Journal of Natural Disaster Science, Volume 5, Number 2, 1983, pp. 15-31

VOLCANO HAZARD ASSESSMENT OF MOUNT FUJI

Natural calamities strike at about the time when one forgets their terror
——a Japanese proverb——

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(Received Nov., 28 1983, and in revised form Feb. 4, 1984)

ABSTRACT

A hazard assessment of a possible future eruption of Mount Fuji was made from data in old documents recording the tephra fall of its 1707 eruption. The thickness of basaltic scoriae and ash in 120 localities as far away as Tokyo was found from historical records. An isopach map was drawn from thes data which is in good agreement with the isopach map made by Tsuya based on his volcano-stratigraphic study. The major axis of the isopachs coincides with the prevailing wind direction during the corresponding months as recorded at the Weather Observatory on the summit of Mount Fuji. Old documents prove that the delay in the tephra fall between Odawara and Tokyo is approximately one hour, enough time for diaster warnings to be given. An eruption of Mount Fuji in the near future is likely after its long period of dormancy and probably will be explosive as was the 1707 eruption. Thus, the volcanic events of the 1707 eruption are considered a good basis from which to make a hazard assessment of Mount Fuji. A hazard map was drawn from the data collected on this 18th century eruption.

1. INTRODUCTION

Mount Fuji, the highest mountain in Japan is located 100km WSW of central Tokyo and is a typical strato-volcano with beautiful slopes. Its volume is about 1400km^3.

Its last eruption was in December 1707 (the Hoei Eruption), since then no marked volcanic activity has been recorded. This 1707 eurption was exceedingly violent and provinces to the east of the volcano were covered by falls of thick scoria and ash.

On October 28, 1707, a major earthquake (the Hoei Earthquake), magnitude 8.4, occurred. Its epicenter was located at the southern tip of the Kii Peninsula. It killed 4900 people and destroyed 29000 houses along the Pacific coast from the central district of Honshu. Then, 50 days after this earthquake, a gigantic eruption of Mt. Fuji took place whose ash falls raised river beds near the volcano. In 1708, heavy precipitation caused flooding of the Sakawa River to the east of Mt. Fuji. The next few years also brought drought and bad harvests to central Honshu. Thus this period of the 1700s deserves special attention in the history of natural hazards in Japan, especially as farmers in the vicinity of Mt. Fuji were left destitute by these disasters.

Historical records tell us that Mt. Fuji has erupted on at least 17 occasions since the 9th century. Two hundred and seventy-six years have passed since the last eruption and an awakening of Mt. Fuji in the near future is probable. Use of the land surrounding Mt. Fuji has changed greatly since the last eruption; traffic networks and land near the volcano have been extensively developed. Consequently, if it erupts the social confusion and economic damage would be impossible to estimate. Thus, there have been many requests for a hazard assessment of the volcano's future activity as well as for volcano watch-

Note: Discussion open until 1 March, 1985.
KEY WORDS: Volcano, Volcano hazard, Hazard assessment, Mount Fuji, Hazard map

ing to mitigate volcanic disaster.

The 1083 eruption was the last from which there was a basaltic lava flow; since then Mt. Fuji has had only tephra eruptions from its summit or flanks. Future activity is expected to be similar to that in the 1707 eruption. Therefore, an examination of the area effected by the air-fall tephra of the Hoei Eruption provides useful data for a hazard assessment. Volcanic hazard maps have been published for volcanoes in the Cascade Mountains of North America, and for volcanoes in Indonesia and Papua New Guinea; they are drawn on spatial hazard zonation.

Often large eruptions start with minor activity, and to establish countermeasures for the

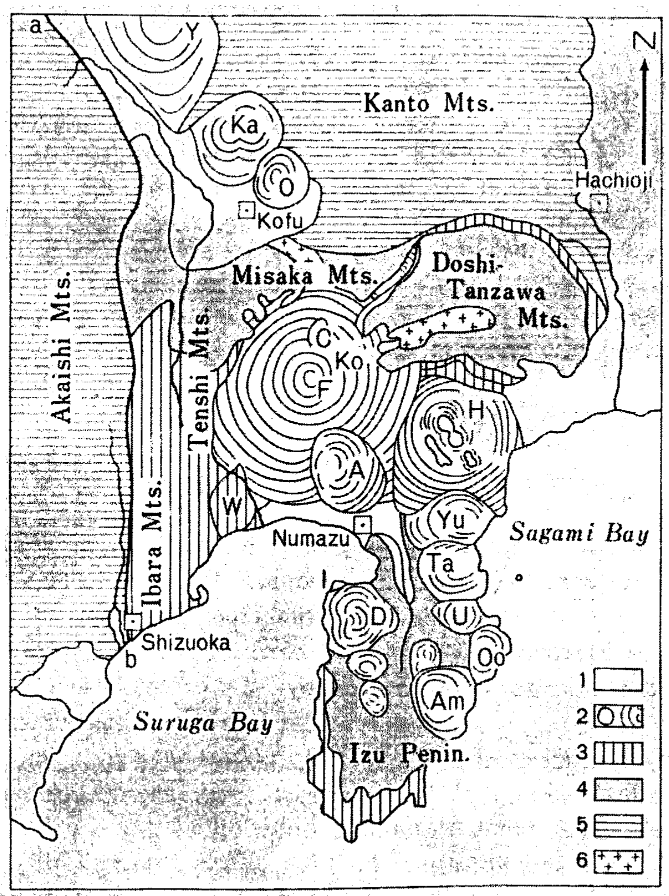

Figure 1. Geologic sketch map showing the position, geographical and geological, of Mt. Fuji (Tsuya, [6])

1. Quaternary formations.
2. Quaternary volcanoes: Mt. Fuji (F and Ko) and adjoining Ashitakayama (A), Hakoneyama (H), Volc. Yugawara (Yu), Taga (Ta) and Usami (U), Amagisan (Am), Omuroyama (Oo), Darumayama (D), Kayagatake (Ka), Yatsugatake (Y) etc., all lying in the Fuji volcanic zone.
3. Middle-Upper Miocene and Pliocene formations.
4. Lower Miocene formations.
5. Paleogene and pre-Tertiary formations.
6. Post-Miocene (lower) quartz-diorite intrusives.

a-b: Southern section of the Itoigawa-Shizuoka tectonic line, the west boundary of the fossa magna.

evacuation of local residents and for traffic control, we must evaluate the time-dependent hazards for each volcano. Thus, volcanic hazard assessments should be made within the following framework.

Hazard Assessment in Time and Space Domains

Space = [Area and thickness of the tephra and/or lava flows
(Volcano-stratigraphic studies
Historical records)]

Time = [Chronology of the eruptive sequence
Period of activity and time of the catastrophe
(Historical records)]

I have collected as many old written records as possible in order to draw up an isopach map of the air-fall tephra of the Hoei Eruption (1707) of Mt. Fuji and to examine the chronological data available on its other volcanic eruptions and resulting disasters.

