21. *Minor Activity of Volcano Yake-yama in 1949.*

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In the morning of February 5, 1949, Yake-yama which is situated nearly at the boundary of Niigata and Nagano prefectures, resumed its activity with detonations like those of avalanche or thunder and lasted about 20 minutes. Soon after that, ash began to fall over the villages on the eastern skirt of Volcano Myōkō, although neither the mountain body of Yake-yama nor smoke column of explosion could be seen at that time because of the thick snowy cloud. Slight precipitation of ash was also noticed at the northern Kwanto Plain. Since then, the volcano continued to emit thick smokes of water-vapour mixed with slight SO_2, H_2S and ash from newly opened fissures.

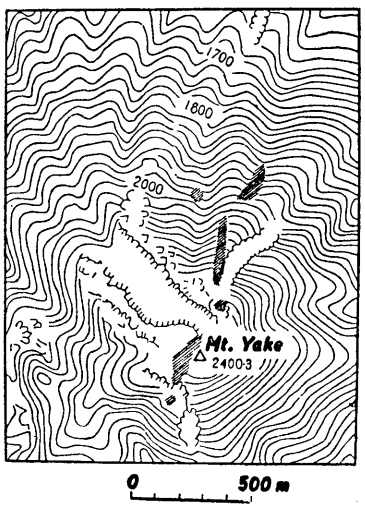

Fig. 1. Topographical map near the summit of Mt. Yake. hatched area; positions of newly formed craterlets, fissures and fumaroles.

Seismometric Observation.

The second took place on 13 h 38 m, February 8, with detonation, which was heard even at Takada. After the second explosion, the volcanic activity decayed by degree. But it manifested ebb and flow sometimes. For instance, detonations like a rushing train and sudden increase water-vapour, with no ash precipitation, were observed on February 15 and September 13. Volcanic ash, detritus and fragments of old lava fell and deposited on the snow of the eastern side of the volcano.

It is well known that not only volcanic tremors but earthquakes of ordinary type also take place before and during the eruptions of andesite volcanoes in which fresh lavas are extruded.

It is, however, an important problem whether earthquakes occur or not in such a minor activity as the present case. For, those volcanic activities

not accompanied by ejection of incandescent lava fragments as the present activity of Yake-yama are often classified into the fumarolic activity of large scale and sometimes ascribed to an extremely shallow origin. However, if earthquakes take place at the depth of several kilometres of the volcano, the volcanic activity may probably be not of extremely shallow origin, but may be caused by deeply seated magma.

Since February 6, the following day of the first explosion, a horizontal seismograph of the improved Ishimoto's type ($T_0=1.0$ sec., magnification $\times$ 200) was set at Akakura, 13 km ESE from the volcano. Since February 11, another seismograph of the same type was operated at Yunokōti, about 9 km NWN. Observations was continued till March 6 at the former temporary station and till June 10 at the latter.

On the basis of those seismometric observation, it was brought out clearly that several non-perceptible earthquakes took place in this period in the vicinity of Yake-yama as given in Table I.

Table I. P-S duration of earthquakes which occurred in the vicinity of Yake-yama.

Date			Akakura	Yunokōti	Nagano
	h	m	sec.	sec.	sec.
Feb. 7	12	29	2.9		
	12	30	2.6		5.0
	13	19	2.7	No observation	
Feb. 8	13	13	? (Sound wave of 2nd explosion ?)		
Feb. 20	15	30	2.4	?	
Mar. 4	11	8	3.0	2.1	
Mar. 21	12	43	No observation	2.0	

Among them the earthquake at 12 h 30 m, February 7, was the most remarkable and was recorded also at the Nagano Meteorological Observatory, about 35 km S from the volcano. P and S phases of seismic waves of this earthquake could be quite easily distinguished on the seismogram obtained at Akakura, where the P-S duration was 2.6 sec. At Nagano, however, the form of the earthquake-motions was so much complicated that even the P-S duration was estimated with difficulty at 5 seconds.

