33. *The Minor Activity of Volcano Azuma in February 1950.*

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1. Introduction.

Mt. Azuma is located at the north-eastern part of the mainland of Japan and is 1948.3 m above the sea-level at its main cone, Issaikyo, of which the geographical latitude and longitude are 37°43′.0 N and 140°15′.0 E respectively. In the vicinity of Volcano Azuma, there are two other volcanoes, Mt. Bandai and Mt. Adatara, the first lying 21 km distant to the south-west of Azuma and the other 13 km to the south-east.

These three volcanoes[1] went into violent eruption one after another within a period of 11 years from 1888 to 1899, notwithstanding the fact that they had been in a perfect dormant state for several centuries. Of these volcanic activities, the 1888 eruption of Mt. Bandai was in fact catastrophic in its nature as well as in its magnitude, and resulted in the lost of Ko-Bandai, one of the two main cones, of which the volume of destroyed formation was estimated at 1.2 km^3 by S. Sekiya and Y. Kikuchi.[2] Since the 1888 eruption of Bandai, the volcanologists in Japan have payed special attention to the volcanic or seismic activity of these three volcanoes including Azuma.

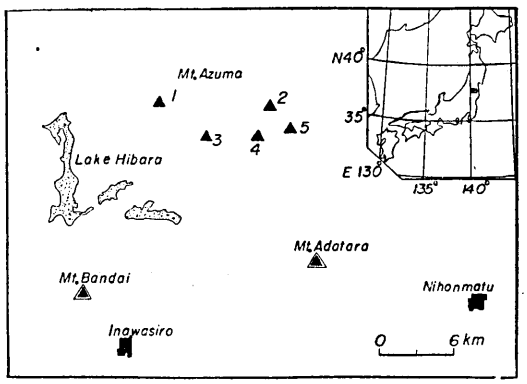


Fig. 1. Localities of Mt. Azuma and its main cones.
1. Nisi-Azuma, 2. Issaikyo,
3. Naka-Azuma, 4. Higasi-Azuma,
5. Azuma-Kohuzi.

At first, it will be necessary to introduce briefly the morphology and an outline of the previous eruption of Mt. Azuma. Besides the main cone, Issaikyo,

1) F. OMORI, *Rep. Earthq. Inv. Comm.*, **86** (1918), 135.
2) S. SEKIYA and Y. KIKUCHI, *Jour. Sc. Coll.*, **3** (1890), 91.

this volcano has four cones on the circular platform, namely Higasi-Azuma, Nisi-Azuma, Naka-Azuma and Ko-Huzi, and in addition several crater-lakes of various sizes including Gosiki-numa and Kama-numa etc. which are located on the flank or at the base of these cones. Therefore, it may be said that Volcano Azuma is not formed in a simple 'conide' and has rather a complex structure from the morphological view-point. Judging from the fact that hot spring and fumaroles issue from numerous spots at the skirts, flanks and summits of these cones, the

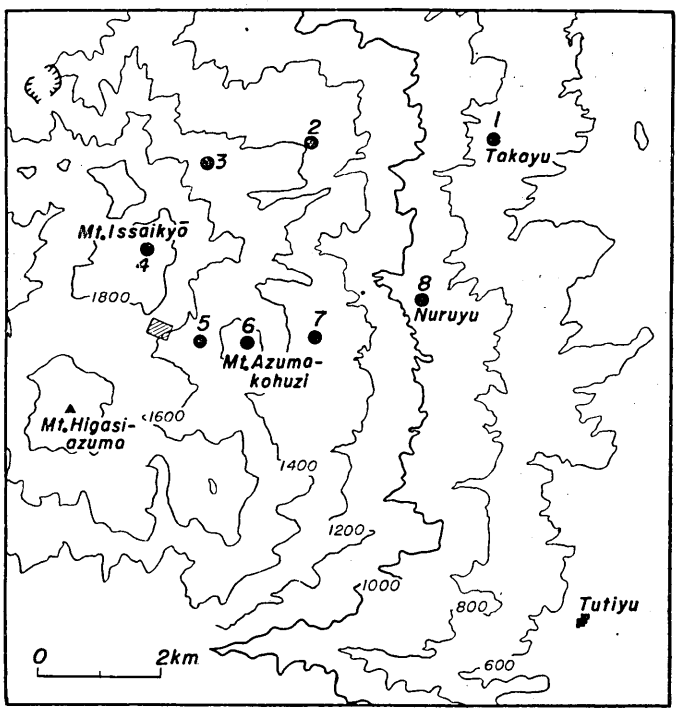


Fig. 2. Topographical map of Mt. Azuma.
closed circles (1~8); magnetic post.
hatched area; locality of the newly opened fissures and craterlets. (Fig. 3.)

mountain formation seems to be saturated to some extent by hot spring water and vapour which may be derived partly from the magma seated deeply and partly from the circulating water. The phenomena just mentioned are frequently observed in the volcanoes showing fumarolic activity such as Kusatu-sirane, Kurikoma-dake etc.