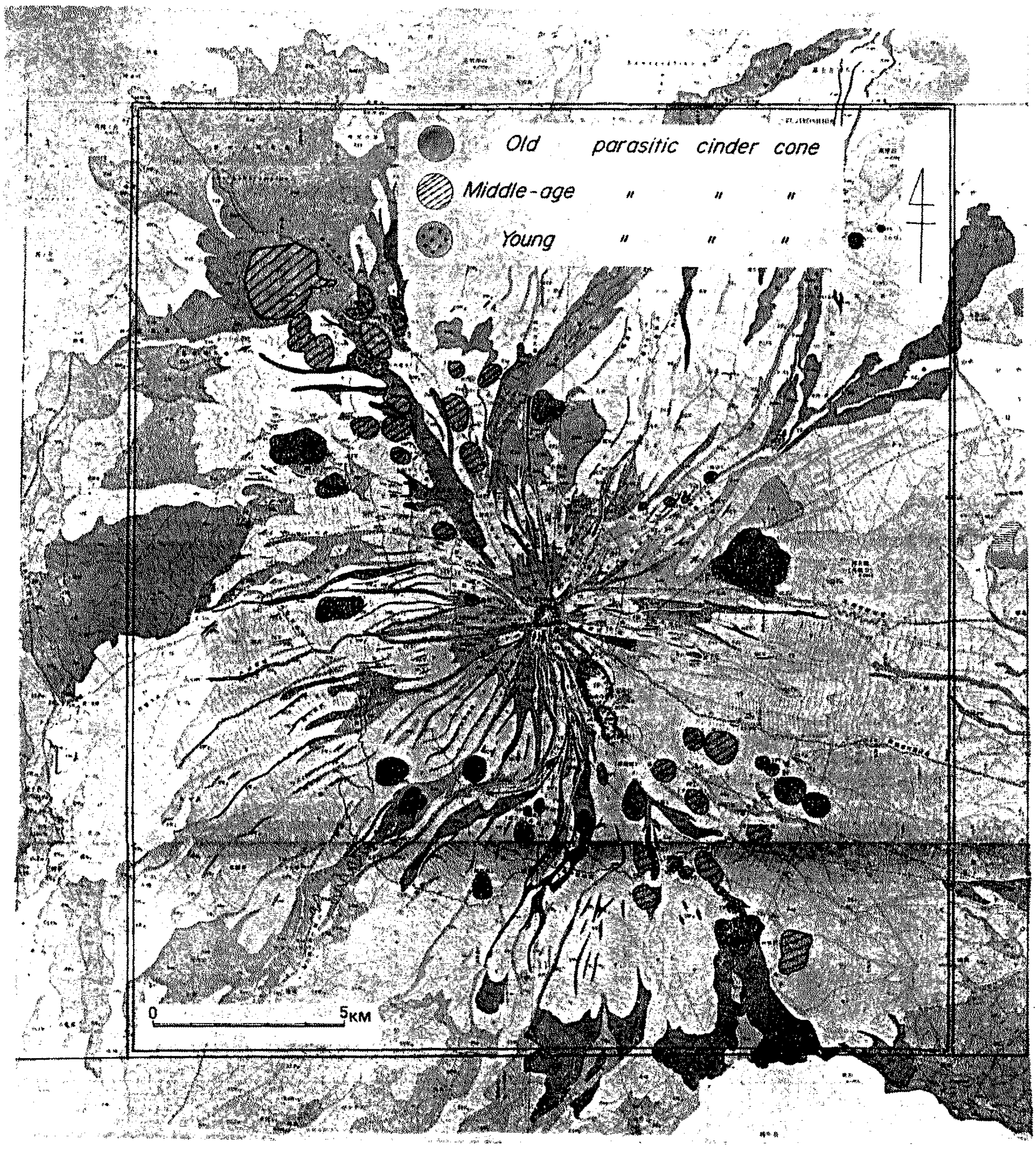

Fig. 2 A part of geologic map of Mount Fuji (Tsuya, [6])

2. GEOLOGICAL SETTING AND PAST ERUPTIONS

Thorough geological and petrological studies of Mt. Fuji have been made by Tsuya [1, 2, 3, 4, 5, 6, 7]. Because this mountain is the highest in Japan and its huge volcanic cone is located north of Suruga Bay, it seems to be an isolated stratovolcano. But, as seen in Fig. 1, Mt. Fuji is one of several volcanoes aligned in a zone called "Fuji Vocanic Zone" that runs east of western boundary of the fossa magna. Mt. Fuji is presumed to rise on Miocene formations, and is not a single structure despite its conical shape. It is composed of three volcanoes; Komitake, Ko-Fuji (old Fuji) and Young Fuji.

Komitake is the oldest of the three and is almost the same age as the Ashitaka Volcano on the southern margin of the present slopes of Mt. Fuji (Fig. 1). Komitake is classed as a giant stratified cone based on its height and the size of its crater exposed on the northern shoulder of the present Mt. Fuji. From the evidence of eroded topography, Tsuya [6, 7] posited that the eruptive activities of Komitake began as early as the middle of the Pleistocene and finished sometime before the end of that period when Ko-Fuji began to erupt.

Ko-Fuji is not exposed on the present Mt. Fuji, but volcanic deposits of agglomeratic mud-flows from it are distributed along the southwestern foot of the mountain [3].

Young Fuji is presumed to have begun its activity during the last ten thousand years of that period the present volcano was formed [6, 7]. According to Machida [8], tephro-chronological data indicates that the growth of Young Fuji possibly started 5000 years ago. A geological map compiled by Tsuya [6] is shown in Fig. 2 in which vents and cones

Table 1. Volcanic activity of Mt. Fuji recorded in historical documents.

Year, Date	Activity
Circa 719	volcanic plume (eruption?)
781, Aug. 4	eruption, ash fall
800, Apr. 15	eruption
802, Jan.	eruption
826	eruption
864, Jun. to 865	eruption with lava flow
870	activity in the summit crater
918 - 926	volcanic plume
932, Nov. 19	eruption (?)
937, Dec.	eruption
952	volcanic plume
969	volcanic plume
993	eruption (?)
999, Mar.	eruption
1017	eruption (?)
1033, Jan. 25	eruption with lava flow
1083, Mar. 25	eruption with lava flow
1205 - 1340	intermittent vocanic plume
1511	eruption
1560	eruption
1615	volcanic plume
1700	eruption
1707, Dec. 16	eruption, ash fall

numbering 100 are presented.

Records of Mt. Fuji's volcanic activities are tabulated in Table 1. During the past 1000 years, some twenty events have been recorded, among which the eruptions of 864-865 and 1707 were exceptionally large. From 1083 to 1511, no eruptions were recorded, but volcanic plumes were sometimes observed. Since that long dormancy, no lava outflow has been recorded.