Judging from our knowledge of the shapes of shallow earthquakes originated from volcanoes as reported in the same Bulletin[1] regarding various earthquakes of the Usu volcano, we can infer that the present

1) T. MINAKAMI, *Bull. Earthq. Res. Inst.*, **27** (1949), 123, 129.

earthquake must have been originated at the depth of not less than a few kilometers, not extremely shallow. Accordingly, it will be reasonable to consider that the activity of Yake-yama also had its source of effusive energy at the depth of a few kilometres at least.

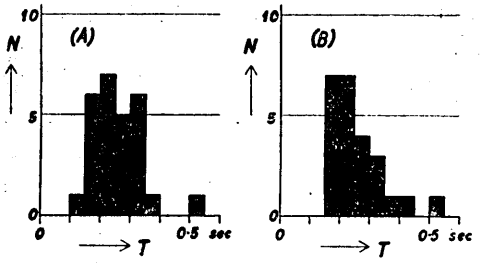

Fig. 2. Frequency distribution of periods of earthquake-motions observed at Akakura.

In order to show a character of two earthquakes recorded at Akakura, we made period analyses of their earthquake-motions and as will be seen on the diagram of Fig. 2, the shorter periods than 0.3 second are markedly predominant for both earthquakes, being 0.25 and 0.26 second in the mean periods respectively. The characteristics just mentioned are similar to the earthquakes of tectonic and volcanic origin, of which hypocentres are found several kilometers deep.

More minute observations (4,000 times in magnification) were also made at Akakura during two nights on February 6 and 7, but no unquestionable micro-earthquake and volcanic tremor were recorded.

Topographical Survey.

Detailed investigations of the newly formed craterlets were carried out in August of the same year. Positions of craterlets and fissures were determined with a transit by triangulations from three base-points whose positions were also fixed with regard to the triangulation points of the Land Survey Department. As shown on the map of Fig. 3, fissures and craterlets were aligned on the several lines running towards N 10°–30° W and as a whole in a single N 20° W zone which is about 150 m wide, 1 km long horizontally, cutting across the eastern wall of the top crater. The lowest fumarole newly in action was about 1880 m high above the sea-level on the northern side of the volcano. Largest craterlet was 50 m in diameter, and some craterlets opened into the others and become cocoon-shaped.

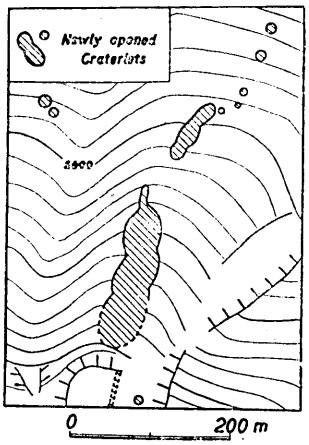

Fig. 3. Newly opened craterlets on the northern side of the volcano.

According to the present investigation, it was made clear that the newly opened fissure passed through the central part of the old summit

crater, in which a craterlet of conical shape, about 30 m in diameter, was newly formed in the present explosion, though it had been already in dormant state at the time of our investigation.

In short, we can conclude that the present explosive activity of minor scale took place along the weak line of formation running through the top in the direction of nearly N 20° W.

On the other hand, water-vapour and volcanic gases were emitting from some of craterlets and fissures in August 1949. Temperature of gases was measured at 92.5° C in the depth of 0.9 m from the jet of a newly formed small fumarole near the summit. Other two fumaroles near by showed the same temperature.

Mud Flow.

