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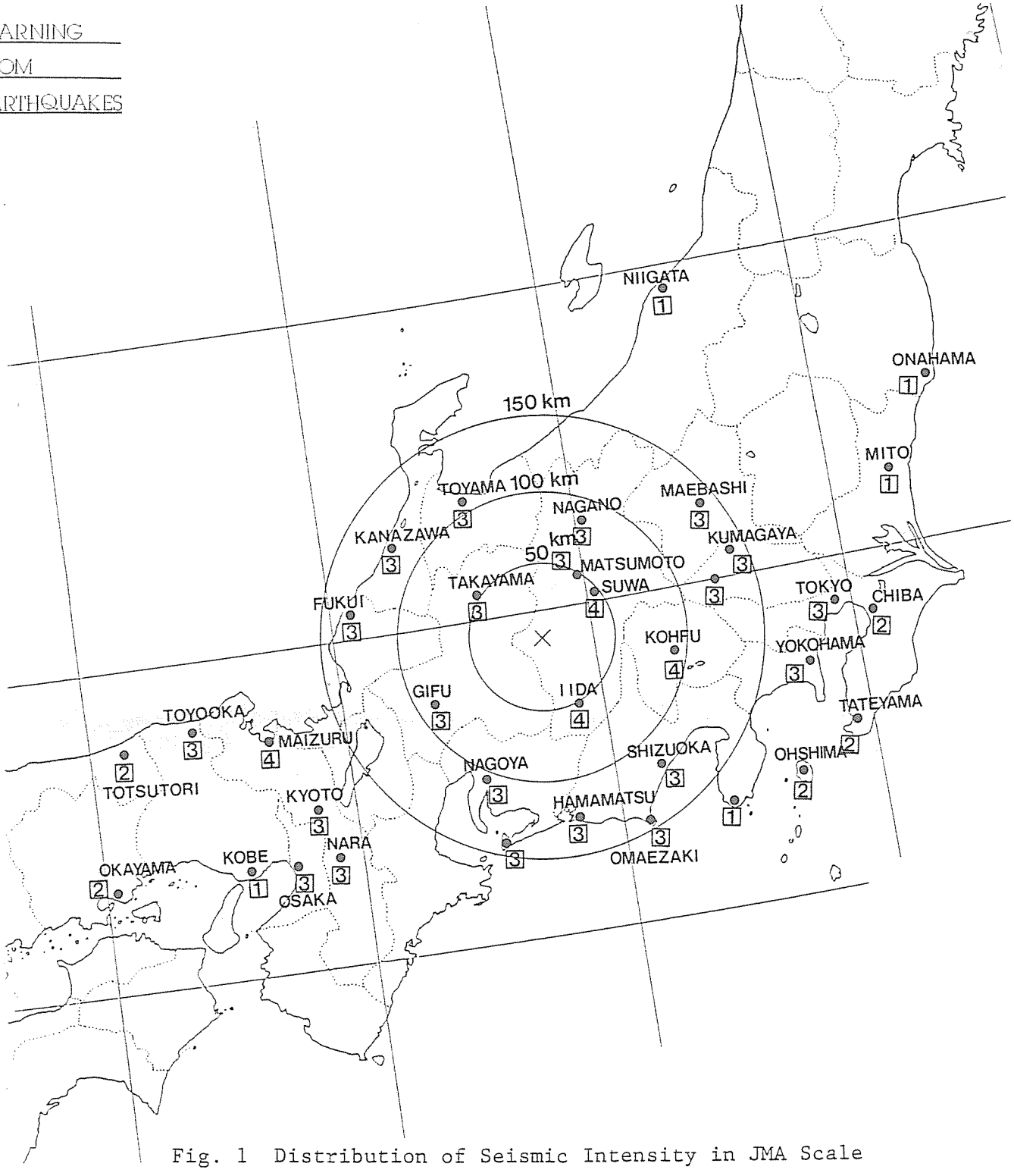

Fig. 1 Distribution of Seismic Intensity in JMA Scale (After JMA)

Fast Report on The Nagano-ken Seibu Earthquake of September 14, 1984 in Central Japan

- Prepared for the EERI Newsletter Earthquake Insert by Yasushi Sasaki, Head, Ground Vibration Division, Earthquake Disaster Prevention Dept. PWRI, MOC.

