Taisho 2*) VIII 1, 0900, ○ (s).
IX 10, 1700, ○ (s).

1914 (*Taisho 3*) I 12, evening ◎ [Shimashima], (s).

1915 (*Taisho 4*) VI 6, 0730, △=→ [Azumi-daira and Aida (穂高, 有明, 豊科, 三郷, 池田, 松川, 大町, 生坂, 坂北, 本城, 坂井, 四賀, 明科)], (g).
Explosive roaring was heard at Matumoto and Azumi-daira. By the eruption (Plate 1, Fig. 1), the fissure, running from eastern wall of the summit crater to the Shimobori valley (WNW-ESE) was formed. The fissure was 1 km long and 100 m wide, and a large amount of ejecta ran down as mud-flows along the Shimobori and Nakabori valleys. The flows dammed up the stream of River Azusa to form Taisho-ike (Taisho Lake). Soon after, some part of the bank was brocken down, consequently a flood was introduced along the lower stream course of the river.
VII 6, ○ (s).
VII 16, 1018, ◎ (s).

1916 (*Taisho 5*) III 17, ◎ (s).
IV 11, ○ [Shimashima], (s).

1919 (*Taisho 8*) XI 1, ○ (m). Kurodani crater (40m × 30m) was formed at the western down side of the crater of 1911.

1922 (*Taisho 11*) III 10, ◎ (s).
III 19, ◎ [southern Azumi-daira (梓川)], (s).

1923 (*Taisho 12*) VI 26, ◎ (s).
VII 3, ◎ (s).
VII 10, ◎ [southern Azumi-daira (堀金, 穂高)], (s).
VII 26, ◎ [southern Azumi-daira and Matsumoto-daira (梓川, 三郷, 豊科, 松本, 塩尻)], (s).
VII 31, ◎ [Azumi-daira and Matsumoto-daira (池田, 松本以南と鳥居峠以北の一円)], (m).
VIII 2, ○ [northern Azumi-daira (穂高, 松川, 大町)], (s).

1924 (*Taisho 13*) XI 17, ◎ (s).
XII 3, ◎ (s).
XII 7, ◎ (s).
XII 9, ◎ (s).
XII 10, ◎ (s).

1925 (*Taisho 14*) I 13, 1330, ◎ (s).
I 22, ◎ (s).
II 10, 1100, ◎ [around Matsumoto (安曇, 松本)], (s).
II 11, ◎ [〃 (安曇)], (s).
II 26, ◎ [Azumi-daira (堀金, 三郷, 豊科, 穂高, 松川, 大町)], (s).
III 3, ◎ [southern foot (安曇, 奈川)], (s).
III 4, ◎ [〃 (安曇)], (s).
III 28, 1005, ◎ [〃 (安曇, 奈川)], (s).
An amount of fallen ash was 45 g on a sheet of newspaper at Azumi village.

IV 27, 2145, ○ [southern side of Matsumoto and around Lake Suwa (松本, 朝日, 山形, 塩尻, 岡谷, 上諏訪)], (s).
V 2, 1530 ○ [Azumi-daira, Matsumoto-daira, and Kiso], (s).
V 13, 0735, ◎ [southern side to Kiso (奈川, 大桑以南の木曾谷)], (s).
V 15, 0130, ◎ (s).
V 17, ◎ [southern Azumi-daira (豊科, 明科, 会田)], (s).
V 18, 0300, ◎→ [southern Azumi-daira, and around Matsumoto (豊科, 穂高, 三郷, 松本)], Mud-flows ran down along Araiashi valley to Nakao. (s).
V 19, 1935, ◎ [around Matsumoto (明科, 生坂)], (s).
V 21, 2200, ◎ [〃 (松本)], (s).
V 22, ◎ [Matsumoto], (s).
V 23, ◎ [Azumi-daira (大町, 穂高, 豊科, 明科)], (s).
VI 27, ○ [Azumi-daira and around Lake Suwa (明科, 大町, 南安曇, 東筑摩, 松本, 塩尻, 下諏訪, 伊那)], (m). Explosive roaring was heard at Matsumoto.
VI 28, 0445 ◎ [around Lake Suwa], (s).
VII 4, ◎ (s).
VIII 22, ◎ (s).
X 4, 1530. ◎ (s).
X 12, 1510, ◎ [southern Azumi-daira, Matsumoto (波田, 安曇, 堀金, 三郷)], (m). In Matsumoto, an amount of fallen ash was about 125 g on 1.8 m^2 and the air was impregnated with sulfurous stinking.
X 13, 1230, ◎ [Matsumoto and Shiojiri], (s).
X 25, 0030, ○ [northern Matsumoto (明科, 松本)], (s).
XI 12, 0750, ◎ [Matsumoto and Shiojiri], (s).
XI 17, ◎ [near Shiojiri (広丘)], (s).

1927 (*Showa 2*) IV 23, 0456, ○ [southern Azumi-daira and Shiojiri (安曇, 豊科, 穂高, 山形, 宗賀)], (s).
IV 29, 1720, ◎ (s).
V 19, ◎ (s).
XII 15, 1030, ◎ [Matsumoto], (s).

1929 (*Showa 4*) IV 19, 0200, ◎ [near Hotaka], (s).

1930 (*Showa 5*) III 17, 1930, △ (s).
III 26, 2100, ◎ [Sawando (沢渡, 大野川)], (s).

1931 (*Showa 6*) VI 18, 1202, ○ [Kamikochi and western foot], (s).
VI 23, 0345, ○ [Kamikochi], (s).
VI 23, 1120 ◎ [Kamikochi (上高地, 徳本峠)], (s).
VI 24, 1415, ◎ (s).

1932 (*Showa 7*) II 6, 1030, ◎ [southern foot (沢渡, 上高地)], (s).

1935 (*Showa 10*) XI 11, 2100, ○ (s)
XI 12, 0300, 0600, △ Earthquake (vertical shock) only, (s).

1939 (*Showa 14*) VI 4, 0700, ◎ [Kamikochi (上高地, 中の湯)], (s).

1953 (*Showa 28*) VII 23, 1000, At Kamikochi and Tokusawa, inhabitants felt the vertical shocks and rumblings and after that time heard rumblings in every third hour.
VII 24-25, Rumblings of several times were heard at Kamikochi.
VII 26, Twice rumblings were heard both in the morning and afternoon, and another more one in midnight.

1958 (*Showa 33*) From middle of June to the end of September a series of many earthquakes which might be originate from near Yakedake occurred successively, especially frequent in June and in August.

III Sequence of Events in the Eruption 1962

Although the eruption of Yakedake Volcano from 1931 to 1932 seems have been one of fairly striking activity, the volcano soon entered the relatively dormant state without little disturbances as mentioned above, leaving several solfatara and fumaroles on northern side of the summit and north of the Nakao pass. The temperature of the fumaroles around the summit had been declining for some years, i. e., above 400°C in 1912, 275°C in 1932, 209°C in 1939, 195°C in 1940, 94°C in 1953, and 83° C in 1958 (Ossaka 1961).

Volcanic earthquakes and subterraneous rumblings occurred in summer of 1953 and 1958, but nothing was the matter in fumaroles and in other surface manifestation. It was informed only that the temperature and the quantity of water of hot-springs near Yakedake Volcano were fairly changed at that times, but nothing was observed quantitatively.

1 Symptoms of the Eruption

We can hardly believe that the earthquake shocks and rumblings of 1953 and 1958 were the symptoms of the last eruption. Several unusual phenomena that have been regarded as premonitory signs of the last eruption occurred around Yakedake Volcano about 20 days before the eruption, peaple who awared these phenomena previously never expected that the eruption was close at hand.

The events which might be suggestive of premonitory symptoms that had reached our ears are as follows:-

1) On May 27, 1962, earthquake shocks were felt three times at Kamikochi (around Taisho-ike).

2) About 10 days before the eruption of June 17, 1962, an earthquake shock was felt at Hirayu spa.

3) A week before the eruption, earthquake shocks were felt and subterraneous rumblings were heard at Kamikochi (near the dam of Taisho-ike). Nevertheless, the occurrence of white smoke from the fumaroles had unchanged untill the first eruption.

4) On June 17, 1962, when the eruption had begun, the weather was fine and the wind had blowing from the southwest. About two hundreds hikers ascended summit and all of them went down to the foot before the evening. However, nobody had taken notice of unusual phenomena. Thereafter two keepers had stayed at rest house beside the Nakao pass. According to Mr. K. Kamijo, who was one of the stayed keeper of hut, from about 8 p. m., intermittent earthquake shocks were felt and these grew gradually powerful with earthtremors and with occassional upward shocks till the beginning the eruption.