3. THE 1707 HOEI ERUPTION OF MOUNT FUJI

Eruptive activity based on historical records has been described in detail by Tsuya [5]. As a warning sign, unusual rumbling were heard from Dec. 3rd, 1707 by residents near the northeast foot of the volcano. From the evening of Dec. 15th, earthquakes were felt more than thirteen times along the southern foot of the volcano (Yoshihara) and were very frequent the next morning. At about 8h on Dec. 16th, thunder-like strong rumbling was heard at Subashiri and black cloulds were seen rising in the west. At Yoshida, Yoshihara, Fujimiya and as far away as Tokyo volcanic could were first observed about 10h. According to the old records, for the first several hours, the air-fall was whitish ash and sand which later changed to black sand. This variation in ejecta can still be observed at outcroppings (Fig. 3).

The eruption took place on the southeastern flank of the volcano and produced three craters, the Hoei Craters, shown in Figs. 4 and 5. Violent eruptions that spewed out

Fig. 3 An outcrop of the Hoei tephra at Shibanta.

Fig. 4 An old painting of the Hoei eruption (by the curtesy of Mr. Takiguchi).

Fig. 5 The Hoei craters of Mount Fuji (by the curtesy of Shizuoka Press).

basaltic scoria continued until Dec. 30th, after which there were intermittent, less violent eruptions which ended on the last day of the year. According to Thuya [5], the total volume of ejecta, calculated from his stratigraphic study data was approximately $847\times10^6\mathrm{m}^3$ ($0.85\mathrm{km}^3$) and the area covered with ejecta was $6,243,751\times10^3\mathrm{m}^2$.

4. CONSTRUCTION OF AN ISOPACH MAP OF THE AIR-FALL TEPHRA FROM THE HOEI ERUPTION OF MOUNT FUJI

Usually, old tephra deposits (especially ash) are hard to trace if the amount was small at the fall time and erosion has taken place over a considerable period. For hazard assessments, the thickness of tephra deposits should be measured immediately after an eruption. Therefore, in addition to Tsuya's elaborate field survey, I have collected data on the thickness of the tephra recorded in old documents other than stratigraphic studies. Fortunately, by the order of the government, which intended to reduce the annual rice tax of farmers in effected area, the thickness of the tephra deposits in many villages was measured and reported. These documents were collected, examined and their data listed by me in Table 2 [9].

The recorded thickness of the tephra was measured at 120 sites as far away from Mt. Fuji as Tokyo. Nearly 70% of the data was collected within a distance 30km east of the volcano, the area likely to suffer most severely or intermediately from a tephra fall in a

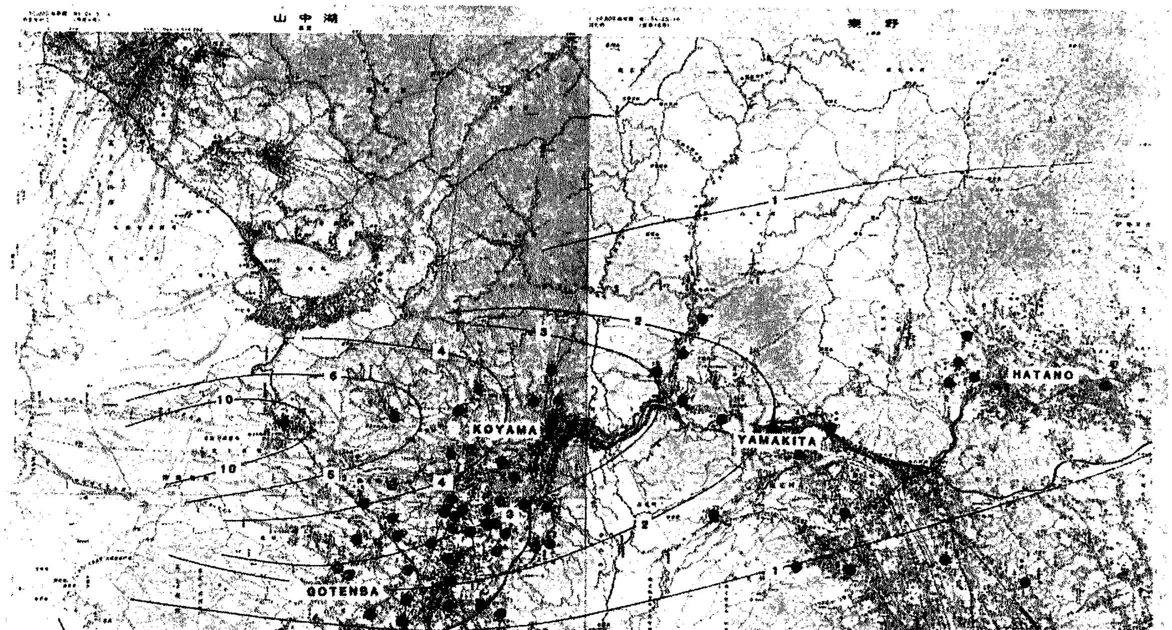

Fig. 6 Isopach map of the air-fall tephra of the Hoei eruption of Mount Fuji. The unit of every isopach line is "Shaku" (1 shaku = 30.3cm).

Table 2. Thickness of air-fall tephra from the 1707 eruption of Mount Fuji recorded in old documents

Locality name	Thickness (in *shaku*)*	Locality name	Thickness (in *shaku*)*
静岡県小山町須走	12, >10, 9	御殿場市駒門新田	0.3
生土	3.5, 3.5, 5.6	駒門	0.5
桑木	2.0	中清水	0.3, 0.5
菅沼村上	3.4, 3.5	中山	0.3, 0.5
〃 下	3.6	二子	0.3, 0.6
藤曲	3.6, 3.6	大阪	0.3, 0.5
湯船	3.6, 3.6	板妻	0.4〜0.5, 0.85,
小山	3.6, 5.0		0.9
所領	3.5, 4.6	杉名沢	1.0, 2.0
吉久保	3.5, 3.4	大堰	3.0, 3.1, 5.0
竹下	2.5, 5.6	萩原	0.6〜0.7
下古城	3.0, 3.2	小倉野新田	2.5
下古林	3.8	二枚橋	2.0
用沢	4.4, 4.5	西田中	2.5, 2.0
棚頭	4.4, 4.7	新橋	1.5, 1.8〜1.9
阿多野新田	3.6, 3.9	中丸	3.2, 5.0
上野新田	4.1, 4.3	北久原	3.0
上野村	4.0, 4.3	竈新田	0.6〜0.7, 1.0
大胡田村	3.2	萩蕪	0.4〜0.5, 0.6
静岡県小山町柳島	3.5, 3.6	神場	0.3〜0.4, 0.6
中嶋	3.6, 5.6	印野	0.5〜0.6, 2.0
新柴	2.4	程沢新田	1.5
大御神	5.0, 5.5	永塚	0.3〜0.4, 2.0
上古城	3.5	東山新田	2.5〜2.6
中白向	4.5, 4.5	古沢	3.6
御殿場市深沢	1.9, 1.8, 2.5	裾野市石脇	少, 0.2
東田中	2.0, 2.5	水窪	0.2
川島田	0.6〜0.7, 1.8	二ツ家新田	0.2
茱萸沢	2.0	麦塚	少, 0.2
増田	3.1, 5.0	平松新田	0.2
小尾田	3.5, 5.0	稲荷新田	0.2
清後	3.1, 5.0	茶畑	少, 0.2
川柳新田	0.4〜0.5, 3.0,	岩波	少, 0.2
	3.5, 5.0	伊豆嶋田	少, 0.2
六日市場	3.5, 5.0	公文名	少, 0.2
中畑	4.5, 5.0, 7.0	今里	少, 0.2
上小林	4.0, 5.0	下和田	0.2
塚原	3.5	須山十里木	降らず
仁杉	4.5, 7.0	駿東郡長泉町竹原	0.2
柴怒田	6.0〜7.0	上土狩	0.2, 少
山之尻	3.1, 5.0	下土狩	0.2, 少
水土野新田	4.5, 7.0	南足柄市千津嶋	1.8, 1.9
神山	少, 0.2	矢倉沢	1.6
沼田	0.4, 0.6	中沼	1.5〜2.0