(1) Outline of the Earthquake

On Sept. 14, 1984, a severe earthquake of magnitude 6.9 on the Richter scale occurred at a central part of Japan. Since the epicenter was at the middle of Honsyu Island, the shaking was felt in wide area from Tokyo to Okayama as shown in Fig. 1, although this felt area was almost equal to the area due to past earthquakes with the same magnitude in Japan.

Large-size landslides occurred due to this earthquake, and 29 persons were killed or missing by debris flow caused by the landslides.

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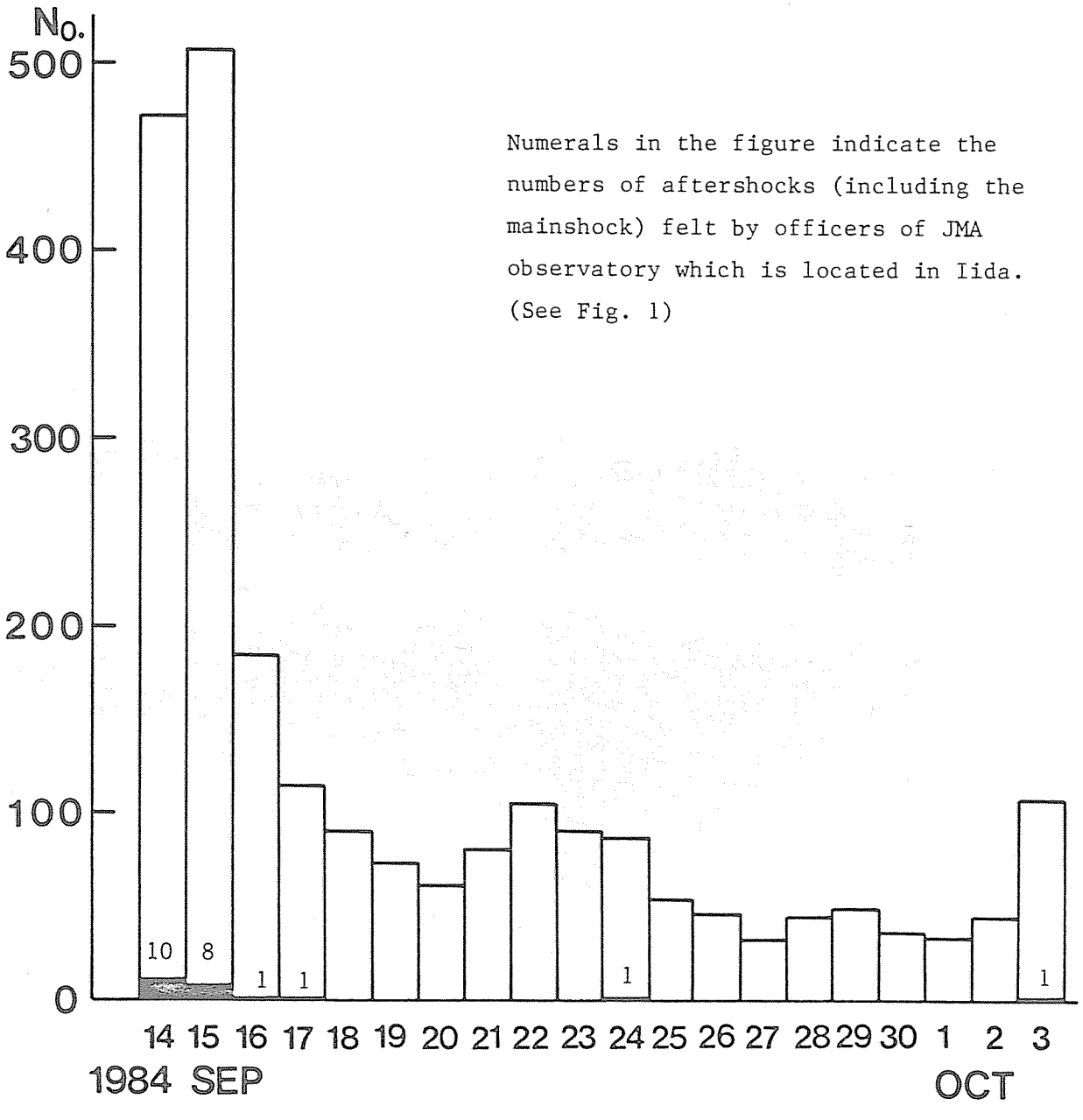

