19. A Brief Note on the Recent Explosive Activity of Volcano Yakeyama.

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Volcano Yakeyama, Niigata Prefecture[1], broke out in sudden explosion on the fifth of February, 1949, after a 95 years period of quiescence since 1854. The explosion was followed by another on the seventh of the same month. In the first explosion, the volcanic ash was blown off southeastwards and fell on the snow-covered ground extending over Nagano, Gunma and Tochigi Prefectures, but there was no eruption of lava-flow throughout the entire period of the present activity.

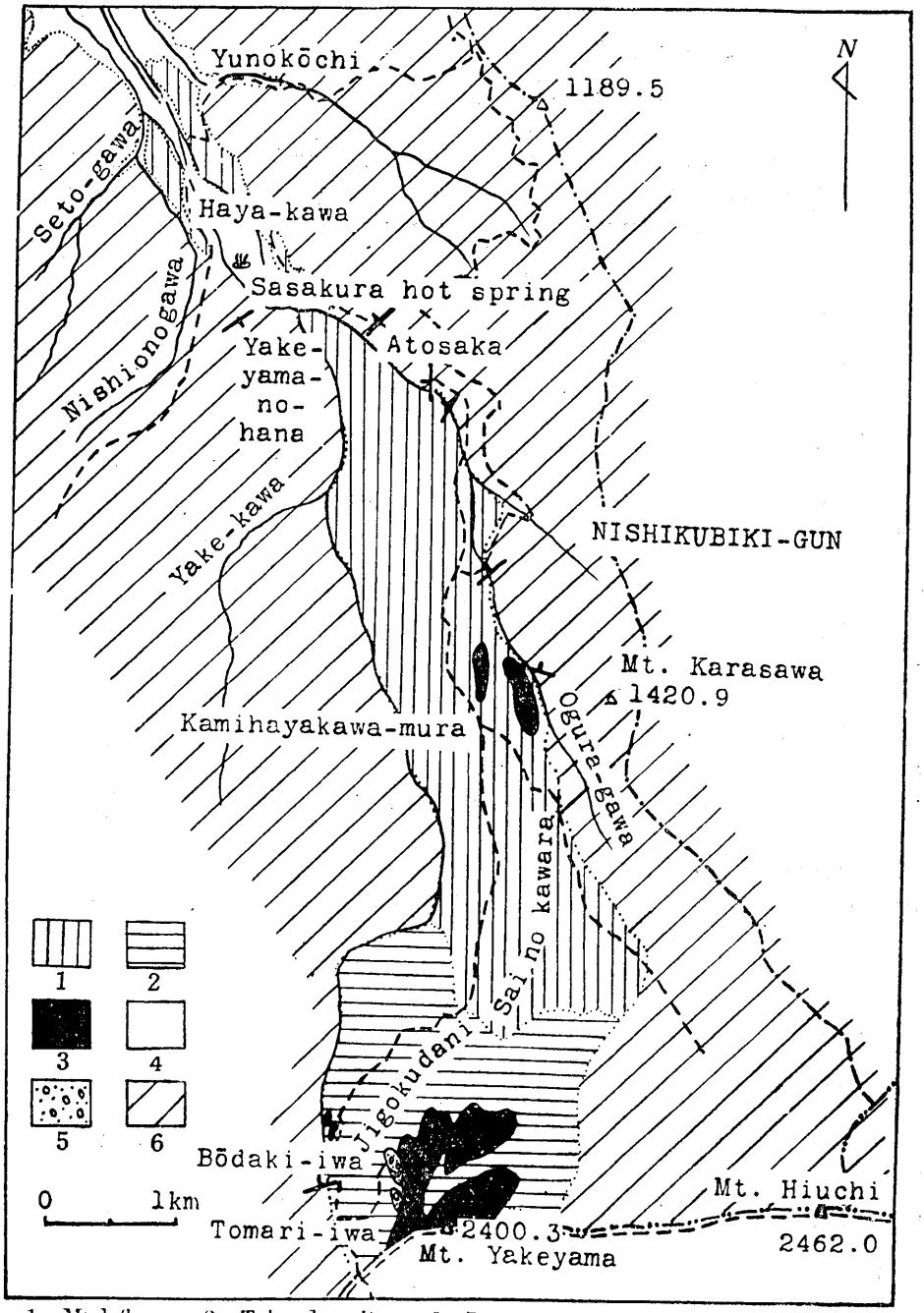
Yakeyama has long been neglected without any further geological investigation except that carried out by late Dr. N. Yamazaki many years ago[2]. Even after the recent explosions, it had not been intended to be examined before Tsuya and Ichimura had an opportunity in this summer to study the activity in co-operation with Dr. Minakami and his associates. In the beginning of August, they spent several days on the volcano and observed geologically the scene of the present activity. The rock-specimens collected by them were petrologically examined by Morimoto, although their chemical characters have not yet been determined. The present paper is a summarized note of the result of these field and laboratory works.