Thus the premonitory earthquakes and earthtremors were felt occassionaly within a local extent.

2 The Eruption

Subsequently to the above-mentioned earthquakes and rumblings on June 17, 1962, an eruption broke out, along the arched fissure, on the northern side of the summit (**Fig. 3**) at 9:55 p. m.. The initial state of the eruption was reported as followings;

1) According to Mr. K. Kamijo, at 9:55 p. m. violent shocks occurred suddenly with strong detonation and blast, and his rest house was destroyed immediately by the blast and fallen large rock fragments (Plate 8, Fig. 1). Ash had enveloped as a thick fog. After a while, he and his friend had a good fortune escape separately from the destroyed house with some wounds.

2) According to Mr. T. Kimura (an administer of Imperial Hotel at Kamikochi), when he rushed out of the house surprisingly to hear the first sound, he saw that thick dark smoke began to rise over in the moon-sky, dark and stinking gas enveloped soon, and ash began to fall. Strong rumblings and earthtremors had continued for about ten minutes.

3) According to Mr. S. Tagawa (the master of the rest house beside the Taisho-ike), about ten minutes after the first sound, it began to fall volcanic lapilli (10 mm in the maximum diameter) as like it hailed, and soon changed to ash-fall, especially for the first ten minutes it fell heavily.

4) The earthquake observatory of Matsushiro, about 65 km distant from the volcano, caught the earthquake vibration at 9 : 56 p. m. and it continued for five minutes. All of these recorded earthquake waves were the short period ones and none long period wave was caught, therefore these waves might be originated from the intermittent explosions of the volcano near the earth's surface.

About 30 minutes after the first eruption, the second detonation more gentle than the first was heard and earth's tremors proceeded till about 11:30 p. m. but it declined in its intencity. Black smokes had risen up strongly.

Ash began to fall at about 11:00 p. m. at Matsumoto and at 0:00 a. m. June 18 at Ueda. Accumulations of fallen ashes were about 30 mm near Taisho-ike, 15 mm at Kappa-bashi, about 520 g on 1. 8 m square at Shima-shima, 1. 5 mm at Ariake, 1 mm at Ikeda and Snhishu-Shinmachi, and they are as like as a light frost upon a leaf at Matsumoto and Hotaka.

According to the official announcement of the prefectural authorities of Nagano, the damages to the mulberry plantation by the ash shower were 1017 hectare in Kita-Saku country, 1493 ha. in Ueda and Chiisagata country, 1897 ha. in Matsumoto and Higashi-Chikuma, 173 ha. in Kita-Azumi, and 380 ha. in Minami-Azumi countries respectively.

On the next morning, it observed from the air-patrol that heavy smoke had risen up along the arched line running about SW-NE on the northern flank of the Yakedake (**Fig. 3**, and Plates 2 and 3). It seems that the fissure, about 500 m in length and 30 m in width, was formed by the first explosion of 9:55 p. m., June 17.

When we surveyed near the Nakao pass on June 20, we observed that the maximum diameter of the explosive breccia which had been come down and had been sunken into the ground was about 0. 5 m near the Nakao pass and 0. 2 m at the place about 500 m distant from the eastern end, opening

about 80 m southeast of the Nakao pass, of the explosion-fissure, and the accumulation of the fallen materials was about 0.1 m at eastern down side of the Nakao pass. In another way, the scale of the last fearful explosion were estimated not only by the vast distribution of the explosive breccia but by such damages of the forest as the cutting off the bamboo bushes and almost of standing tree's branches near tha Nakao pass and its eastern side (Plate 7, Figs. 11, 12).

There is, however, no evidence that the essential materials were thrown out by the explosion.

June 18

Emission of white smoke still continued actively was been relatively mild for all day long. Rumblings were several times heard, and mud-flows invaded on a small scale (70-80 m in length) from the eastern end of the explosive fissure, about 80 m east of the Nakao pass, into the top of the Toge valley. It was like a flow as if the oversaturated steam might flow as a small amount of water together with ash. It was fine weather.

June 19

1:30 a.m.. A mud-flow began to stream down along the Shiramizu valley and rushed down to the upside of Nakao, near the constructing place for the sand guards of the Araiashi valley (about 2 km. distand from Nakao), and the neighbourings was covered with mud together with large blocks (about 2 m in the maximum diameter). On the downstream, the Gamata river became to the stream as like ash flow. (By Mr. Y. Yaguchi and the Asahi Press on June 20).

11:16 a.m. Small detonation with the rising up of black smoke.

12:00 a.m. Strong emission of black smoke occurred. It had a sprinkling of rain at Kamikochi.

0:40 p.m. A moderate detonation with rumblings and emission of black smoke occurred. (1:30 p.m. the fog lifted, then the smoke had changed wholly to white one).

2:08 p.m. Small detonations as like blasting were heard twice.

2:35 p.m. A large amount of the mud-flows poured out from the eastern end of the explosive fissure and rushed down along the Toge valley with violent white smoke like steam engine. The front of the flows reached to the joint of Yusawa and Toge valleys in about 10 minutes, extending fan-shaped, and stopped in the forest.

3:20 p.m. A small amount of mud-flows poured out from the same opening without detonation.

3:30 p.m. A relatively large amount of mud-flows occurred from the same point and rushed down.

3:43 and 3:47 p.m. Moderate overflowings of mud-flows occurred from the same point.

3:58 p.m. A small amount of mud overflowed.

These occurrences of mud-flows on June 19 was observed clearly from the opposit bank of the Taisho-ike by a watchman of the electric power-station of Tokyo Electric Power Co..

At about 3:30 p.m., pressmen approached to the mud-flows, they said that the flow was about 20 m width and 3~4 m thickness near the entrance of the Toge valley, and numerous large blocks (2~3 m in diameter) had floted, when they stood upon these blocks they sunk under their feet, and the temperature of the mud-flows was about 20°C.

4:18 p.m. A detonation was heard.

Emission of white smoke from the explosive fissure weakened gradually toward the

evening. In the afternoon, the meterologic station of Takayama caught three times the air shocks at 2:09, 2:18 and 4:20 p.m..

June 20

We went around the Nakao pass in this afternoon. Near the entrance of the Toge valley, we found that overflowed marks of mud-flows (Plates 5, Fig. 8 and 6, Figs. 9, 10), the muddy brownish-grey colored current was trinkling upon the flood surface of the last mud-flows which was not yet consolidated (Plate 5, Fig. 7, Pl. 6, Fig. 10), and also an interesting impression suggesting that mud-flows had once certain fluidity.

Approaching to the explosive fissure, the violent whitish vapour clouds had still been emitted with hissing noises along the fissure and from neighbouring fumaroles. Then we could not approach closely and observe enough the occurrences of the mud-flows, and fumaroles. Though, we noticed then that the incrustation of sulphur had sublimated around the fumaroles opening on an extended line of the fissure.

None detonation and outstanding explosion of the mud-flows were occurred newly. Emission of white smoke declined extremely in a day.

June 22

In the forenoon of June 21, it was sprinkled at Kamikochi. On June 22, it rained off and on from the morning and it continued to rain in the afternoon.

In this afternoon, the mud-flows rushed down along the Toge valley and the Kamibori valley. The flow was began from about 2:00 p. m. and continued to 6:00 p.m.. At about 5:00 p.m. the front of the mud-flows of the Kamibori valley reached to the Azusa river at a point downstreams from the dam of Taisho-ike and dammed up the Azusa river for a time. Though, a serious event did not happen because some part of the accumulated mud was soon broken down.

4:36-4:50 p.m. Rumblings and knocking sounds of stone falls were heard from the direction of Toge and Kamibori valleys.

11:18 p.m. Rumbling just like the passing jetplane were heard, and mud-flows along the Nakabori valley began to stream down at about 11:20 p.m. and had proceeded till the morning, June 23.

June 25

In the evening, mud-flows rushed down along the Toge valley.

June 26

None detonation and explosion occurred. We ascended again near the Nakao pass. The temperature of the new fumaroles on the east of the Nakao pass was determined as 92°C and 93°C. On this day, we observed the eastern end of the explosive fissure and found a small amount of muddy streamlet (about 2 *l*/sec.) was flowing out from the bottom of the fissure. Because the wall of the fissure was apt to crumble down and it was hard for us to stand on the bottom because it was so weak, we collected the sample of the muddy-currents by a shovel with a long helve. The temperature of the sample was as same as the atmospheric temperature.