Numerals in the figure indicate the numbers of aftershocks (including the mainshock) felt by officers of JMA observatory which is located in Iida. (See Fig. 1)

Fig. 2 Number of Aftershocks (After JMA)

The origin-time of the main shock was 8:48 am and the epicenter is temporarily reported to be 35° 47' N and 137° 31' E with focal depth 0 to 10 km by the Japan Meteorological Agency. Observed aftershocks are shown in Fig. 2. Among the aftershocks shown in Fig. 2, the one with magnitude of M = 6.4 which occurred on 7:14 am of Sept. 15 was the largest aftershock.

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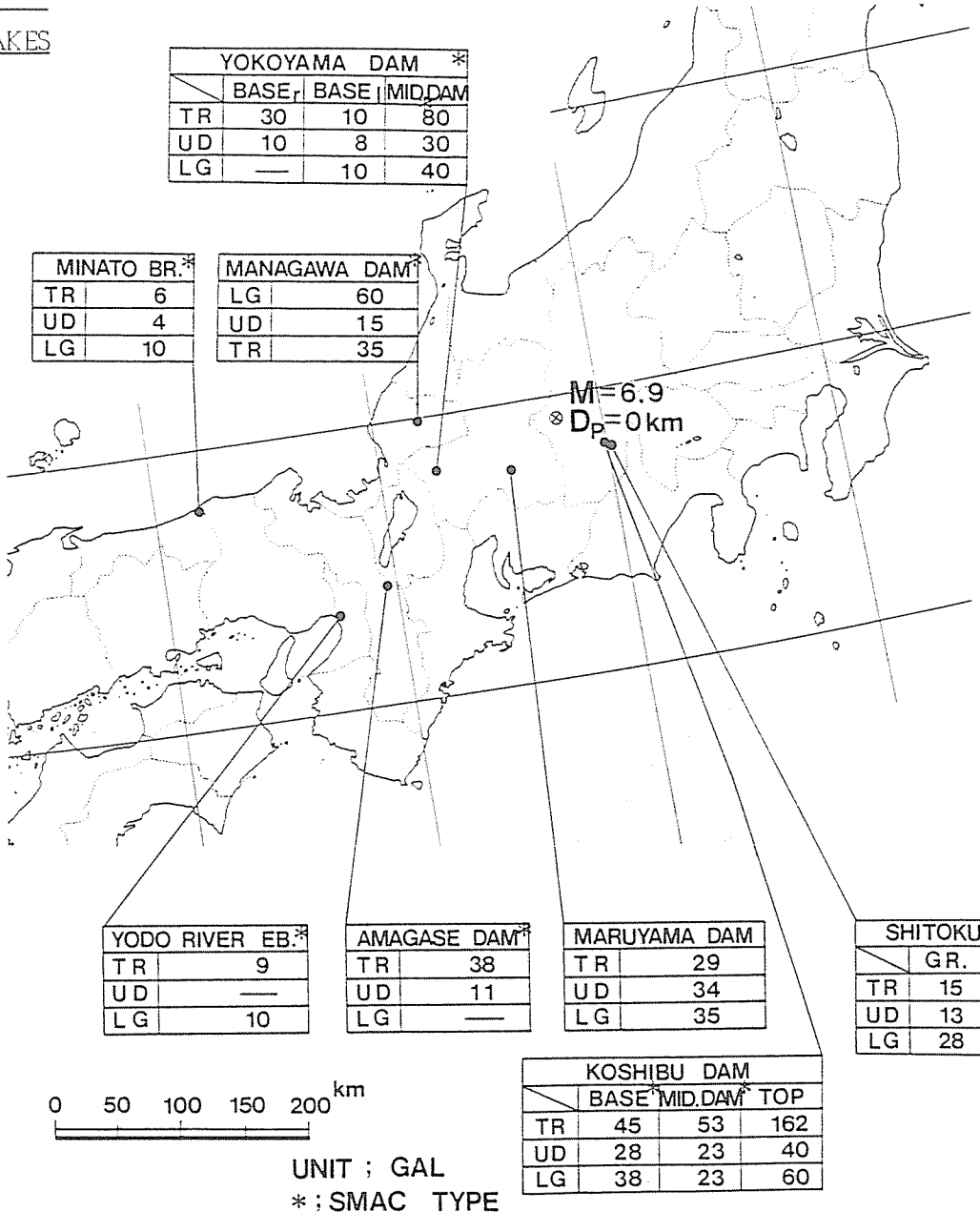