On May 19, 1893[3] Mt. Azuma erupted from an ancient crater and from the newly formed craterlets in its vicinity, which were all located at the south-eastern flank of Issaikyo, and ejected volcanic detritus with vapour to the top of Issaikyo, of which the total volume of ejecta on the first day of the eruption was estimated at 10^6 tons. After eruptions of similar feature occurred at the same craters on 4,5 and 7 June of the same year, the volcano remained in calm state up to February 1894. However, Mt. Azuma resumed again several minor eruptions during the periods from March to April 1894, from March to September 1895 and September 1896. The ejecta from these outbursts were composed of only detritus and fine mud-like ash which both had formed a part of the mountain formation at the craters newly into action, and no juvenile material from the magma was found.

Since the 1893-1895 activities, we have had no information available for the subsequent 57 years concerning the volcanic or seismic activity of this volcano.

2. The Minor Fumarolic Activity in February 1950.

Towards 19h 30m on February 10, 1950, Mt. Azuma outburst, with no noticeable forerunning phenomenon, in the neighbourhood of the craters newly opened in the previous eruption. Another explosion followed in the same location accompanied with rumblings at about 18h 30m on the 19th of the same month, nine days after the first explosion.

In order to study the nature of the present eruption of Azuma, the writers with their associates carried out two series of investigations, the first being devoted to seismometric observations for two months soon after the first outburst and the other including the topographical survey of the craterlets newly formed in the present eruption and the geomagnetic survey of this volcano.

Several craterlets and numerous fumaroles were newly formed in the present explosions on the south-eastern flank of Issaikyo, as in the case of the 1893 eruption. The locality of these craterlets and fumaroles is shown on the map of Fig. 3, which was made with the aid of the plain-table method during the period from June to July 1950. As shown clearly on this map, these craterlets and fumaroles are arranged on three fissure lines (A_1A_1', A_2A_2', and A_3A_3'), the first of which runs in the east-west direction passing through an ancient crater partly buried and the other two in parallel are located at the western side of the 1893 crater.