July 2

In midnight, mud-flows streamed down along the Shiramizu valley. The total amount of rainfall observed at the agency of the Regional Construction Bureau of Hokuriku at Nakao was 10.6 mm in July 1, and 74.1 mm in July 2 (relatively concentrated between 11:00 a.m. and 4:00 p.m.) respectively (Y. Yaguchi).

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Because of the rain fall lasted for several days, the mud-flows were pushed out along the Kamibori valley and rushed near to the dam of the Taisho-ike. The front of the flows filled up the river bed of the Azusa river of about 30 m width, extending for

100 m from the foot of the dam to downstream, and 4 m in thickness. On the other hand, another mud-flows of the Toge valley reached to the Taisho-ike at last.

About this day, at Nakanoyu spring (on the southern foot of the volcano), the quantity of hot-spring decreased down to about two thirds while the temperature increased from 80°C to 90°C.

July 12

5:40 a.m. Small detonation was heard, and thereafter, it rained with black ashes at the Abo pass.

0:50 p.m. Mud-flows streamed down along the Shiramizu valley. The amount of rainfall at Nakao was 16.2 mm in July 11, and 10.8 mm in the morning of July 12. (Y. Yaguchi)

3:00 p.m. A large amount of the mud-flows rushed down from the Kamibori valley near to the dam of the Taisho-ike and across the Azusa river (Plate 8, Fig. 14 and Plate 9, Figs. 15, 16). Therefore, the roadway to Kamikochi was reclaimed with about 1.5 m in thickness and cut off the traffic temporarily.

On July 16, we visited the Nakao pass, mud-flows ejected on July 12 had dried up and cracked on its surface. Emission of the water vapour from the eastern part of the fissure had fairly subsided (Plates 10, and 11, Fig. 19), and the temperature of fumarole on the east of the Nakao pass determined as 80°C.

July 26

8:13 a.m. Small detonation happened and rumblings had continued for about 20 minutes after the first sound. Mud-flows ran down along the Toge valley.

August 9

8:13 a.m. Small detonation was heard and ash cloud was risen up. Two hikers were wounded by the explosion near at the Nakao pass.

9:50, 11:10 a.m., and 0:10 p.m. small detonations were heard at Nakao.

In the evening, mud-flows ran down along the Shiramizu valley. An amount of rainning at Nakao in August 9 was 28.4 mm. (Y. Yaguchi)

August 14

3:30 p.m. Mud-flows ran down along the Shiramizu valley. The amount of rain was 0.8 mm in the afternoon of August 13 and 10.2 mm in August 14 (from 2:00 p.m. to 4.00 p.m.) respectively. (Y. Yaguchi)

August 15

2:40 p.m. and 3:05 p.m. Mud-flows ran down twice along the Shiramizu valley for about 10 minutes respectively. (Y. Yaguchi)

August 22

9:59 a.m. Small explosion with detonation occurred. (Y. Yaguchi)

August 25

11:52 a.m. Small detonation with explosion was heard and earth's tremors were felt faintly at Nakao. (Y. Yaguchi)

August 29

9:25 a.m. A detonation was heard at Kamioka. (Y. Yaguchi)

September 1

10:45 and 10:50 a.m. Detonations were heard twice. (Y. Yaguchi)

September 6

10:37 a.m. An explosion with detonation occurred (Y. Yaguchi)

September 10

10:35 a.m. A detonation was heard at Kamioka. (Y. Yaguchi)

September 16

7:10 a.m. A relatively violent explosion occurred with rumblings. It was viewed from Kamikochi that black smoke rose up (Plate 11, Fig. 19 and Plate 12). and many stone blocks were shooted up. This explosion was a remarkable one following the explosion of June 17. A small amount of ash fell with a light rain at Kamikochi.

September 17

10:21 p.m. A small detonation was heard at Kamioka. (Y. Yaguchi)

September 19

10:13 a.m. and 3:24 p.m. Detonations were heard twice, and the latter was larger than the first. (Y. Yaguchi).

September 24

2:30 p.m. An detonation was heard.

October 17

6:30 a.m. An explosion with rumblings was occurred, and black smoke was risen up about 1,000 m in height.

October 24

7:00 a.m.

November 7

8:50 p.m. An explosion with rumblings was occurred, white smoke was risen up highly. At the western foot of the volcano, inhabitants heard the sound as a jetplane flew low.

December 13

4:09 p.m. and 4:25 p.m. Explosions with detonation occurred. Smoke-cloud was risen up about 500 m in height, but no ash fell at Kamikochi.

December. 17

4:30 p.m. An explosion occurred with rumblings. Ash cloud was risen up about 400 m in height.

IV Some Notes on Ejecta of the Explosion 1962

1 Rock Fragments

A large amount of the rock fragments was thrown out around the explosive fissure and carried down by mud-flows. We collected some fragments which sank into the ground and some fragments floating in the mud-flows. Almost of these fragments are biotite-hornblende andesite. We observed several rock samples, there is little difference between these rock types.

Andesite of this volcano is somewhat porous and porphyritic rock with a grey color, although it often bears a reddish color due to reheating. It is characterized megascopically by the presence of black-colored long prisms of hornblende (up to 7 mm in length and 3 mm in width), white tabular plagioclase (up to 10 mm in diameter), and grey-colored ground mass. The andesite includes frequently dark colored schlieren as large as a fist-size and/or a bean-size. Hornblende crystals which are carried as phenocrysts, separated from the rock, are found singly in the present fluvial beds and on the flood plain at the foot of the volcano.

It is also characterised microscopically by the presence of phenocrystic plagioclase, hornblende, hypersthene, biotite, and augite in the groundmass composed of plagioclase, hypersthene, augite, and glass. Phenocryst plagioclase is usually oscillatory zoned from basic andesine to acidic andesine, and its central part is often charged with glass inclusions. Groundmass plagioclase is somewhat more acidic than the large tabular one. Hornblende is commonly prismatic and sometimes sieve-structured and twined. Pleochroism is X=pale greenish yellow, Y≒Z=brownish green, and extinction angle is usually 2°~5°. Sometimes hornblende is rimmed by thick opathitic margin and replaced mostly by opathitic aggregates with the relic hornblende in the central part. Hypersthene is often poikilitic large prism (up to 5 mm), and shows distinct pleochroism. Biotite occurs as idiomorphic flake and shows strong pleochroism X=light brown, Y≒Z=brownish black. Sometimes its large flake (up to 3 mm) is found. Augite is subordinate to hypersthene in amount, and large crystal is hardly found. Sometimes hypidiomorphic grains of augite flock together with hypersthene and form a large glomeroporphyry.

The andesite described above is identified petrographically with the mica-bearing hypersthene-hornblende andesite namely the upper lava of the Yakedake Volcano divided by T. Kato (1912).

2 Ashes

The volcanic ash thrown out by the explosion on June 17, 1962 distributed in an elliptical area, having been transported by wind northeastward from Yakedake, and the extent of the ash-showered area is shown by broken line in **Fig. 2**. The remarkable accumulation of ash was described in the previous chapter, and very little ash fell over the other places in this surrounded area. Their deposits were less than 100 mm thick even around the explosive fissure, moreover such thick deposits as seen near the Nakao pass was mainly composed of rock fragments.

The ash collected beside Taisho-ike was sieved into the grain-fraction between 125 and 250 meshes, and its mineral composition was observed. The results are as follows;

1) The ratio of heavy minerals to light minerals is 12:88 in weight.
2) Among the heavy minerals, hypersthen : magnetite : hornblende : biotite: augite are counted as 45.0 : 30.1 : 12.7 : 10.8 : 1.4 in percentage with regard to the total heavy minerals.
3) In the light minerals plagioclase and glass are existing in the ratio 61 : 39.

Glass often sticks to the hypersthene and magnetite grains, and the pleochroism of hornblende is somewhat distinct and reddish rather than hornblende carried in rock fragments.

Though, most of the minerals are fresh and well-formed.

Other ashes thrown out by the later explosions distributed in a limited area near the Yakedake and their amounts were very little as hard to collect their samples.