YOKOYAMA DAM *	BASE	BASE	MID.DAM
TR	30	10	80
UD	10	8	30
LG	—	10	40

MINATO BR.*	
TR	6
UD	4
LG	10

MANAGAWA DAM*	
LG	60
UD	15
TR	35

YODO RIVER EB.*	
TR	9
UD	—
LG	10

AMAGASE DAM*	
TR	38
UD	11
LG	—

MARUYAMA DAM	
TR	29
UD	34
LG	35

SHITOKU BR. *	GR.	PR.
TR	15	69
UD	13	10
LG	28	43

KOSHIBU DAM	BASE	MID.DAM*	TOP
TR	45	53	162
UD	28	23	40
LG	38	23	60

Fig. 3 Records of Strong Motion Accelerometer (Tentative)

Strong motion acceleration records are not precisely analyzed yet, however, maximum ground accelerations are tentatively compiled as shown in Fig. 3. The maximum ground acceleration recorded by SMAC-type accelerometer was at Shitoku Bridge site, 47 km apart from the epicenter, which was 28 gals in longitudinal direction to the bridge axis.

(2) Topographic and Geologic Features near the Epicenter

1) Topographic Features

Mountainous area on the southern slope of Mt. Ontake; there is the river Ohtaki which flows east at the southern edge of the Mt. Ontake slope. The Mt. Ontake slope is incised by several streams making valleys which are mainly north-south in epicentral area.

The elevation of the top of the Mt. Ontake is 3063 m above the sea level and the elevation of the Ohtaki River is between 900 m and 1100 m in that area.

There is no apparent active fault reported in this area, although the Adera Fault runs north west to south east 15.5 km from the epicenter. (See Fig. 4)