3) F. OMORI, *loc. cit.*

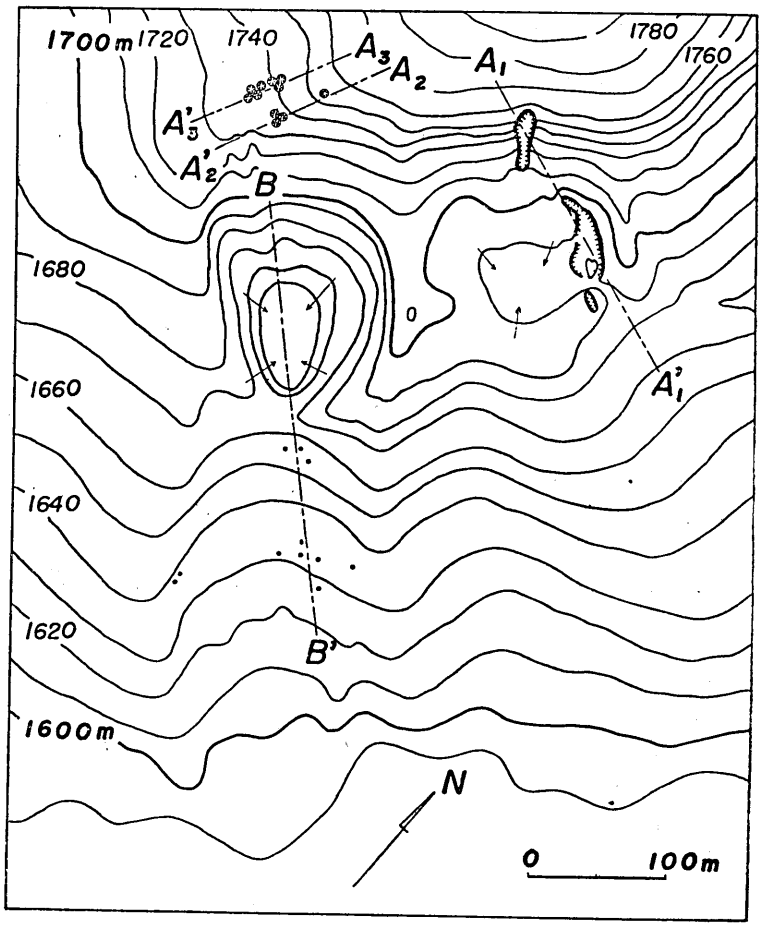


Fig. 3. Topographical map of the craterlets and fumaroles formed in 1950 and in 1893.

A_1A_1', A_2A_2' and A_3A_3', fissures opened in 1950.
B_1B_1'; fissure opened in 1893.

Although the 1950 activity included only the two explosions mentioned above, steam vapour from some of these craterlets still kept issuing at the beginning of June 1950, varying in intensity and accompanied with or without rumblings. Fig. 7 shows a portion of the crater and fumaroles on the fissure line A_1A_1' on June 28, 1950.

It must be added that the crater and fumaroles along the BB' line on the map of Fig. 3 were formed in the 1893 activity, and from these fumaroles, vapours

with evaporated sulphur have issued incessantly for 57 years from the previous eruption up to the present. As the result, sublimates rich in condensed sulphur were observed at the margin of the orifice of each fumarole. Besides the activity of these fumaroles, hot springs, about 95°C in their orifice temperature, have welled up from several spots on this fissure line and flowed down to the eastern base in a narrow stream, though not so abundant in volume.

As described above, the activity of both the fumarole and hot spring which formed in 1893, did not change so remarkably as to be noticed by several observations throughout the present eruption, notwithstanding the fact that they are situated near the active fissures newly opened.

The orifice temperatures of mineral water issuing from the fumaroles formed in 1893 and in 1950, were measured on June 29, 1950, the result of which is given in the following table:

Table I. Orifice temperature of mineral water.

(a) The 1893 fumaroles.

No.	(1)	(2)	(3)	(4)	(5)	(6)
Orif. Temp.	94°C	95°C	88°C	94°C	94°C	56°C

(b) The 1950 fumaroles.

No.	(7)	(8)
Orif. Temp.	95°C	94°C

The present ejecta including volcanic detritus and fine fragmental rocks, which are petrologically characterized by pyroxyne-andesite, were not originated from the fresh magma as was the case in the previous and historical activities of this volcano.

According to the field investigation carried out in the summer of 1950, the present volcanic detritus of larger sizes, 20-50 cm in their diametre, were mostly distributed within a distance of 500 m and towards the eastern side of the newly opened craterlets, or in other words, towards the base of Issaikyo. It is quite natural that the distribution of detritus of large diametre, as mentioned above, should have been affected greatly by the topography of the area in which the present craterlets were opened. On the other hand, the fine ejecta such as ash

and fine fragmental rocks fell on the south-eastern flank and foot of the mountain, blown there by the wind prevailing at the time of the present two explosions.

Judging from the size of the newly formed craterlets and the distribution of ejecta, we may conclude reasonably that the 1950 eruption was of a smaller scale than the 1893 eruption in the volume of ejecta as well as in the intensity of outburst.

3. Seismometric Investigation.

On the basis of the seismometric investigations[4] and the ancient records[5] both concerning numerous volcanoes in Japan as well as in the other parts of the world, it will be remarked that earthquakes at a depth of several kilometres under the volcanoes take place predominantly prior to and in the course of remarkable eruptions, in which fresh lava, especially that of acidic character such as andesite or dacite is extruded to the earth's surface. Thus it may be interesting to investigate whether such phenomenon appears or not in the eruption of the fumarolic type extruding no fresh material from the magma as was the case in the present activity of Azuma.

In the fumarolic activities of Volcano Kusatu-sirane[6] during 1937–1942, earthquakes of this type did not appear, notwithstanding the fact that the seismometric observation near the active crater was made by means of a highly sensible seismograph throughout the active period, though only microtremors caused by incessant steam explosions throwing mud-like ash were recorded as in the cases of the Strombolian eruption. However, in the 1949 activity of Mt. Yake-yama[7] which was apparently similar to those of Kusatu-sirane and Azuma in the nature of eruption, earthquakes of various depth ranging from several kilometres to the earth's surface took place in the course of the 1949 activity, and especially predominated for two or three days before the main explosions. Therefore, one of the writers[8] concluded in the previous Bulletin that the 1949 activity of Mt. Yake-yama or its effusive force at least must have originated directly from the depth of several kilometres under the volcano, or in other words, from the intrusive force of the fresh magma, which was not extruded to the earth's surface.