Ash and detritus which were ejected in the series of the present explosions and deposited on the snow of the eastern side of the volcano, flowed down mixed with abundant water in spring when the snow began to melt by degree. Namely, the water of the riverlet Ogura (Hiuti) which

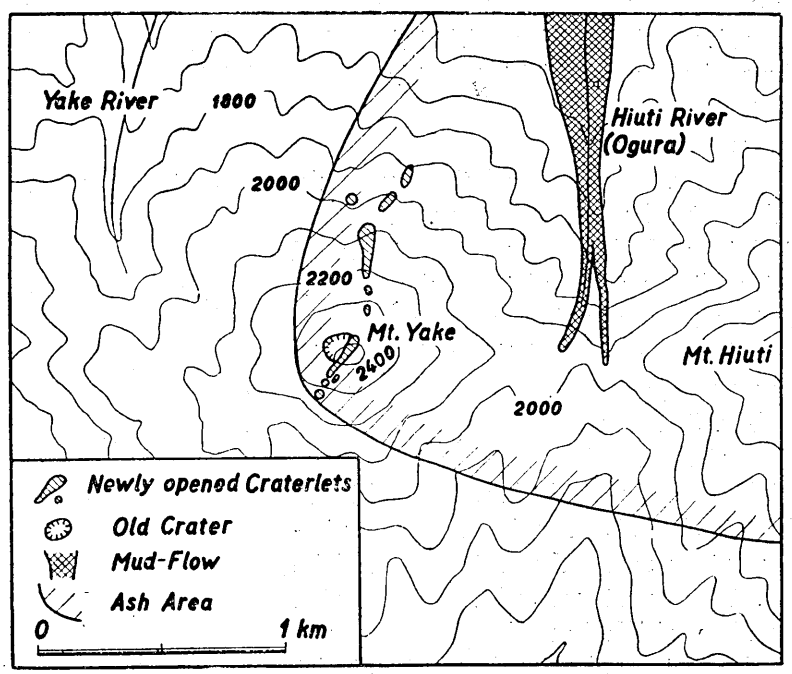

Fig. 4. Devasted area caused by the mud-flow on July 30 and the craterlets newly formed.

runs between Mt. Hiuti and this volcano, became muddy of greyish black colour and piled muddy ash upon the rice-fields under irrigation. After

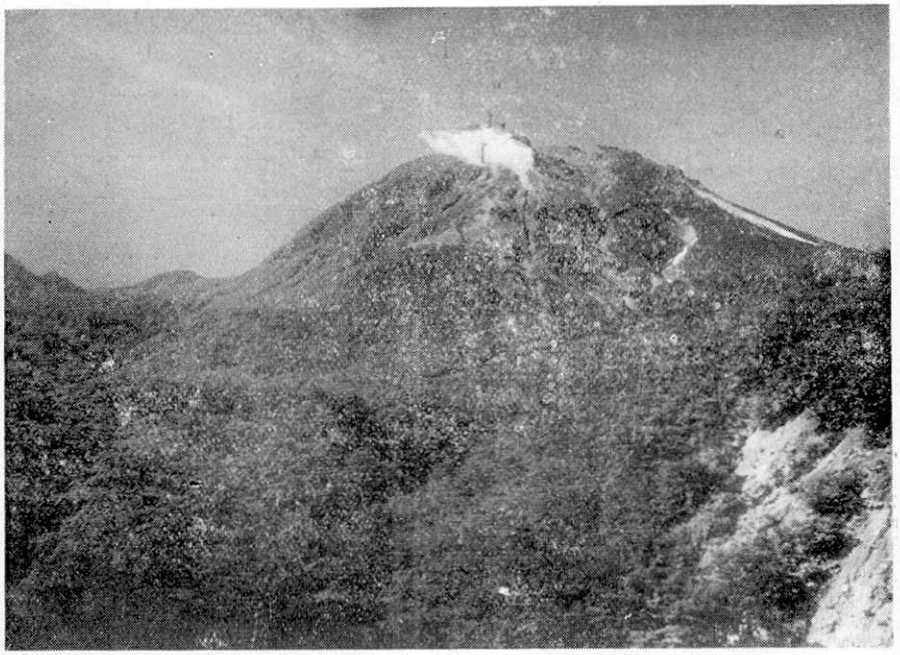

Fig. 5. Mt. Yake viewed from the northern side.