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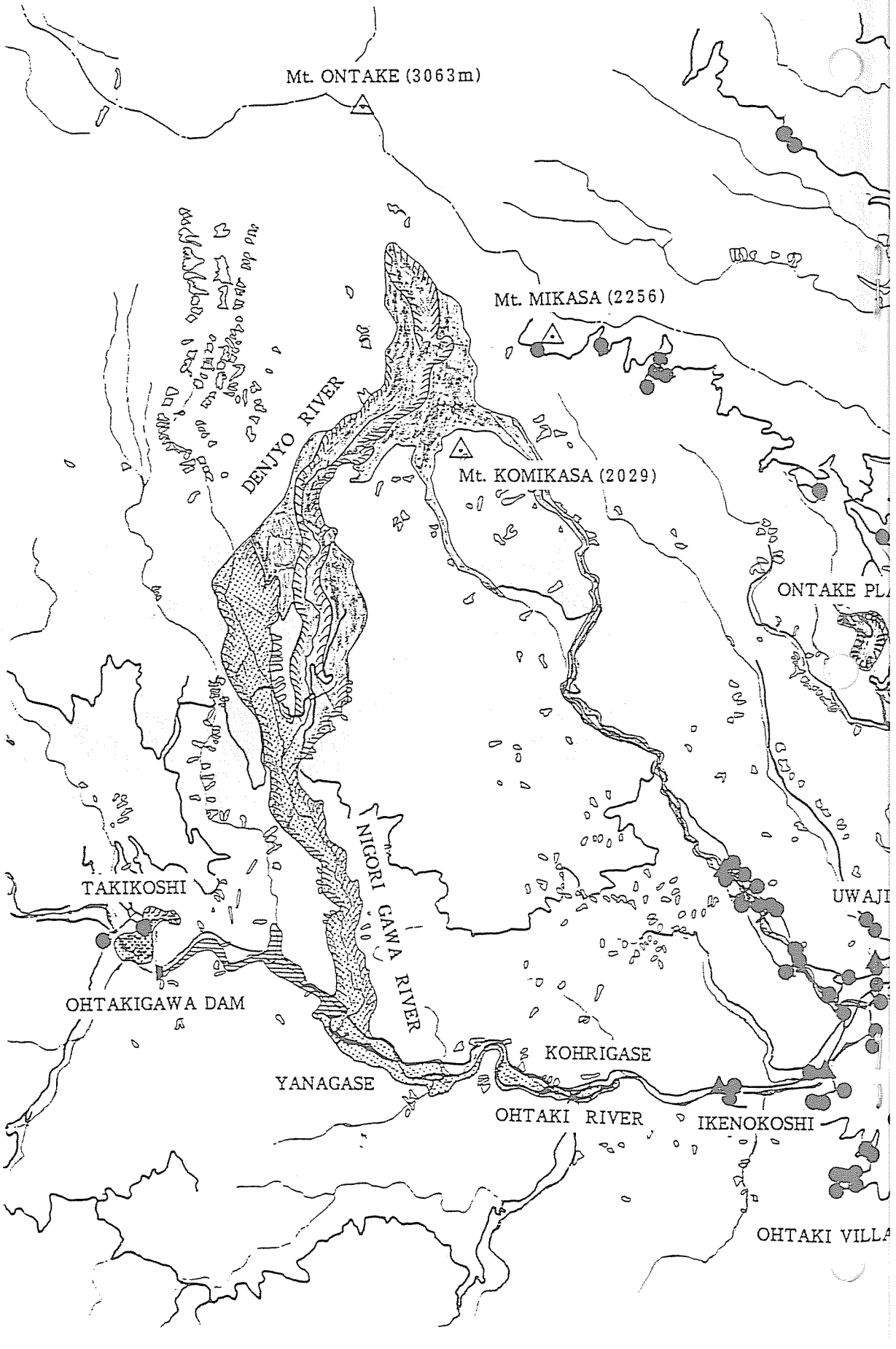