In contrast to that, it may be said that the eruptive force of Kusatu-sirane

4), 5) F. OMORI, *Bull. Earthq. Inv. Comm.*, **5**, **6**, **7**, **8** and **9** (1911—1921).
T. MINAKAMI, *Bull. Volcanol. (I.U.G.G), Sér*, II, **10** (1950), 59.

6) T. MINAKAMI, *Bull. Earthq. Res. Inst.*, **17** (1939), 590: **20** (1942), 505.

7) S. SAKUMA, and T. MINAKAMI, *Bull. Earthq. Res. Inst.*, **27** (1949), 117.

8) *loc. cit.*

just mentioned was derived through a mechanism similar to the geyser near the earth's surface and not from the fresh magma deeply seated.

Which is actually the case for the present fumarolic activity of Azuma? To throw a light on this problem, a seismometric observation was carried out for two months soon after the first explosion on February 10, at Tutiyu at the south-eastern skirt of the volcano, 8.5 km distant from the active craterlets. Notwithstanding the fact that a highly sensible seismograph (or to be more exact, the instrumental constants were always 1.0 second in its proper period of vibration and 200 on the smoked paper and 4,000 on the bromide paper both in its geometrical magnification) was used for this purpose, no earthquake from Azuma was recorded through the period of observation.

On the basis of the facts discussed above together with the feature of the present activity, it seems that the 1950 outburst of Mt. Azuma was not caused directly by the activity of fresh magma inferred to exist under the volcano. But this conclusion does not deny the idea that the heat energy necessary for the present fumarolic activity of Azuma and of Kusatu-sirane may have been supplied slowly or rapidly in the form of vapour and other gases of high temperature derived from the fresh magma.

4. Geomagnetic Survey of Mt. Azuma.

One of the writers has devoted himself to the geomagnetic surveys of the active and dormant volcanoes in Japan such as Asama, Huzi (Fuji), Miyake-Sima, Sakura-zima and Kusatu-sirane[9] etc. and also from now on intends to continue this investigation in order to elucidate the magnetic feature of volcanoes relating to the characteristics of each volcanic zone.

In the present investigation of Azuma, the writers spent several days on the magnetic survey, in which only the inclination of the geomagnetic field was measured at eight localities, which, as is shown on the map of Fig. 2, are distributed on the summit, flank and foot of the mountain. The results of measurement are given in Table II together with the heights above sea-level of the eight spots, and in addition, the relationship between these two kinds of value is illustrated in Fig. 4. As the figure shows clearly, the value of the magnetic dip increases in accordance with the height of the localities on which the measurement was made, though this relation is to some extent affected by the irregularities in topography.

9) T. MINAKAMI, *Bull. Earthq. Res. Inst.*, **16** (1938), 100: **18** (1940), 178: **19** (1941), 356: **18** (1940), 318: **16** (1938), 117.

Table. II. Magnetic inclinations and the heights above the sea-level of the eight spots at Mt. Azuma.

No.	Date	Mag. incl.	Height (a.s.l.)
1	June 27 (1950)	50° 3.'4	700 m
2	〃	51 56.9	1370
3	〃	51 15.9	1550
4	〃	53 6.0	1949
5	June 28	50 31.7	1560
6	June 29	51 47.8	1700
7	〃	51 7.0	1330
8	〃	49 8.3	900