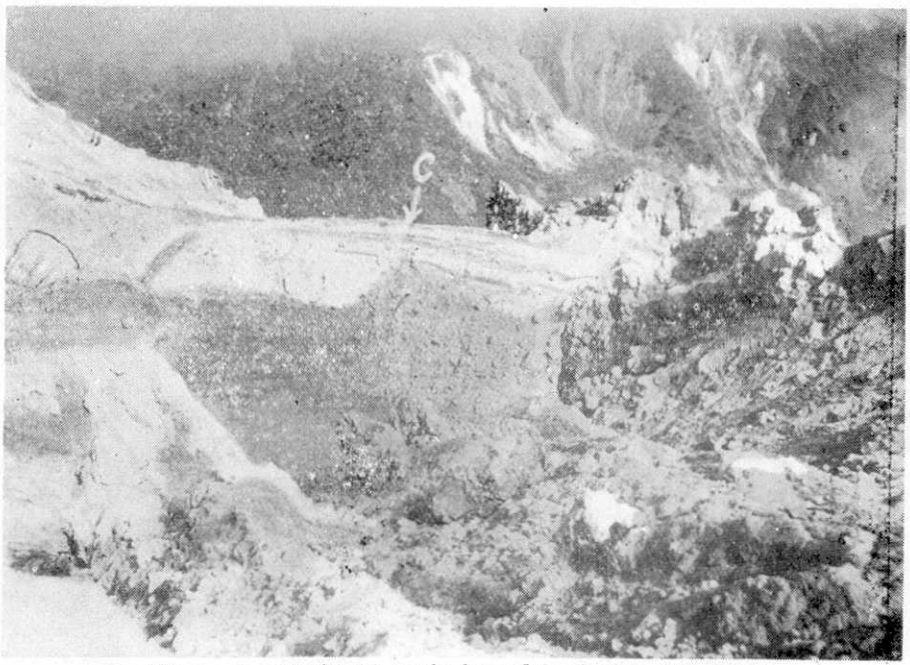

Fig. 6. A craterlet (c) newly formed in the summit crater.

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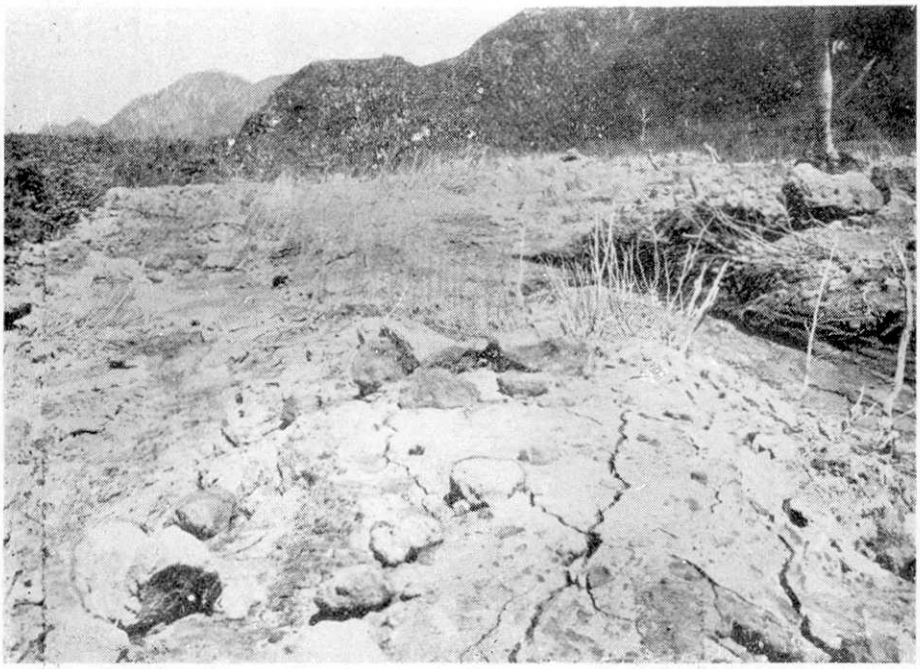

Fig. 7. Devastated area caused by the mud-flow on July 30, 1949.