Yakeyama is an isolated volcano in a highly mountainous area, rising up to 2400.3 m above the sea (Pl. Figs. 1—2). It adjoins Hiuchiyama (2462 m) on the east and Hirukurayama (1840.9 m) on the northwest, while it lowers abruptly northwards to a gently sloping ridge between the rivers Yake-kawa and Ogura-gawa. Although the volcano is in a young stage of the erosion cycle, it is more or less asymmetrical in shape. Thus, looking from the northern foot, its left-hand (eastern) side is convex upward in profile, suggesting the original slope of a lava-dome,

1) The volcano is accessible from Kajiyashiki, a small town along the Hokuriku Railway Line, passing through the villages Otozaka and Yunokochi and the Sasakura hot-spring resort. Its summit is about 16 km distant from Yunokochi.

2) N. YAMAZAKI, *Rep. Earthq. Inv. Comm.*, 8 (1895) 55-60.

Fig. 1. Geologic map of Volcano Yakeyama.



1. Mud flow. 2. Talus deposits. 3. Lava. 4. Recent fluviatile deposits.
5. Agglomeratic lava. 6. Tertiary.

whereas the other side is concave upward, being mostly covered with talus conoid studded with lava crags.

The volcano (Fig. 1) is underlaid by Tertiary sediments composed of dark-gray or black shale and gray or dark-gray sandstone. These sediments are well bedded and highly cliffed along the Yake-kawa and Ogura-gawa, where there are likely to be two different formations unconformable to one another, dipping 20°—70° northeast or northwestwards. They may be assigned to the Miocene and Pliocene, although their definite

Table I.

Phenocrysts	1	2
Plagioclase	An 65—60, An 55, An 70—47, An 60—54, Commonly An 60—55.	An 78—73.
Augite	β_D=1.700, 2 V=49°	2 V=55°, 57°.
Hypersthene	(−) 2 V=55°, 56°, 58°, 56°−58°, (core) (margin) γ_D=1.712, ρ>v about X	(−) 2 V 56°, 57°. ρ>v about X.
Oxyhornblende	(−) 2 V=74°, 76° α_D=1.666 β_D=1.705 c ∧ Z≒ 3°, γ_D=1.730 X=Light orange yellow Y=Orange Z=Dark reddish brown X<Y<Z ρ<v about X.	——
Olivine	−	(−) 2 V=86°
Magnetite	+	+
Groundmass	Andesine Augite Hypersthene Magnetite Glass Tridymite (±)	Labradorite (An 65±) Augite Hypersthene Magnetite Glass

1) Hornblende-olivine-bearing two-pyroxene-andesite.
2) Basaltic inclusions in the andesite.

horizons have not yet been determined by ossils. Some of these Tertiary formations exposed here are intruded by liparite, propylite and allied volcanics. Hiuchiyama, Hirukurayama, Eboshiyama, etc. are the mountains made up of the similar Tertiary sediments and locally covered by andesitic agglomerates. Recent fluviatile deposits form the alluvial flat in the down stream of the Haya-kawa, whereas a volcanic mud-flow accumulates in terraces in the valleys extending from the northern foot of Yakeyama down to the middle of the Haya-kawa.

Yakeyama is a massive volcano, where the lava, partially agglomeratic, is represented exclusively by olivine-hornblende-bearing two-pyroxene-andesite. The andesite here is mostly a compact and porphyritic rock with a dark gray color, although it often has a reddish color due to reheating. It is characterized by the presence of phenocrystic olivine, hornblende, augite, hypersthene and labradorite in the groundmass composed of augite, hypersthene, andesine, tridymite, magnetite and glass. The mineral components, as determined by Morimoto are shown in Table I.