(to be continued)

(continued)

Locality name	Thickness (in *shaku*)*	Locality name	Thickness (in *shaku*)*
南足柄市大雄	1.2~1.3	山北町岸	1.9~2.1
秦野市曽星	1.4~1.5	向原	1.9~2.1
菖蒲	1.3~1.4	足柄下郡松田町菅沼	1.5
八沢	1.3~1.4	横浜市戸塚区新橋	0.7
柳川	1.3~1.4	港南区関	0.6~1.8
三廻部	1.3~1.4	〃 日野	0.6~0.7
厚木市上落合	0.6~0.7	中区根岸	0.7~1.2
小田原市曽我谷津	0.65	葉山町木古庭	1.0
足柄下郡大井町	0.5~0.6	桜山	0.3
二宮町	1.3~1.4	逗子市掘内	0.8
山北町皆瀬川	2.5, 3.0	平塚市北金目	0.7~0.8
湯触	2.9, 3.0	南原	1.0
都夫良野	2.8, 3.0	藤沢市羽鳥	0.6~0.7,
神縄	1.6, 3.0		0.8~0.9
山市場	2.5, 3.0	東京都文京区護国寺	>0.02~0.03
川西	3.0, 3.2	名古屋	0.06~0.07
山北	1.9, 2.1		

* The *shaku* is an old Japanese unit of length equal to 30.3cm.

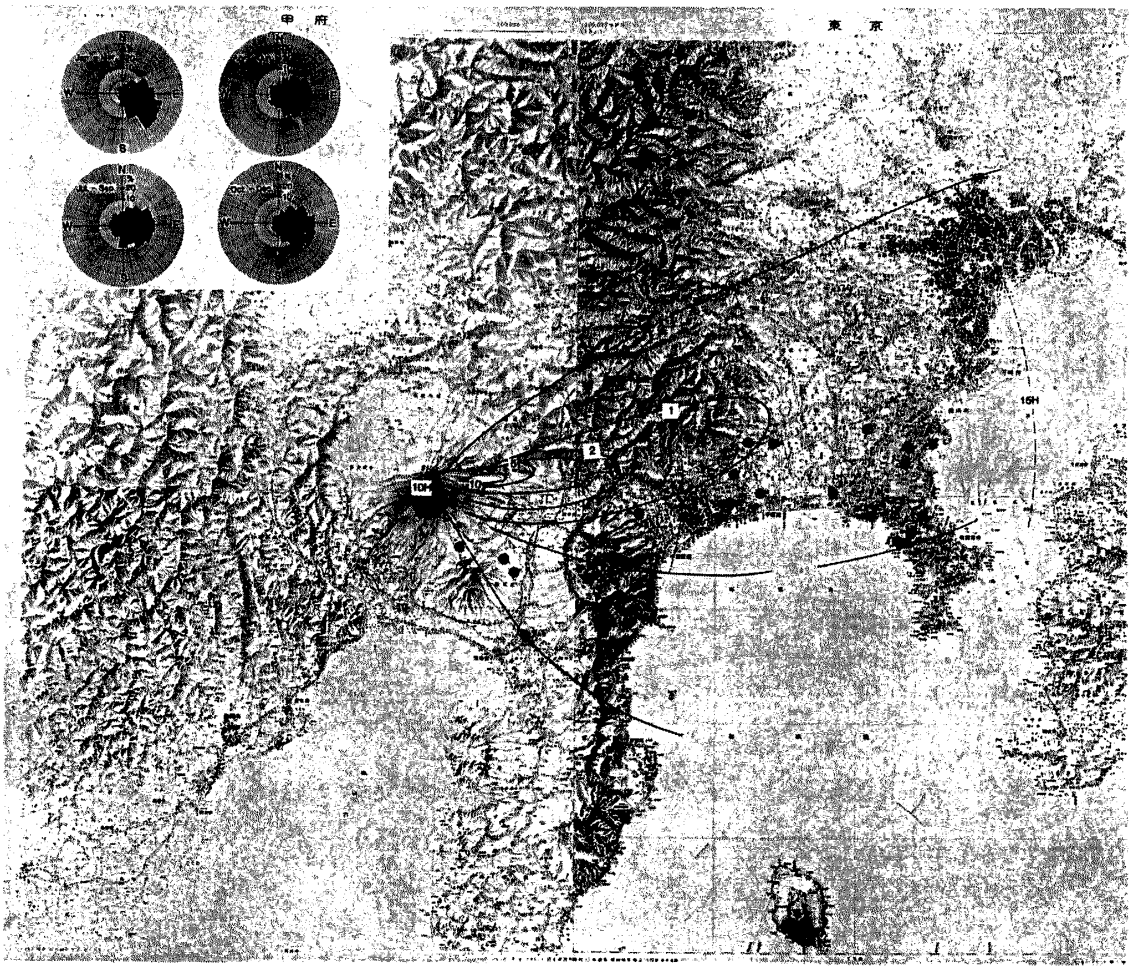

Fig. 7 Isopach map of the air-fall tephra of the Hoei eruption of Mount Fuji at far-field. Rose diagram at the top left is the arerage wind direction during four seasons of 10 year period observed at the Weather Observatory of J. M. A. located at the summit of Mount Fuji.

future eruption. When plural data were obtained for the same site from different documents, the smallest values were adopted as the most reliable and listed in the table.

The isopach lines in Fig. 6 were drawn from this table. Dots show locations where data were collected. Far-field isopach lines are shown in Fig. 7. Even in the central part of Tokyo, ash was deposited as deep as several centimeters. The Rose diagram at the left in Fig. 7 shows a 10-year average of seasonal wind directions and speeds recorded at the weather observatory of the Japan Meteorological Agency on the summit of Mt. Fuji. The bottom, right in the Rose diagram corresponds to the season in which the 1707 eruption took place and is correlated with the major axis of the isopach lines. The top, left in the Rose diagram corresponds to the period Jan. to Mar. If an eruption should take place during these monthes, the major axis of the tephra fall might shift slightly towards the south, consequently, Tokyo would be less affected.