Fig. 8. Mud and water dammed up by collapse of riverside cliffs.

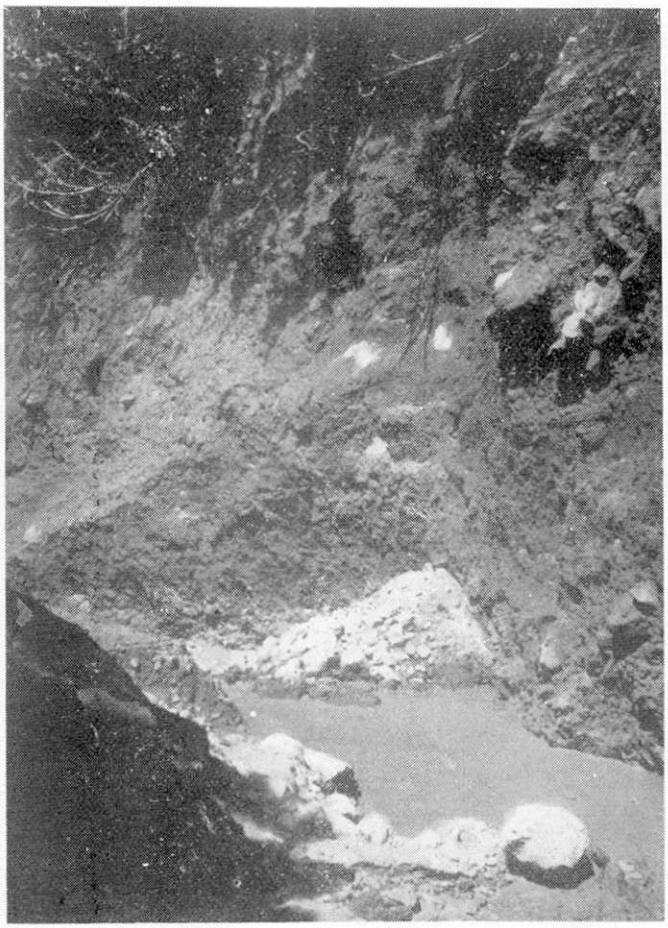

Fig. 9. Mud and water dammed up by collapse of riverside cliffs.

heavy rainfalls on the upperreaches on 30 th July 1949, extremely thick mud-flow rushed down the Ogura (Hiuti) river, buried some of the rice-fields and destroyed wooden bridges. (Fig. 4). Especially at a narrow valley of U-shape and of 8 m wide, about 4 km south of Yunokōti, trace of mud-flow was about 10 m higher than the usual water-level. Moreover, difference of height of mud trace in the both sides at a curved channel attained to 3.5 m. On the basis of the investigation just mentioned, the flowing velocity and viscosity of the mud-flow were roughly estimated at 8 m per sec. and 2×10^4 c. g. s..

Though, of course, the mud-flow consisted not only of newly ejected ash and detritus but also of fragments of old formations on the riverside, it may be properly called a kind of minor mud-flow of volcanic origin or secondary volcanic origin. When the writers ascended the upperreaches of the mud-flow on August 5, ash and fragmental detritus still remained on the snow, and as will be seen in Figs. 8 and 9 mud together with water was dammed up by collapses of riverside-cliffs at several spots. Judging from the result of field investigation, it may be evident that the mud-flow on July 30 might have been caused by sudden collapse of such dammed muddy water as described above.

The detailed study of this volcano and its present activity is under way on the basis of the seismometric observations and the present field investigation. The writers report here only an outline of the present activity of Volcano Yake-yama.

Finally, it may be added that the writers made the present research in cooperation with Dr. T. Ichimura, Dr. H. Tsuya and Dr. R. Morimoto[2] and most of the expense necessitated for the field investigations was defrayed from the funds for Scientific Research of the Department of Education, which were given to Dr. H. Tsuya and one of the writers.

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2) T. Ichimura, R. Morimoto & H. Tsuya, *Bull. Earthq. Res. Inst.*, **27** (1949), 107.