3 Mud-flows

Ash and rock fragments which were ejected in the series of the present explosion and deposited on the eastern and northern flanks of the volcano, flowed down mixed with abundant water caused by rainfall. Though, of course, these mud-flows were consisted not only of newly ejected ash and rock fragments but also of fragments of old debris and other deposits on the riverside. Those mud-flows may be called *"a kind of mud-flows of secondary volcanic origin"*. A large amount of the mud-flows rushed down along the Kamibori-, Toge- and Shiramizu- valleys on June 22, 1962 and later may belong the secondary origin.

On the other hand, the first mud-flows rushed down the Toge and Shiramizu valleys in the afternoon of June 19 is of the different origin from those above mentioned. It has clearly observed from the opposit side of Taisho-ike that the mud-flows perhaps with much water poured directly out from the lowest part of the explosion fissure.

At that time when we ascended and went near to the explosion fissure, we certified ourselves that the mud-flows setting out from the lowest opening of the fissure (Plate 4, Figs. 5, 6). Furthermore, we have scarcely rainfall on June 18 and 19, 1962 in this area, and also there is little residual snow bank around the summit. It is, therefore, hard to consider that such large amount of mud-flows with much water could rush down on June 19 caused by surface water and rainfall. It may be natural to conclude that the excessive water originated from the new fumarolic activity began to pour out from the fumarolic fissure carried down ash and rock fragments already thrown out around the fissure and/or collapsed down from fissure-side. These mud-flows may be called *"a kind of the mud-flows of primary volcanic origin"* in such a sense that the medium of the mud-flows is the fumarolic water, even if the water is connected with the underground water near the fumaroles.

The latter type of mud-flows is subordinate in amount to the first type, and this relation was clearly observed at Toge valley. The tracks of so-called *primary mud-flows* of June 19, was completely covered by the so-called *secondary mud-flows* rushed down on June 22, and the latter ran over on the both side of the tracks of the first.

We will summerize here on the mode of occurrences of mud-flows as follows.

(1) Immediately after the first big explosion of Yakedake Volcano, two sorts of mud-flows as mentioned above, namely the one is *"a kind of mud-flows of primary volcanic origin"* and another is *"a kind of mud-flows of secondary volcanic origin"* in which mass-movement of mixture of water and ash containing blocks of all-sizes took place on steep slope and along gullies having been caused by rainfalls.

(2) In the first, in the case of *primary mud-flows*, a large amount of water was supplied from fumaloric fissure and mixture of ash and blocks oversa-

turated by water repeatedly rushed down. In this case, the water in question is, anyhow, endogenetic if not the juvenile water.

(3) The current from the fissure, as it was a sort of muddy current, continued from June 19 for about 10 days, perhaps for a period of intensive steaming. As read in the record of activity, on June 26, T. Yamada estimated the amount of water pouring out from the lowest end of the steaming fissure to be about 2 *l*/sec. It may be a moot question why and how such a large amount of water could be originated to flow down for pretty long period, and if such fine materials as volcanic ash were produced within the volcanic body.

(4) At 2:35 p. m. of June 19, some of the people staying in Kamikochi, witnessed the mud-flows rushed down Toge Valley rapidly toward Taisho-ike. Many persons believed that this was the first occasion when mud-flows rushed down since the renewed activity. But this is not the case. Just before that time T. Takada, a student of our Department was in the lowest part of Toge Valley, took a photograph of the muddy currents with floating rock fragments (Pl. 5, Fig. 7). The picture may seem to demonstrate that before 2:35 p. m. muddy current or mud-flows more or less flowed down.

(5) The stream tracks of the mud-flows of primary origin, which flowed down actually in these occasions, were almost confined within the preexisting fluvial channel. The total amount of mud-flows of primary origin should be said as very small. The muddy water in question having mixed with showered ash and ejected blocks formed the mud-flows of primary origin.

(6) According to our observation made on June 20, it was supposed that the mud-flows might have flowed down the valley, several times. Half-dried mud-flows comprised numerous wooden fragments and sometimes even manmade goods flowed over a little outside of the stream channel. (Plate 6. Fig 10).

(i) On the way to the lowermost part of the valley, the muddy current having intermingled with ashes and blocks in the fluvial channel might have flowed down as a density current. But the flows might have lost rapidly the fluidity and could not reached to the Taisho-ike owing to the desiccation caused by the loss of water contained in mud-flows.

(ii) It is note worthy that the mud-flows must have lost the water rapidly. The absorption of water by underlying graveliferous surface or the escape of water as runoff water from the mud-flows seems to cause the loss of the fluidity.

(iii) Frontal margin of the mud-flows which flowed over the preexisting channel shows that the desiccation of the mud-flows took place very rapidly (Plate 5, Fig. 8). The fact showing the rising up of mud-flow-level might have lasted for a little while is observed as shown in Plate 6, Fig. 9, where the water mark of muddy current is recorded on the left of the picture.

(iv) After the subsidence of the mud-flow-level, half-consolidated mud-flows covered the higher bank and the lower bottom of channel with pretty

uniform thickness, sometimes remaining huge boulders on both side (Plate 9, Fig. 16). These facts may suggest to explain the peculiar mode of occurrence of the mud-flows upon topographic surfaces with varying heights.

(v) The members of the Quatarneny Research Group of the Kiso Valley have long acquainted with the facts that the so-called Suekawa mud-flows of Ontake volcano are lying at places upon the Takabe terrace with the thickness of about 10 m, but upon the higher terraces above the Takabe terrace are recognized the same mud- flows lying with the thickness a little less than 10 m. The muddy flood current oversaturated with water, and caused by volcanic activity, may explain the peculiar mode of occurrence of the mud-flows.

V Conclusive Remarks

1) The 1962 activity of Yakedake Volcano is the typical flank eruption took place on the northern side of the summit. Numerous fumaroles were newly formed along the explosive fissure. The fumarolic activity weakened gradually since the first explosion, but it has intermittently renewed with an interval of a month or a month and a half, and the activity in this state is still continuing.

2) New ejecta including detritus and less coarser fragmental rocks, which are petrographically characterized by biotite-hornblende-hypersthene andesite, were not originated from the new magma.

3) The last eruption, therefore, is only a notable water-vapour explosion ——a well-known type of explosion recognized often in acidic volcano.

4) Mud-flows is divided into two types, namely *"a mud-flows of primary volcanic origin"* caused by the fumarolic water and *"a mud-flows of secondary volcanic origin"* caused by rainfall.

5) Notable is the fact that muddy-water poured out from the explosion fissure for about 10 days during the period of intense steaming, and caused the formation of a part of mud-flows.

6) The last eruption happened to take place after a long interval of dormant stage, therefore, it might indicate a renewed activity. Although the temperature of fumaroles was temporarily some high (93°C), it tends already to descend. It seems, therefore, the present activity will not continue for long and will not renew in near future.

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Explanation of Plates

Pl. 1, Fig. 1 The explosion of 1915 as seen from Kamikochi. Ash shower is seen in the left side. Taisho-ike was formed by the mud-flows owing to dammed up the Azusa river. (Photo S. Hokari)

Fig. 2 June 20, 1962. Yakedake as seen from Kappa-bashi, Kamikochi. Emission of ash cloud was fairly subsided already. The black streak beneath the lowest fumarole is the track of the mud-flows on June 19. (Photo T. Yamada)

Pl. 2, Fig. 3, 9:00 a. m., June 18, 1962. Flank eruption of Yakedake as seen from the northern side by air. A high mountain with residual snow banks behind the Yakedake is the Norikura Volcano, and the high peak away in the distant haze is the Ontake Volcano. (Photo Sinano Mainichi Press)

Pl. 3, Fig. 4 About 9:00 a. m., June 18, 1962. Flank eruption of Yakedake from northwestern side by air. Fumaroles line up. One of the right most is the relapsed fomarolic activity from the Kurodani crater formed in 1919. (Photo Shinano Mainichi Press)

Pl. 4, Fig. 5 About 11:00 a. m., June 20, 1962. Fumaroles on the top of the Toge valley. Black band on the left side is the mud-flows from the lowest opening of the explosive fissure on the east of the Nakao pass. (Photo T. Kobayashi)

Fig. 6, 3:00 p. m., June 20, 1962. Water vapuor cloud rising from the fumaroles east of the Nakao pass. Dark band of the left side is the mud-flows rushed down to the Toge valley. (Photo T. Yamada)

Pl. 5, Fig. 7 2:00 p. m., June 19, 1962. Muddy streamlet in the Toge valley. Rock fragments are floating. T. Takada heard the noise like the murmur of a brook. (Photo T. Takada)