My isopach map of the Hoei tephra is based completely on old documents, no field research was used. It is interesting to compare it with the isopach map made by Tsuya [5], who compiled his map from field survey data. As shown in Fig. 8, both maps roughly overlap, however, the area covered by thin tephra at the time of the eruption could not be identified by the geologic study. In my study, the southern boundary of the tephra fall is clear; this is one advantage of using data from old documents.

But, when one fall unit is for ash, or alternating ash and pumice, as in the 1783 tephra

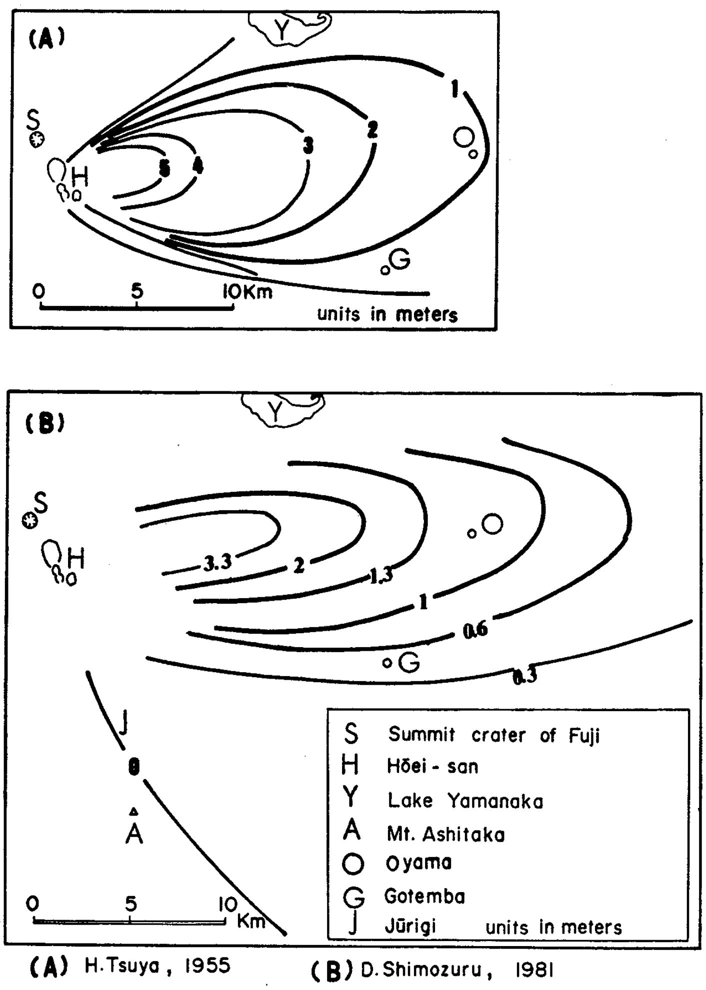

Fig. 8 Comparison of the two isopach map of the air-fall tephra of the Hoei eruption. (A) is based on stratigraphic study by Tsuya [5] and (B) is based on Historic records by the present author.

Fig· 9 An outcrop of the 1783 air-fall tephra of Asama Volcano photographed at Asama Volcano Observatory.

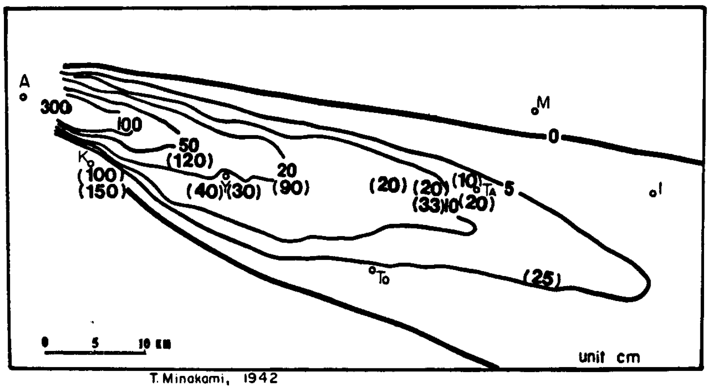

Fig. 10 Isopach map of the 1783 air-fall tephra of Asama Volcano after Minakami [10]. Numerals in parenthes are the thickness documented in Historic records added by the present author.

fall from Asama (Fig. 9), there is a large difference in isopach maps based on field surveys and on old documents. The 1783 tephra isopach map of Asama was made by Minakami [10], who measured the thickness of the air-fall tephra at outcrops in many localites (see Fig. 10). Numerals in parenthese indicate the thickness of the air-fall tephra based on old documents. Clearly, there are important differences. As the 1783 air-fall tephra of Asama was (as seen from Fig. 9) an alternation of fine ash and pumice, compaction and erosion of the ash layers may well have taken place, and this would produce the differences in thickness. In contrast, most of the 1707 Hoei tephra is uniformly composed of basaltic scoriae of lapilli size; hence, little compaction or erosion would have occurred in the 276 years since the eruption.

Table 3 shows part of the historic records that describes the time and process of the falling tephra from the 1707 eruption.

5. HAZARD ASSESSMENT OF MOUNT FUJI

According to Machida [8], Young Fuji must have been formed during the past 5000 years, for which period 20 major eruptions have traced in his tephrochronological study. The tephra production rate was 0.14km^3 per one hundred years, or 0.3km^3 tephra was produced by a major eruption. From this figure, the total volume of 0.85km^3 tephra produced by the Hoei Eruption is seen to be three times larger than the average volume of tephra produced by a single previous major eruption. The Hoei Eruption took place 840 years after the previous largest eruption (in 864) as shown in Fig. 11. On the basis

Table 3. Records of types of tephra fall at some localities for the December 1707, Hoei Eruption.

Place	Distance* (km)	Time	Tephra fall
Yamakita	32	Shocks and tephra fall from 10th, Dec. 16	Initially, 2-3cm of fine pumice deposited. Continued tephra fall until Dec. 31. Total thickness of tephra 60 to 70cm.
Nakamura, Minami-ashigara	35	Rumblings at 10 : 30h, Dec. 16	Greyish pumice for the first 3hr. Sand began to fall from 18h. Very dark in the daytime for 7 days. Tephra fall gradually decreased after one week and finished on Dec. 31.
Odawara	40	Dark cloud observed at noon on Dec. 16 in the SW	Ash fall from 14h becoming black sand during the night.
Yokohama	80	Shocks from 10 to 16h, Dec. 16	Became dark as if becoming night. Initially, white lapilli of a 1 to 3cm pumice fall, became greyish sand from 16h and gradually changed to black sand. Continuous tephra fall for 7 days, then intermittent falls for a 4 to 6h period. Total thickness 20 to 30 cm.
Tokyo	100	Rattling of windows from early morning of Dec. 16 until 8h of the next day	Darkened sky from 14h, and sand fall from 15h. Tephra deposited until evening of the same day. Depth 1cm.
Hashima, Fujisawa	66		Sand fell from the 16th to 31st of December.
Enoshima	68		Fishing from the beach become impossible due to sand deposition.
Totsuka	72	Quake at 14h on Dec. 16th. Rumbling at 8h on the 17th.	Lightning every day until the night of Dec. 18th. Coarse and fine sand fell until Dec. 31st.
Konan-ku Yokohama	78	Dark cloud from west at 10h, Dec. 16th.	White sand fell from 16th, followed by black sand until Dec. 31st. Thickness 20cm.
Oi-machi	40		Sand fell like a shower from 18th on Dec. 16th until Dec. 31st.