Moreover, the lava includes frequently a number of small fragments of a basaltic rock and white-colored liparite. They must have come

Fig. 2. Doleritic inclusion in the andesite. Crossed nicols.

Fig. 3. Olivine coated with the groundmass similar to that of doleritic inclusions. Phenocryst below is oxyhornblende. Crossed nicols.

from the base rocks through which the lava erupted to the surface. The basaltic inclusions contain phenocrysts of bytownite, olivine, augite,

hypersthene, and microphenocrysts of augite and magnetite in the intergranular groundmass composed of labradorite, augite, hypersthene, magnetite and glass.

Olivine crystals, which occur as phenocrystic grains associated with pyroxene in the andesite lava, are always coated with the groundmass similar to that of the basaltic inclusions. Accordingly, it is inferred that the olivine crystals in the lava are xenocrysts derived from a basaltic (or doleritic) rock similar to the basaltic inclusions. Some of the pyroxene and calcic plagioclase that occur as porphyritic minerals in the lava have also microscopic characters suggestive of xenocrystic origin.

The mud-flow, which extends about 16 km from the volcano down to Otozaka along the valleys of the Yake-kawa, Ogura-gawa and Haya-kawa, with the width of 250–1500 m and the thickness up to 200 m, is one of the remarkable products of the volcano. It forms the bush-covered flat land (Fig. 4) of Saino-kawara, about 1450 m in height above the sea and 1500 m in width, on the northern foot of the volcano, and is traceable up to the middle of its northern flank. The mud-flow is a chaotic mass consisting of andesite-blocks, angular to sub-angular, and light-gray sandy material, together with fragments of various rocks (lamprophyre, silicified sandstone, shale, etc.) which must have come from the base of the volcano. The andesite-blocks, which are most abundant and attain

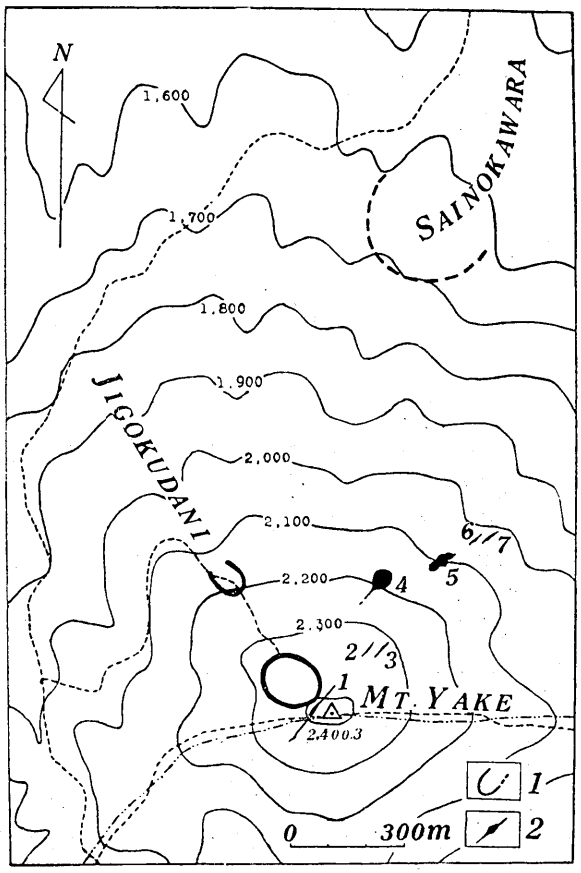


Fig. 4. Map showing the distribution of explosion craters and fissures
1···Explosion crater, 2···Fissures with fumaroles.

sometimes up to 2 m in diameter, are petrographically uniform, being quite similar to the lava (olivine-hornblende-bearing two-pyroxene-andesite) that forms the main part of the volcano.

The volcano has, at least, three explosion-craters. One of these is found on the summit, where it forms a bowl, about 150 m (E–W) and 60 m (N–S) in diameter, surrounded by walls, partly vertical and 30–70 m in height. Its bottom is buried with ashes and lava-blocks crumbled down from the surrounding walls. This crater was probably formed in 1361 when, according to a local tradition, an eruption of the volcano is said to have occurred, and when the volcano had been called Mt. Chausu or Mt. Jigoku.