Fig. 8 1:00 p. m., June 20, 1962. Mud-flows overflowed beside the main

stream rushed down in the afternoon, June 19. Its surface was cracked then. (Photo T. Yamada)

Pl. 6, Fig. 9 1:00 p. m., June 20, 1962. At the entrance of the Toge valley, and a sign of depth of the mud-flows which rushed down on June 19. The light colored band in the middle is the track of later and relatively mild mud current. The horizontal mark on the large brock of left indicates the height of surface level of mud-flows. (Photo K. Kobayashi)

Fig. 10 1:00 p. m., June 20, 1962. Muddy streamlet remainning in the middle of the track of mud-flows, at the entrance of the Toge valley. (Photo T. Yamada)

Pl. 7, Figs. 11 and 12 June 20, 1962. Tree trunks blasted by fall of ejecta on the east of the Nakao pass (Photo K. Kobayashi)

Pl. 8, Fig. 13 June 20, 1962. Destroyed rest house by fall of large rock fragments beside the Nakao pass. Two men had stayed in it when the explosion began, and they were wounded. (Photo T. Fujita)

Fig. 14 July 16, 1962. Mud-flows rushed down to the Azusa river on July 12. The dam of the electric power station under the bridge seen in the upper left corner of the picture was almost buried. (Photo T. Fujita)

Pl. 9, Fig. 15 July 16, 1962. Mud-flows streamed down along the Kamibori valley on July 12, being looked down from the upper part of the valley. Wooden rampart seen in the upper part of the picture is made for the sand guards. The mud-flows was obstructed by the guards here, and turned to right and rushed the dam of Taisho-ike. (Photo T. Fujita)

Fig. 16 July 16, 1962. Ditto, looking from the down stream. Large blocks standing in a line are carired by the mud-flows and leaved along the both side of the current. They are about 2~3 m in extreme diameter. (Photo T. Fujita)

Pl. 10, Fig. 17 July 16, 1962. Fumarolic activity of the explosive fissure as looked from the Nakao pass. The steam emission on the left side fairly weakened compared with one of about June 20, 1962. (Photo T. Fujita)

Pl. 11, Fig. 18 July 16, 1962. The lowest opening of the explosive fissure near by the Nakao pass. The wall of the fissure dried up then and no muddy current was found on the bottom. (Photo T. Fujita)

Fig. 19 7:11 a. m., Sept. 16, 1962. The explosion as seen from Kamikochi. A mushroom like cloud was risen up. (Photo T. Fukazawa)

Pl. 12, Fig. 20 9:00 a. m., Sept. 16, 1962. Yakedake seen from west-northwestern direction by air. An explosion occurred in this morning. (Photo The Shinano Mainichi Press)

A: Shoga-ike, crater lake on the bottom of the old crater. B: An old crater. C: Inkyo-ana, the crater of eruption-1911. D: Shimobori explosive crater. E: Samega-ike. F: Nakao-toge explosive crater, G: Shiramizu-dani explosive crater. H: Summit. I: Shimobori valley. J: Kamibori valley. K: Explosive fissure in 1962, whitish cloud is an active emission of stearm. L: Mud-flows of July 12, 1962. M: Dam of electric power station. N: Taisho-ike. O: Toge valley. P: Kurodani crater formed by an explosion 1919.

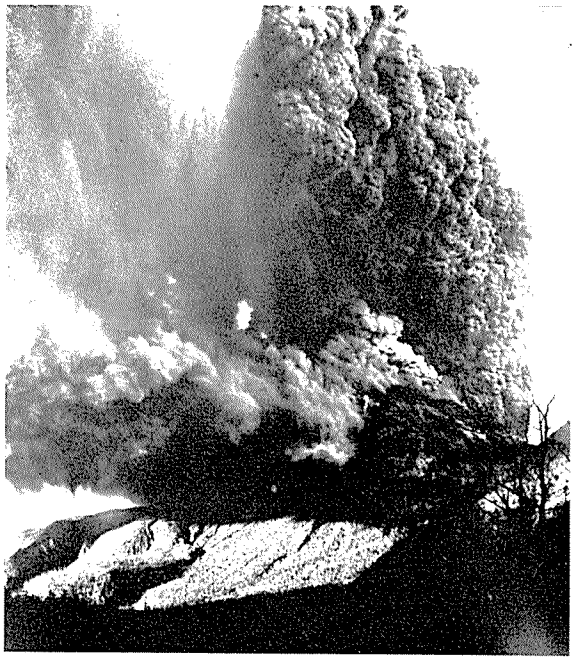


Fig. 1

Fig. 2

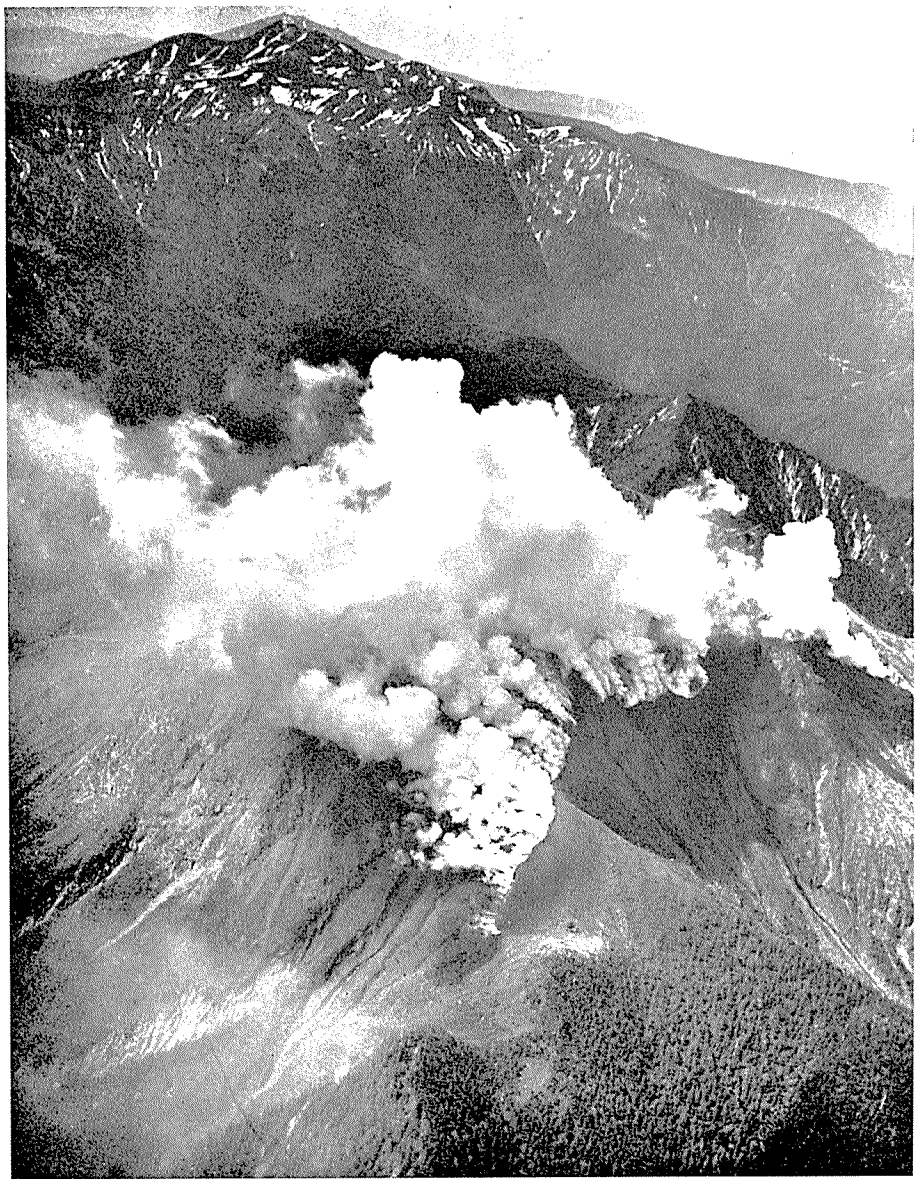
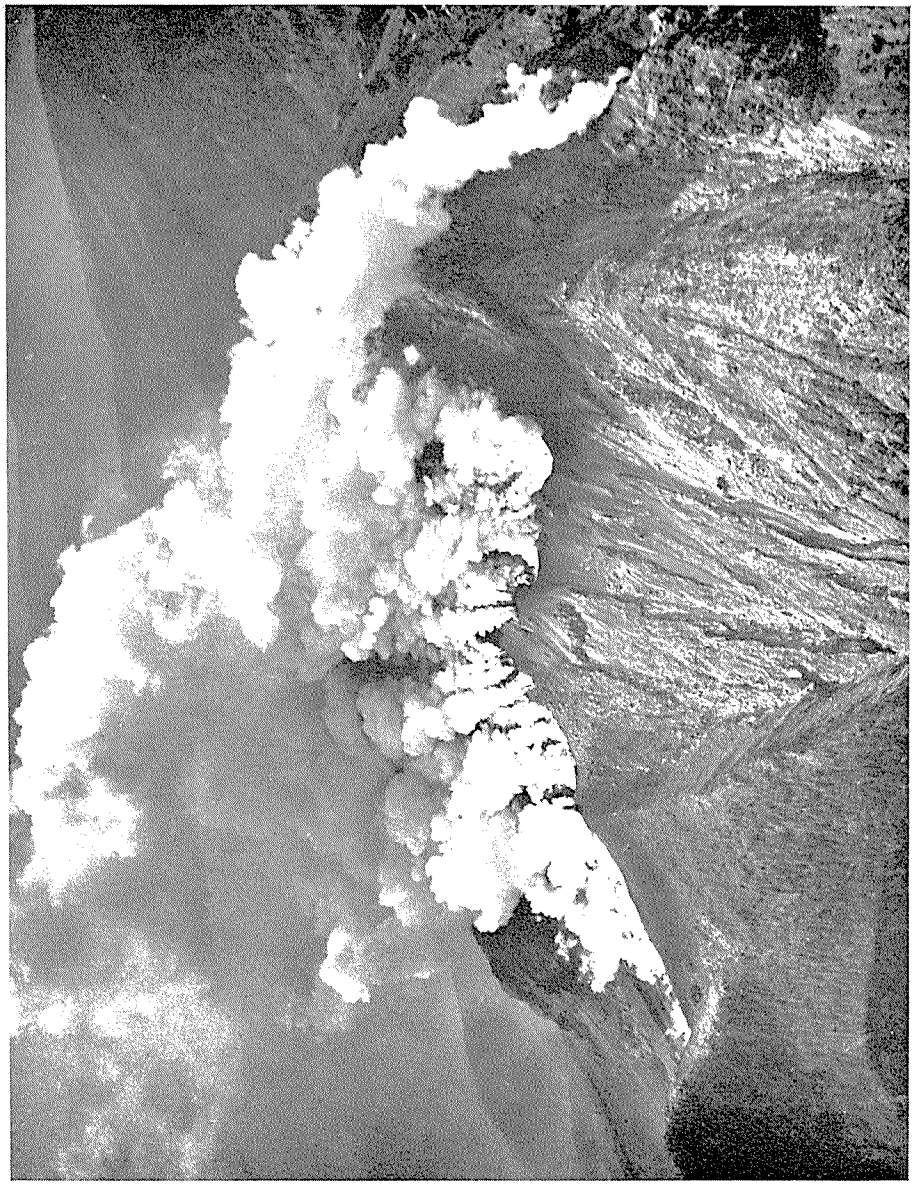