* Distance from the summit crater of Mt. Fuji.

of an average production rate, 1.1km^3 tephra should have been produced by the Hoei Eruption. The difference between the volume of tephra actually produced and that predicted is very close to the volume for a single major eruption. As 276 years have passed since the 1707 eruption, the next eruption is expected to produce 0.3—0.4km^3 of tephra.

In conclusion, in spite of its present quiescence, Mt. Fuji is potentially dangerous and, if it awakens, a considerable amount of tephra will be produced. Since 1707, human activities around this volcano have greatly increased and at its southern foot, major roads and railways have been constructed. Also, the area's population now is concentrated between

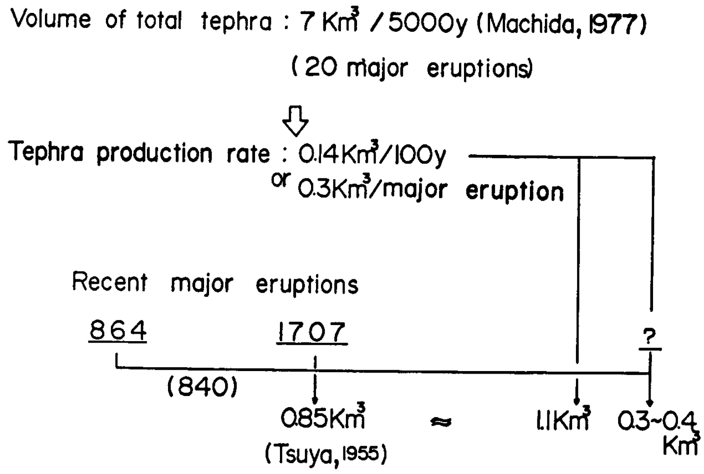

Fig. 11 Diagram showing the production rate of tephra from Mount Fuji.

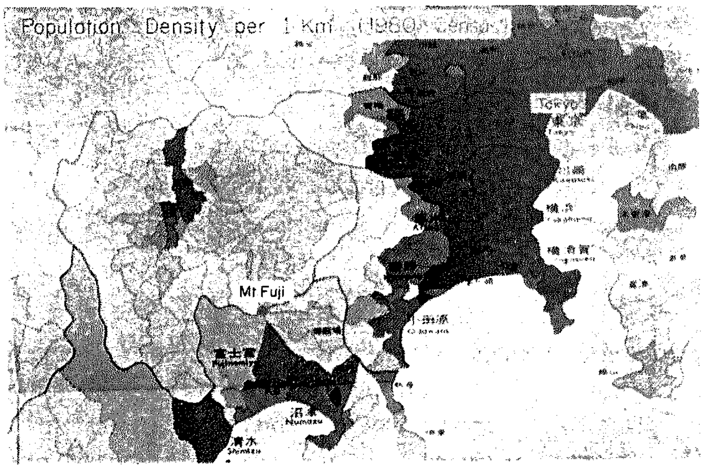

Fig. 12 Population density map per 1km² based on 1980 Census. The area is divided into 9 categories. The most dark colour indicates the area of the density more than 2000/km² and white colour is less than 50 persons.

the mountain and Tokyo (see Fig. 12). Because of these conditions, hazard zoning is an important criterion for land development as well as for countermeasures against the volcano's future activity.

Estimation of possible eruption sites

An azimuthal distribution of parasitic cones and flank openings on Mt. Fuji, based on Tsuya's table [7], is shown in Fig. 13. The summit crater is at the center. The prevailing trend of vent alignment is N 30° W. This trend probably reflects the pattern of the regional stress field. The direction of the openings is in the direction of tensional stress and the prevailing direction of vent alignment may well reflect the direction of compressional stress. To prove the regional stress field, focal mechanism solution of major earthquakes in the Kanto region are shown in Fig. 14 [11]. The direction of horizontal compression in the Fuji area is in good agreement with the direction of vent alignment on Mt. Fuji. It shows also that the regional stress field seems to have been stable for at least the past 5000 years. From this evidence, the possible zone of a future eruption can be predicted.

Expected volume of tephra

From the data given in this section, the statistical estimation of the total volume of the tephra from a future eruption is 0. 3—0. 4km³.

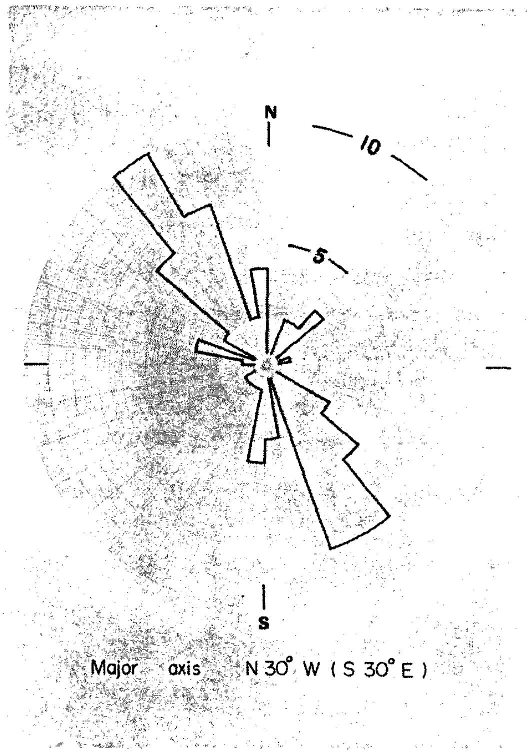

Fig. 13 Azimuthal distribution of parasitic cones and flank openings of Mount Fuji based on Tsuya's table.

Type of eruption

The Hoei Eruption was, according to Tsuya [5], not only the most violent eruption ever produced in the history of Mt. Fuji but severely explosive. Moreover, at the very beginning of activity, prior to the ejection of a tremendous amount of basaltic scoriae and bombs, acid andesite or dacitic pumice and obsidian were hurled out for several hours. On the basis of his petrological study, Tsuya concluded that the Hoei Eruption originated at a considerable depth, possibly more than 2km below its craters. At that depth, andesitic magmas have been formed over a considerable length of time through crystallization–differentiation from the basaltic magma. Now, Mt. Fuji has been dormant for 276 years, during which time the concentration of andesitic magma in the upper part of the underlying magma body may have advanced. If we accept this probability, new activity is very likely in the near future, and it will be a manifestation similar to the 1707 eruption although probably of smaller magnitude.