Another explosion-crater is located on the northwestern flank, about 200 m down from the summit. It is a fissure-like opening, 10 m or more in width, running in a SE–NW direction along a cliff of the agglomeratic lava. This crater was probably formed by the explosion of 1852. Some small sulphur deposits are said to have been worked before on the ground about the crater, although at present only a feeble fumarole is found thereabout, together with a little sulphur incrustation on the rock.

The explosion-crater from which the Sainokawara mud-flow poured out is supposed to be situated just above the upper end of Saino-kawara, about 1700 m above the sea, on the northern flank of the volcano, although it is now obscured probably by the surface erosion and the thick accumulation of talus deposits.

Besides the craters above mentioned, there are several lines of fissures, suggestive of scars by explosions of unknown ages, on the southwest and south sides near the summit of the volcano. From the arrangement of these craters and fissures, it is inferred that the lava-dome of Yakeyama has been cracked radially with the summit crater as the centre.

The present explosions occurred on fissures arranged in parallel or *en echelon* in a zone running NE–SW through the summit of the volcano. Thus, several new explosion-fissures are traceable on the eastern wall of the summit crater (No. 1) and on the northeastern flank (No. 2–No. 7) (Figs. 4–5). Some of the fissures extend from the summit to several scores of meters down the southern flank. When the writers visited the scene, there were a number of fumaroles on the fissures, issuing whitish vapour-clouds from fissures or crater-like openings, with rumbling and hissing noises. On the summit were found eight fumaroles (Pl. IV, Figs. 3–4), of which the most active one was situated on the highest part of the eastern wall of the summit crater (Pl. IV, Fig. 4). The ground about

the fumaroles has been covered with incrustations of sublimates, the most predominant of which are sulphur and halotrichite [$FeAl_2(SO_4)_4 \cdot 24H_2O$][3]. The fumaroles showed a temperature ranging from 90.2° to 94,5°C. at their mouth, their exhalations being composed mainly of superheated steam with a small amount of H_2S and SO_2.

The fumaroles on the northeastern flank are located on the slope between 1950 m and 2300 m in height above the sea (Figs. 4–5; Pl. IV Fig. 2). Of these, No. 2 and No. 3 are at the highest level, about 70–80 m below the summit, whereas No. 4 is found by descending the slope, about 100 m northwards from No. 2 or No. 3. There is also No. 5 in the vicinity of No. 4, being followed by No. 6 and No. 7. The fumarole No. 4 is the largest and most active of all, while No. 5 has become dormant at the time of the writer's visit, leaving three bowl-like pits connected in a line on one of the fissures. One of the writers (Ichimura), who approached the rim of the fumarole No. 4 after traversing with difficulty the dangerous area intensely fissured by the present explosions, has found there a bowl-like pit, 60m in length, 40 m in width and 40 m or

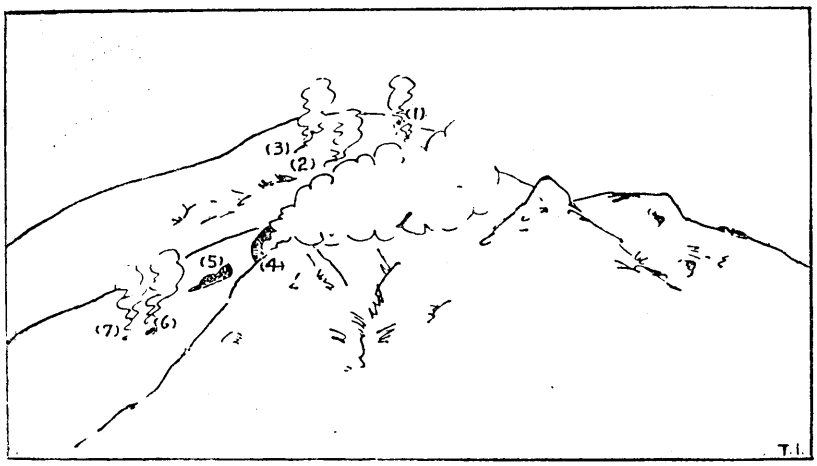


Fig. 5. A sketch showing the position of fissures with fumaroles.

more in depth, bordered with a steeply inclined wall (Pl. IV, Fig. 5). Its southern end passes into irregular crevasses, 4–6m in width, opened on the cliff of old lava (Pl. IV, Fig. 6), where sulphur is deposited beautifully as well as abundantly from the exhalations containing SO_2 and H_2S. The ground about the pit is thinly covered with halotrichite and traversed by small cracks here and there.