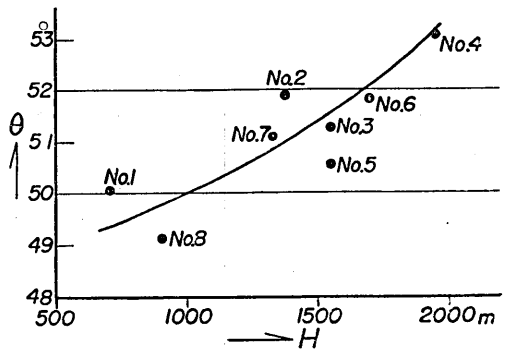
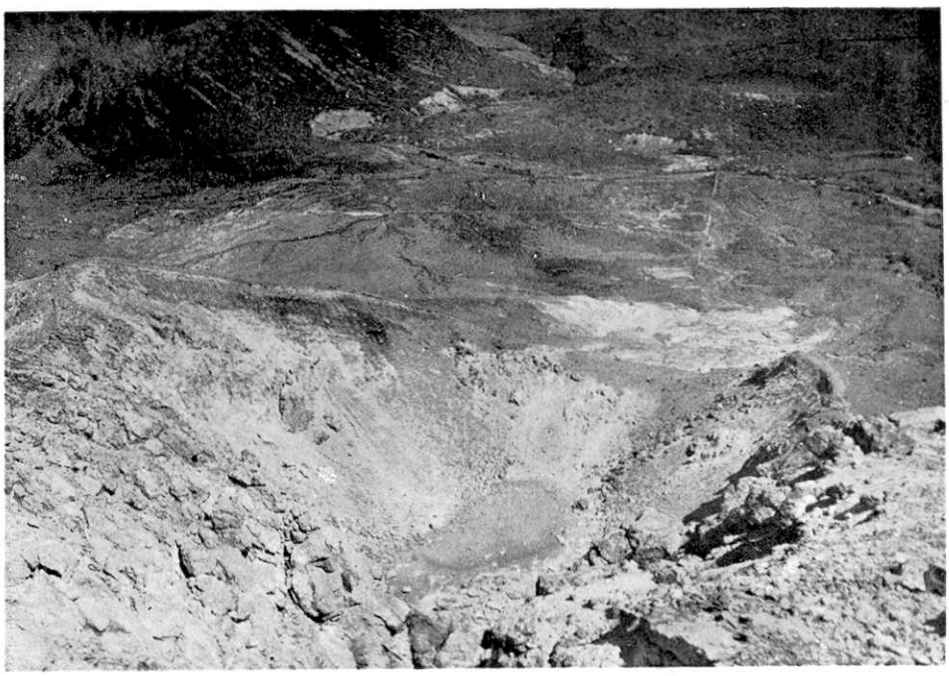


Fig. 4. The magnetic dip of eight points at Mt. Azuma and their heights above sea-level.

So far as the mode of magnetization[10] of the volcano is concerned, the phenomena are common with those of the volcanoes mentioned above. However, it must be remarked that the intensity of magnetization of Azuma is similar to that of the andesite volcanoes such as Asama, Sakura-zima and Kusatu-sirane etc., or in other words, with a third or a fifth of that of the saturated basalt volcanoes such as Huzi, Oo-sima and Miyake-sima. Seeing that the rocks forming Mt. Azuma are mainly characterized by pyroxyne-andesite as in the former andesit group of volcanoes, it will be only natural that the feature concerning the magnetic property of Azuma also coincides with the former.

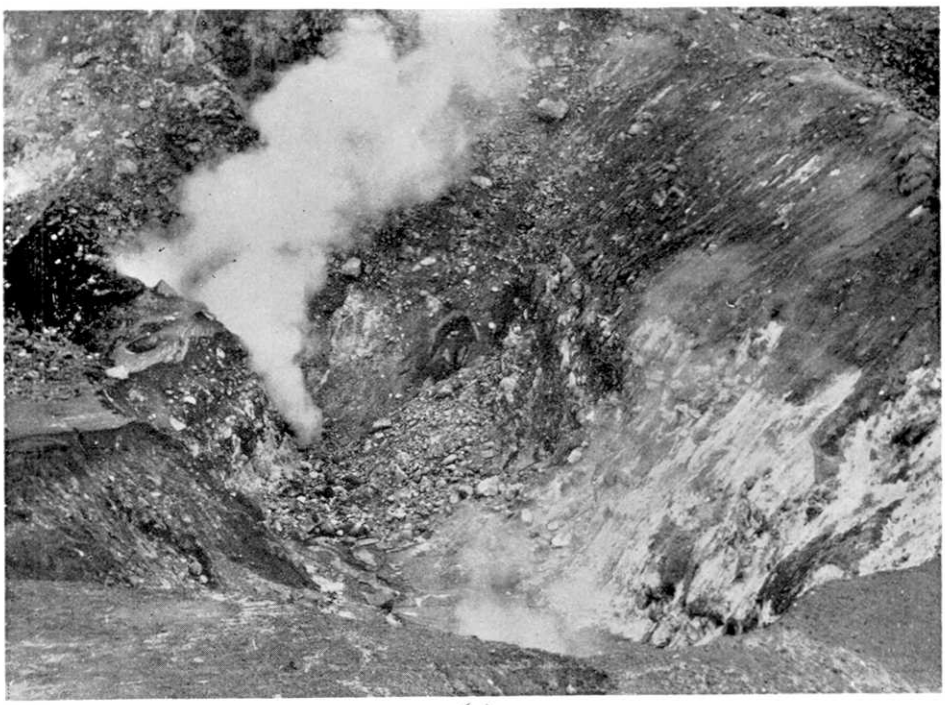
10) T. NAGATA, *Bull. Earthq. Res. Inst.*, **21** (1943), T. MINAKAMI, *loc. cit.*