Hazard map

Zones of potential hazard that may be affected by a future eruption of Mt. Fuji have been projected from the above data and probability; they are shown in Fig. 15. In this figure, the area most likely to be affected intermediately by a tephra fall extends 30km to the east of the volcano. As in the Hoei Eruption, a deposition of tephra would raise the riverbed and flooding would take place after any heavy precipitation. Tephra also would pollute water supplies for drinking and irrigation. During an explosive eruption, the volcanic dust in the air would affect aircraft, and runways would have to be closed even if the tephra deposition were not thick. Such considerations must be included in any countermeasures proposed for disaster prevention and mitigation.

6. SURVEILLANCE OF MOUNT FUJI

Short term seismic and other volcanic observations have been carried out on several

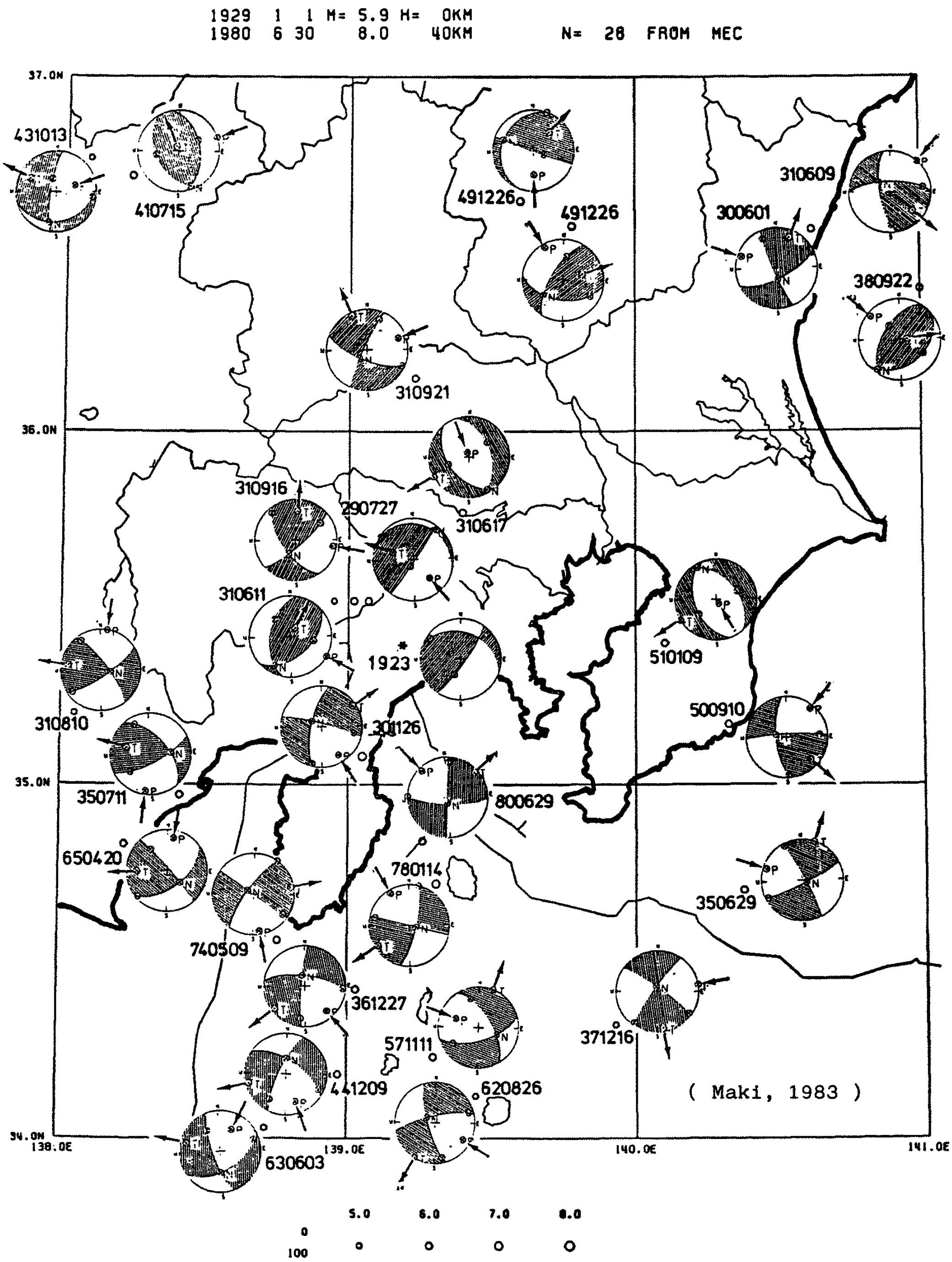

Fig. 14 Focal mechanisms of the major earthquakes in Kanto region after Maki [11].

occasions by university scientists and the staff of the Japan Meteorological Agency over the past few decades. We have found no marked sign of volcanic activity in Mt. Fuji, though several earthquakes have been located there. But, considering its potential danger and the seriousness of the effects of nay future activity, permanent monitoring of Mt. Fuji has been started along with a national program on the prediction of volcanic eruptions. In October, 1982, a seismic and tilt monitoring station was established in a tunnel in the SW flank of the volcano at the altitude of 1040m. Two-component seismometers and bubble type tiltmeters that are operated by solar batteries were installed. Their signals, as