Fig. 3



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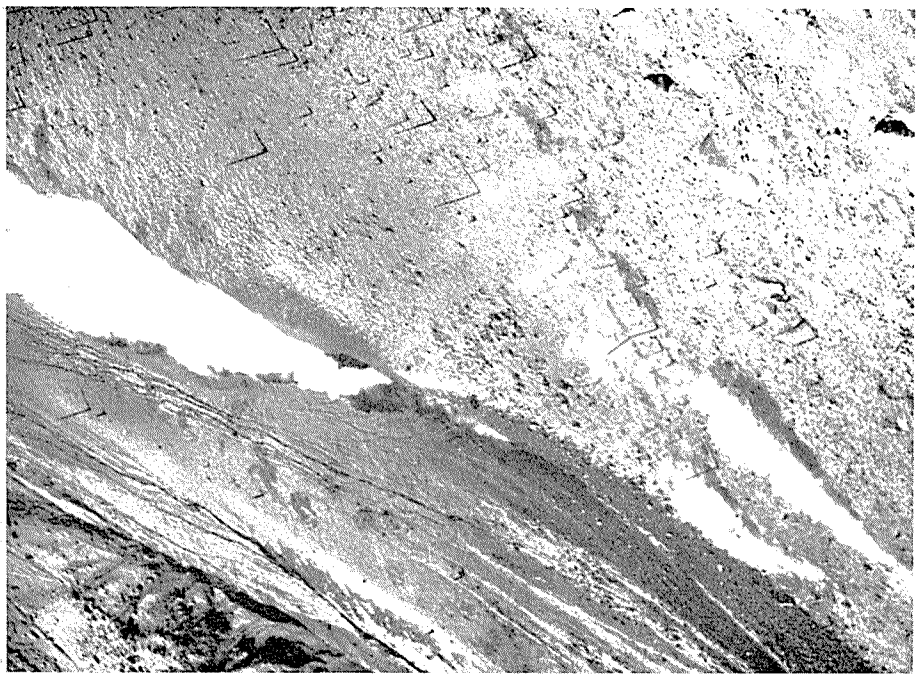