(a)



(b)

Fig. 5. (a) Mt. Issaikyo, main cone of Azuma, viewed from its south-eastern base.
(b) The crater formed in 1893.



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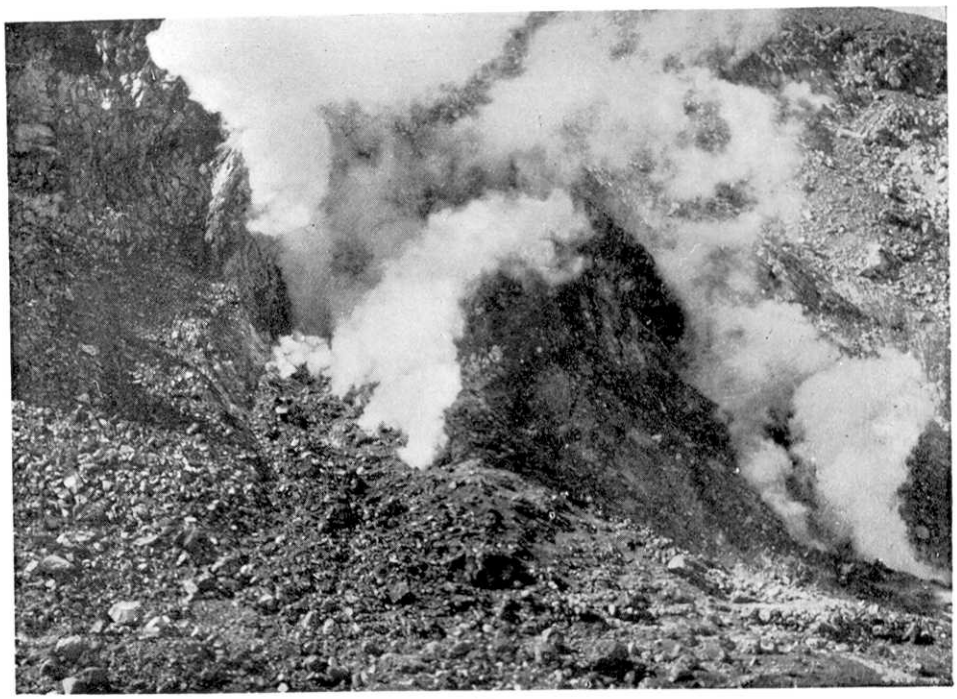
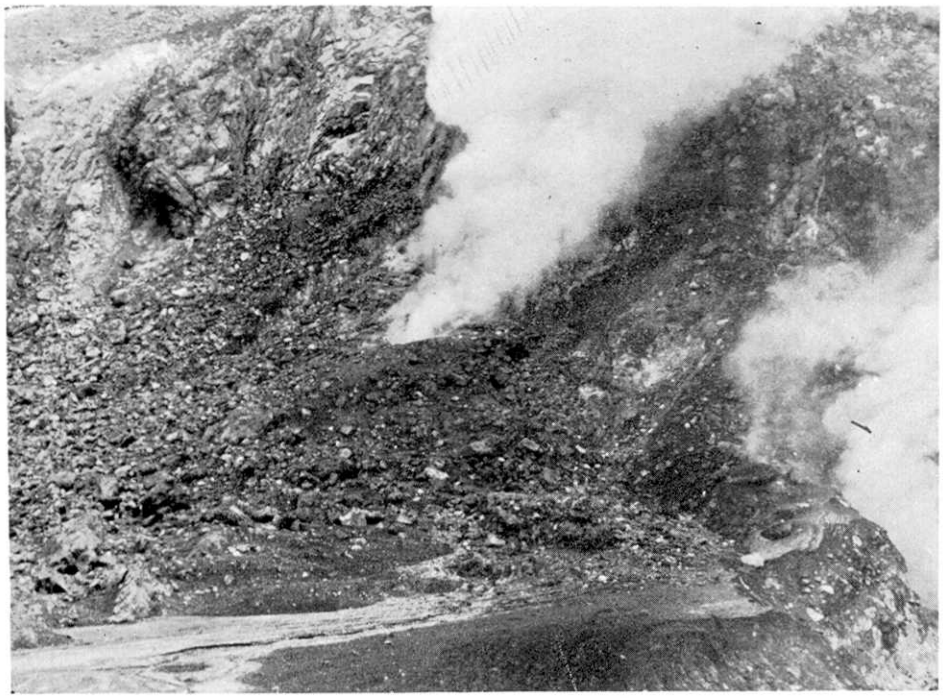