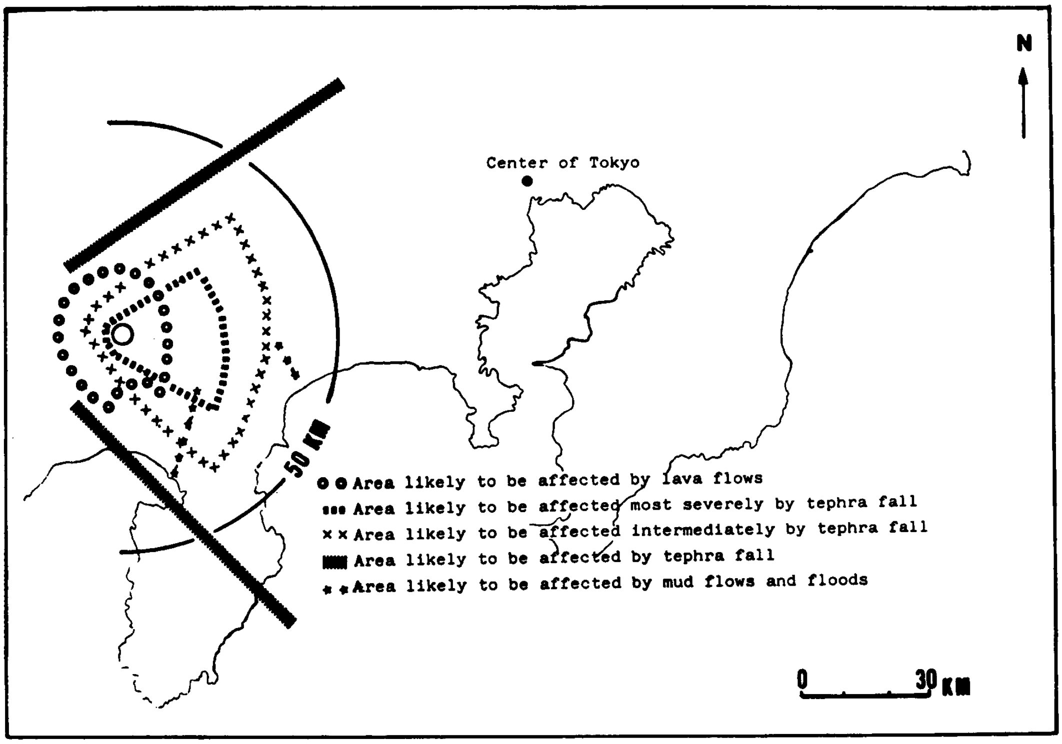

Fig. 15 A volcanic hazard map of Mount Fuji.

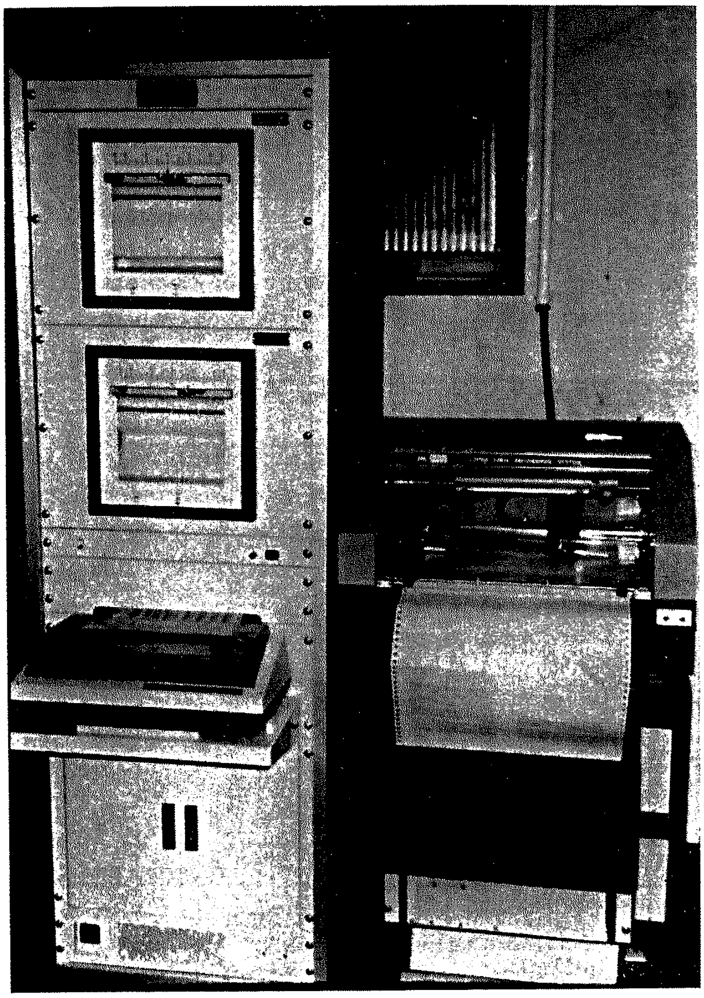

Fig. 16 The monitoring equipment of seismic (right), tilt and meteorological data (left) installed at the author's laboratory. Tilt and meteorological data are printed at every 30 minutes by digital printer.

well as meteorological data, are telemetered by commercial telephone cable to the Earthquake Research Institute in Tokyo. Since their installation, no marked sign of volcanic activity has been observed, although some seismic noise has been recorded.

7. ACKNOWLEDGMENTS

I thank Miss Y. Ohkita for her assisstance in the collection of old documents on the Hoei Eruption of Mt. Fuji and Mrs. T. Matsumoto for her drafting of the illustrations.

This study is a part of group research on "Volcanic Disaster Characteristics and Hazard Appraisals" supported by Grant-in-Aid No. 302013 for Natural Disaster Scientific Research from the Japanese Ministry of Education, Science and Culture.

REFERENCES

[1] Tsuya, H., Geological and petrological studies of the volcano, Fuji, 1. Geological structure of Komitake, Bull. Earthq. Res. Inst., Univ. Tokyo, Vol. 16, pp. 452-469 (1938) [Japanese].

[2] Tsuya, H., Geological and petrological studies of the volcano, Fuji, 2. Distribution of the Aokigahara lava and its vent, Bull. Earthq. Res. Inst. Univ. Tokyo., Vol. 16, pp. 638-657 (1938) [Japanese].

[3] Tsuya, H., Geological and pertrological studies of the volcano, Fuji, 3. Geology of the southwestern foot of Mt. Fuji, Bull. Earthq. Res. Inst. Univ. Tokyo, Vol. 18, pp. 419-445 (1940) [Japanese].

[4] Tsuya, H., Geological and pertrological studies of the volcano, Fuji, 4. Structure and distribution of parasitic volcanoes, Bull. Earthq. Res. Inst. Univ. Tokyo, Vol. 21, pp. 376-393 (1943) [Japanese].

[5] Tsuya, H., Geological and petrological studies of the volcano, Fuji, 5. On the 1707 eruption of Volcano Fuji, Bull. Earthq. Res. Inst. Univ. Tokyo, Vol. 33, pp. 341-383 (1955).

[6] Tsuya, H., Geology of the volcano, Mt. Fuji, Special Issue from the Geol. Surv. of Japan, pp. 1-24, (1968).

[7] Tsuya, H., Topography and geology of the volcano, Mt. Fuji, in the Report of the Co-operative Scientific Survey of Mt. Fuji, Fuji Kyuko Co., Ltd., pp. 1-149 (1971) [Japanese].

[8] Machida, H., The Evidence of Volcanic Ash (Kazanbai wa Kataru), Soju Shobo, pp. 1-324 (1977) [Japanese].

[9] Shimozuru, D., Volcanic activity, disaster map and hazard assessment of the volcano, Fuji, in the Report of Volcanic Disaster Characteristics and Hazard Appraisals, pp. 88-97 (1981) [Japanese].

[10] Minakami, T., On the distribution of volcanic ejecta. (Part 2) The distribution of Mt. Asama pumice in 1783, Bull. Earthq. Res. Inst. Univ. Tokyo, Vol. 20, pp. 93-106 (1942).

[11] Maki, T., An active zone and focal mechanisms of shallow earthquakes in the Kanto District, Jour. Japan Soc. Natural Disaster Science, Vol. 2, pp. 16-32 (1983) [Japanese].