3) The writers owe Prof. T. Shirai for the chemical identification of the mineral.

As is shown by the fumarole No. 4, the explosion-pits have a tendency to from a bowl or funnel-shaped opening on the unconsolidated ash or talus-covered ground, but they become narrower and pass into crevasses in the hard and massive lava, representing the fissures that cut the volcano in the NE–SW direction through the summit. Though enlarged and came clearly into sight by the present explosions, these fissures seem to have been formed, together with other radial fissures on the volcano, either by the contraction due to cooling of the lava-dome or by the expansion due to upthrusting of the dome.

The present activity of Yakeyama is a type of the simple steam explosions that occur near the earth's surface without incorporation of the incandescent material. Thus the solid ejecta newly accumulated several scores of centimeters deep on the ground about the explosion-pits are exclusively fragments, ranging in size from blocks to ash, of the pre-existing lava of the volcano, neither new lava nor juvenile pyroclastic material having been ejected by the present explosions.

Expense of this research was defrayed from the fund for Scientific Research of the Educational Ministry.

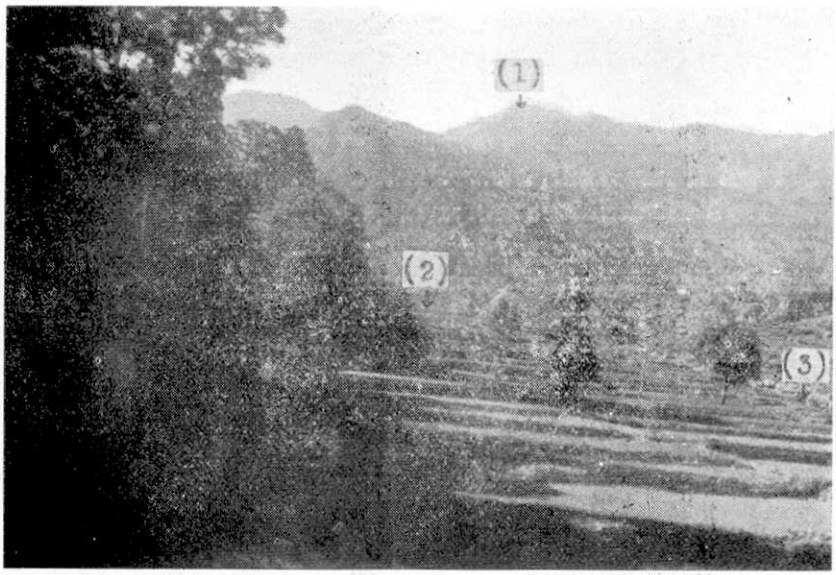


Fig. 1. Volcano Yakeyama looking up from Yunokochi.
(1) Volcano Yakeyama, (2) Sasakura hot spring. (3) The Haya-Kawa.

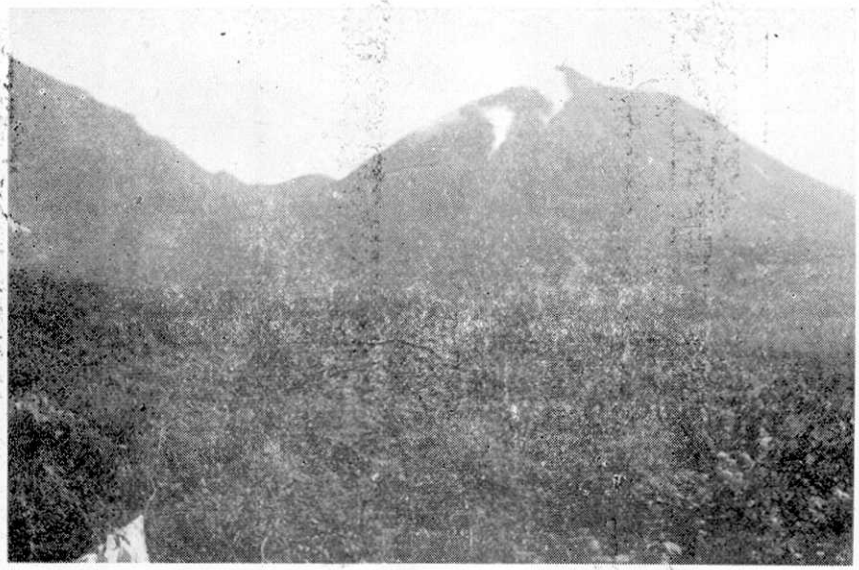


Fig. 2. Volcano Yakeyama viewed from near Sainokawara.