Fig. 5

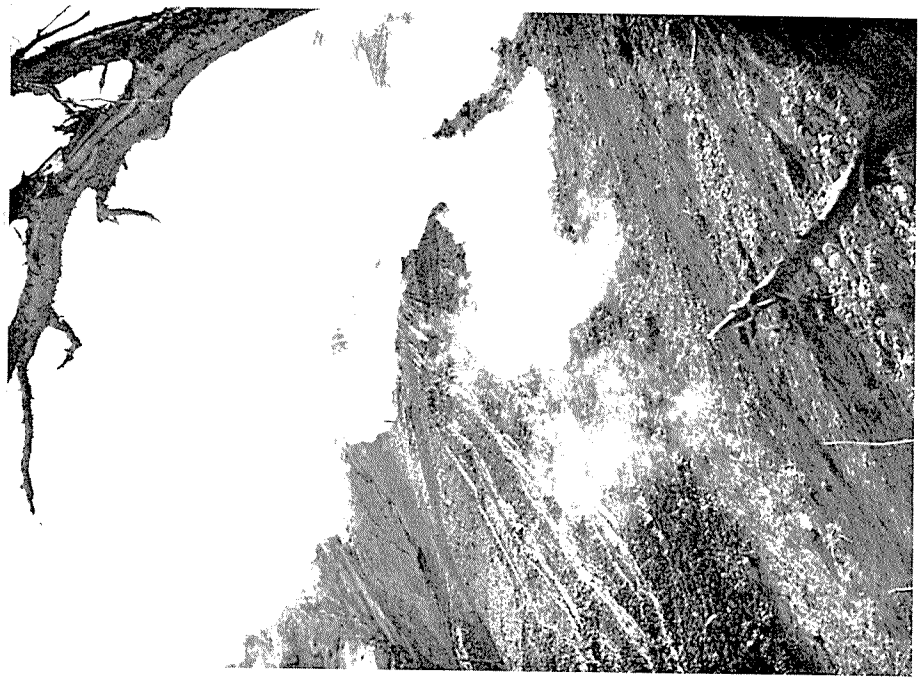

Fig. 6

Fig. 7

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Fig. 9

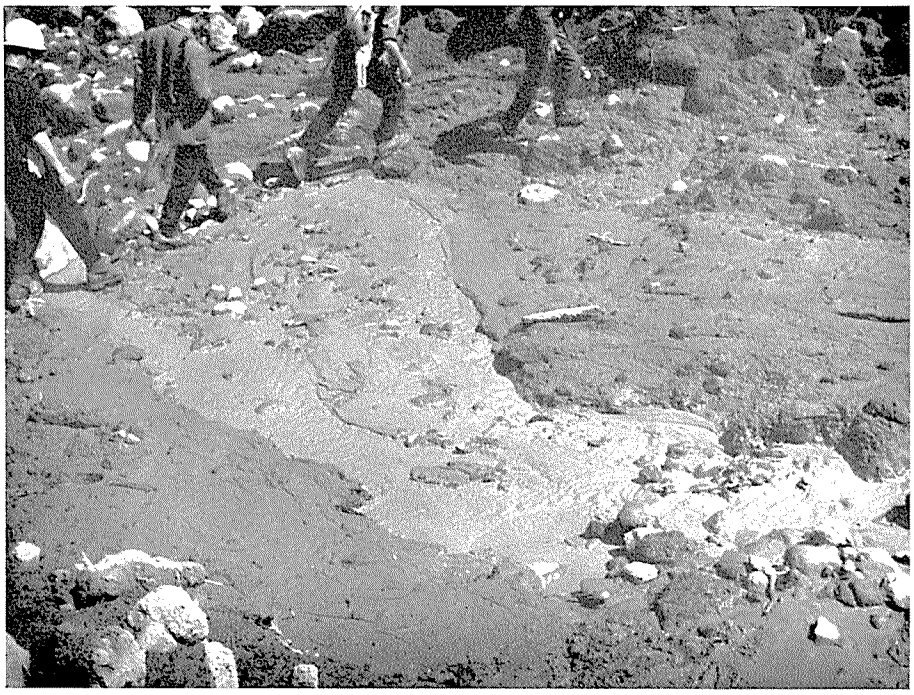


Fig. 10

Fig. 11

Fig. 12

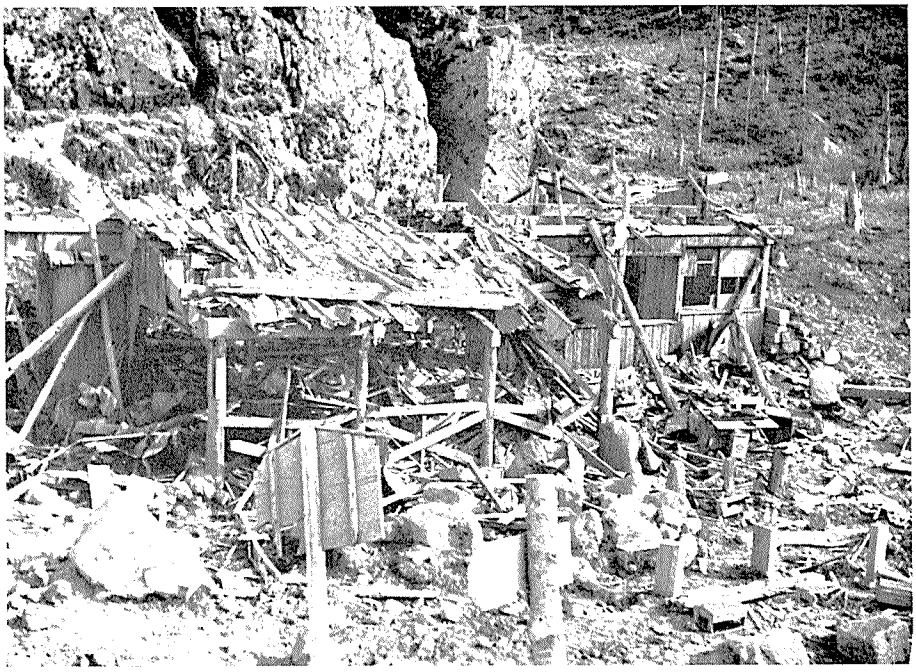


Fig. 13

Fig. 14

Fig. 15