(b)

Fig. 6. (a) and (b)
The craterlet newly opened in the 1950 eruption.



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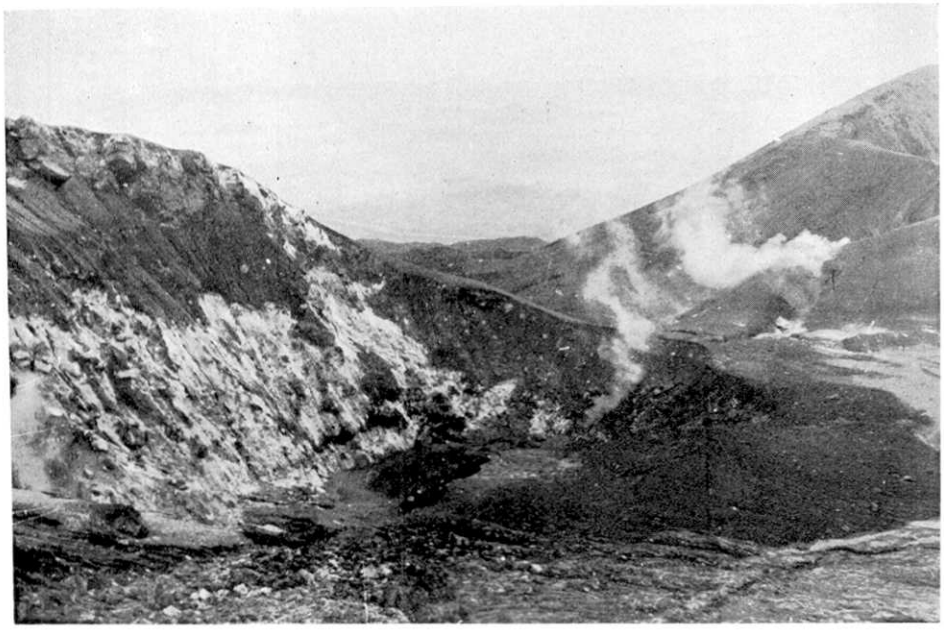
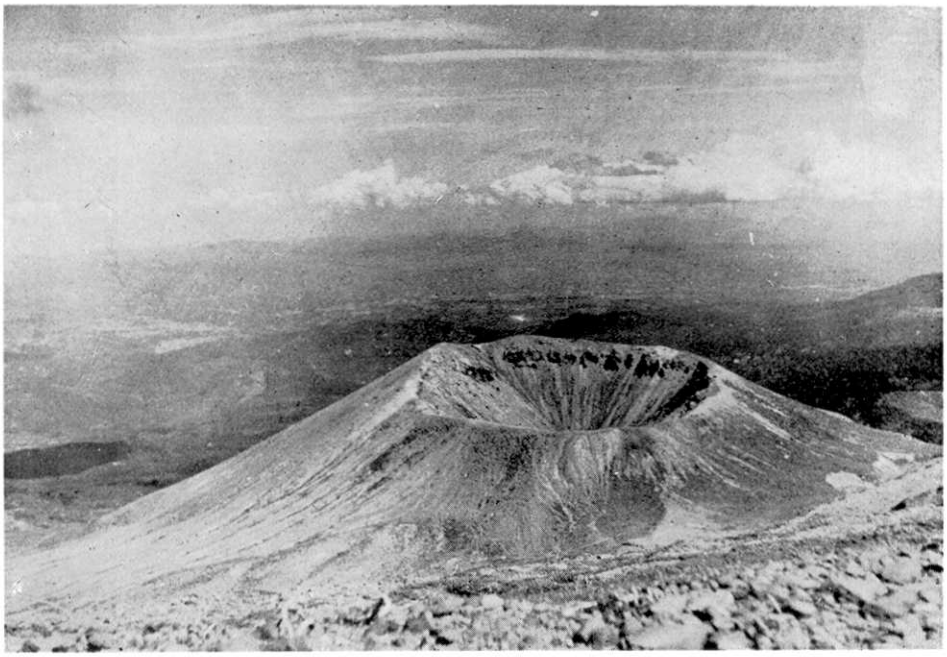
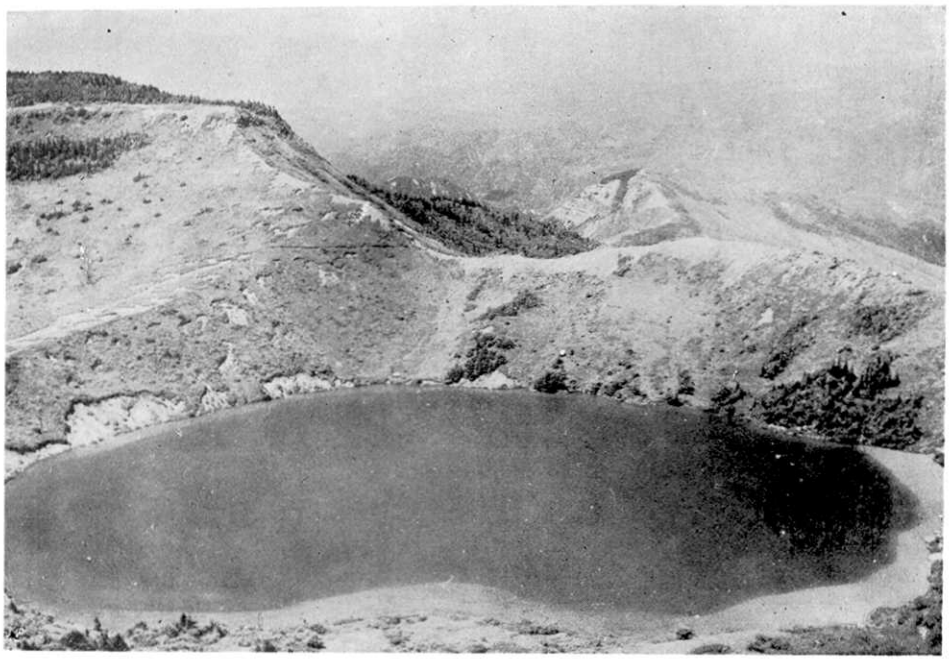