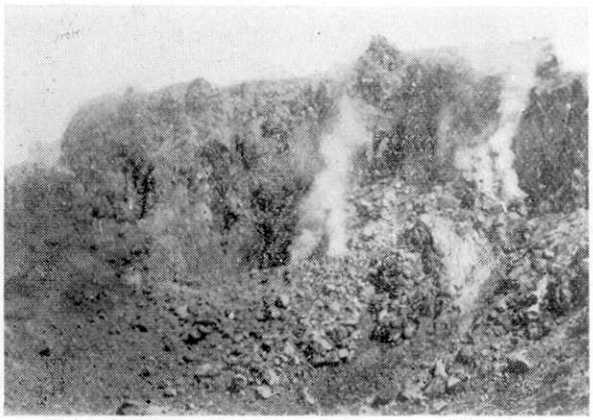


Fig. 3. Fumaroles on the summit (I).

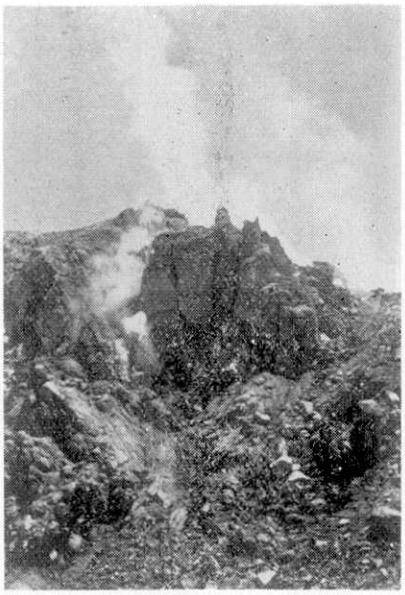
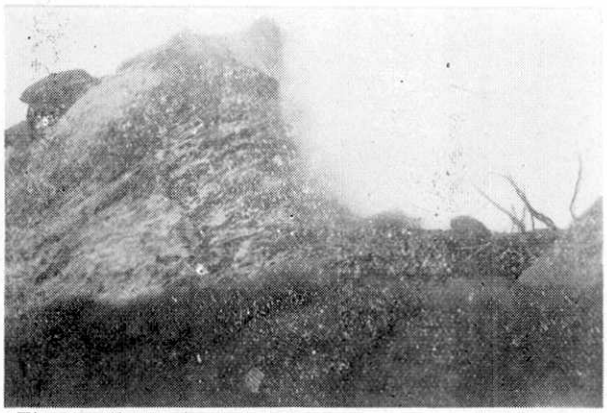


Fig. 4. Fumaroles on the summit (II)



Fig, 5. The most active fumarole on the northeastern flank. The white substance on the surface is halotrichite.

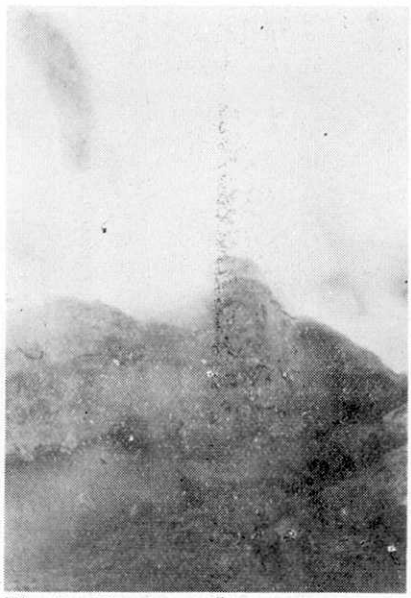


Fig. 6. The largest crevasse cutting through the andesite lava exposed on the northeastern flank. It is connected with a bowl-like pit northwards.