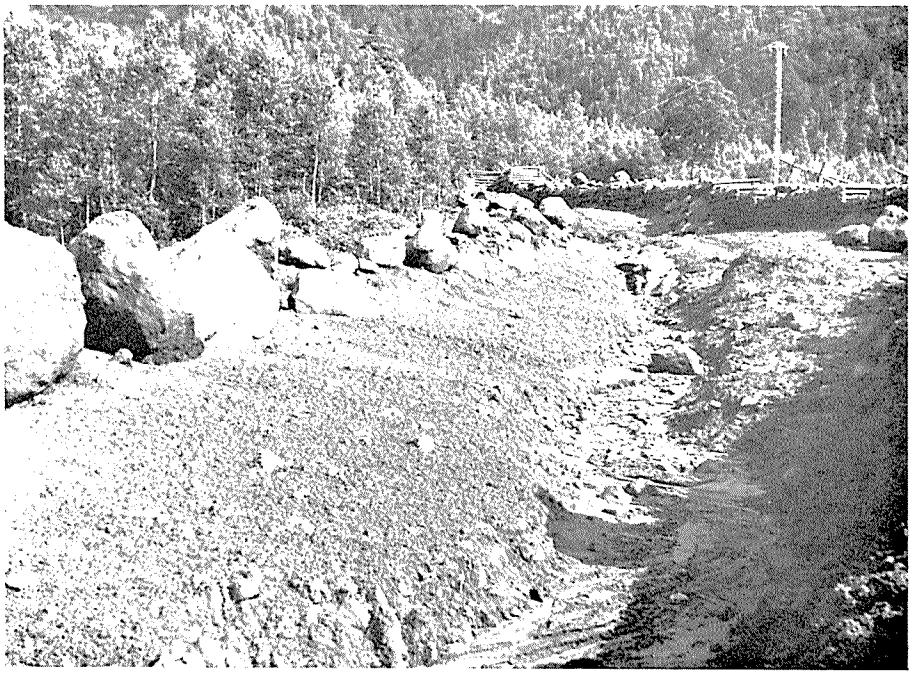


Fig. 16

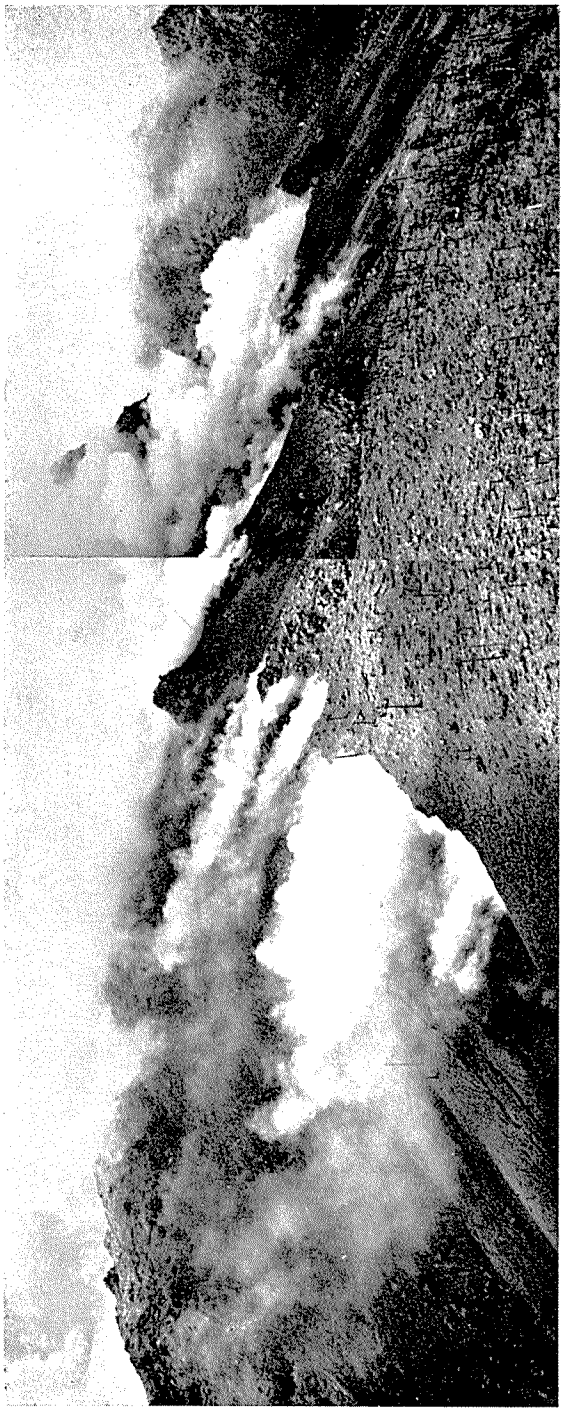


Fig. 17

Fig. 18

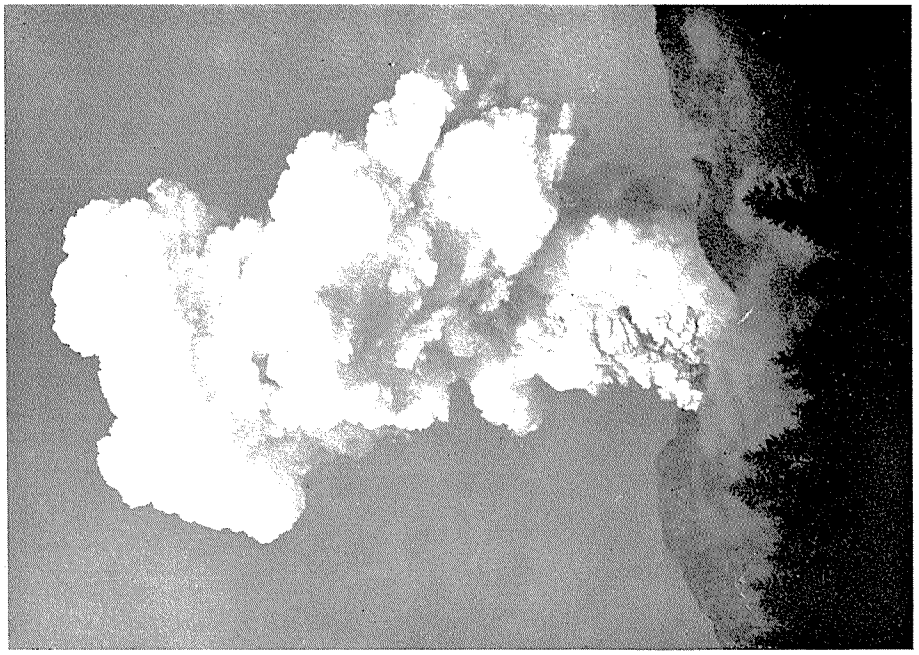
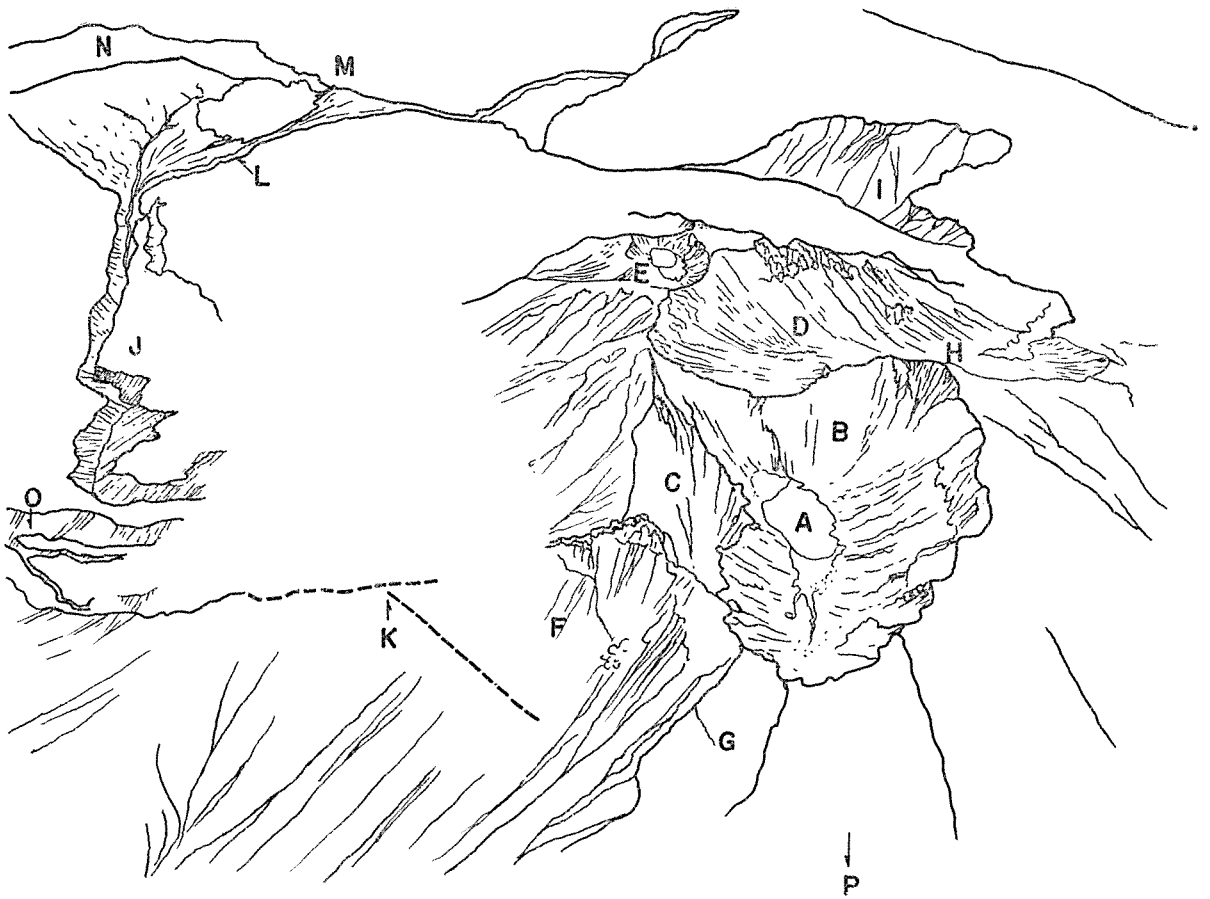


Fig. 19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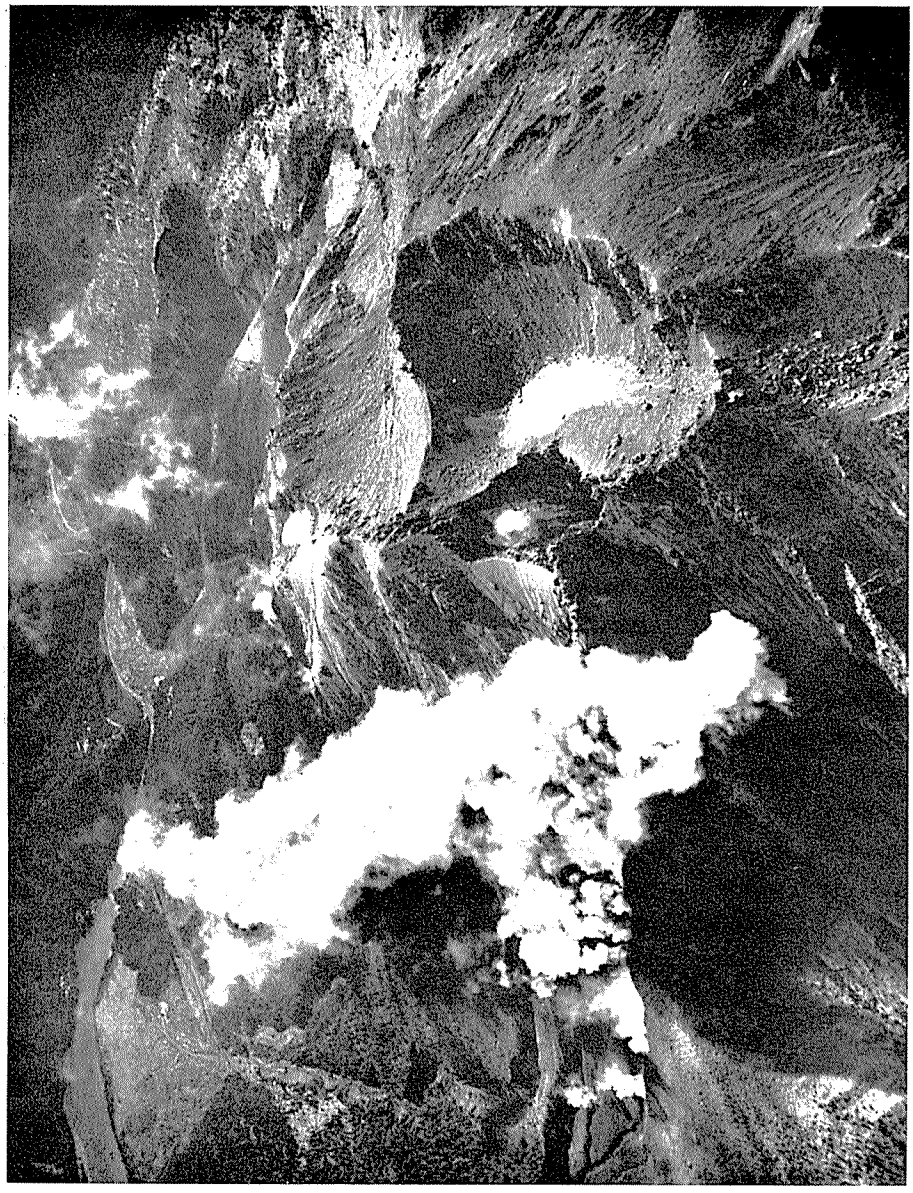

Fig. 20