(b)

Figs. 7. (a) and (b)
The craterlet and fumaroles on the the fissure line (A_1A_1') opened in February, 1950.



(a)



(b)

Fig. 8, (a) Azuma-Kohuzi viewed from the top of Mt. Issaikyo.
(b) Gosiki-numa, a crater lake, viewed from the top of Mt. Issaikyo.

In conclusion, the writers wish to express their cordial thanks to Mr. M. Izeki, Chief of Civil Engineering Section of the Hukusima Prefecture for the facilities given them in the present investigation, and to Mr. T. Miyazaki for his valuable assistance in the field investigation.

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33. 1950 年 2 月の吾妻山の小活動

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吾妻山は 1893 年の噴火以來 57 年ぶりで 1950 年 2 月に活動した．前回の噴火は磐梯山の大爆發及び安達太郎山の噴火と共に 1888 年より 1899 年の間にこれ等の互に近接する 3 火山が相次いで活動を示した．從つて今回の吾妻山の噴火が他の隣接する諸火山に波及するか否かについて大いに注目された．しかし一年後の今日迄は他火山に異常は認められない．

今回の吾妻山の噴火後直ちにその山麓の土湯に高倍率の地震計を設置して約 2 ケ月間觀測したが火山に源を持つ地震は全く發生しなかつた．

1950 年 7 月に，2月の噴火で生じた小火口群及び噴氣孔の位置を定めるためにその附近の地形測量を行つたが，同時に火山の帶磁の狀態を知るために磁氣伏角の測定を行つた．

地震觀測の結果並に噴火の性質から判斷して，今回の吾妻山の噴火は地表近くの溫泉現象に類似する活動であつて，同火山の下或る深さに存在すると推定される岩漿の噴出作用に直接關連する活動とは考えられない．

またその活動の規模は，1893 年の噴火に較べて，その噴出岩屑の量においても，その噴出力においても著しく小さいものであつた．