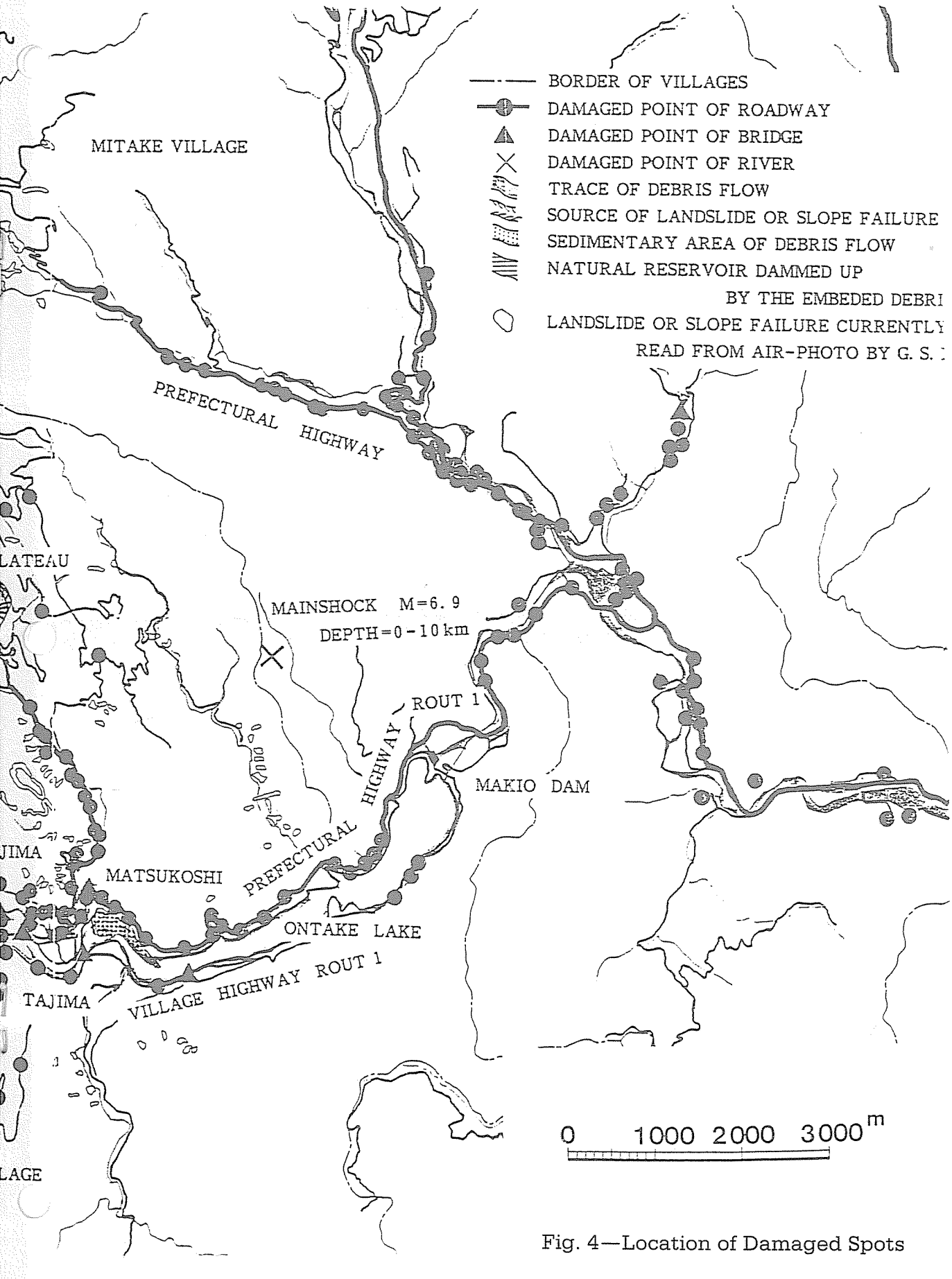

Fig. 4—Location of Damaged Spots

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2) Geological Feature

The epicentral area is located near the border of Paleozoic Era rocks and Cretaceous Period rocks.

The bedrock near the area is mainly Hornblende - biotite rhyolite welded tuff of Cretaceous Epoc which is covered by andesite, basalt, and volcanic ash from Mt. Ontake explosions.

(3) General Aspects of the Damage due to the Earthquake

The damaged spots are concentrated near the epicentral area as shown in Fig. 4, and the general aspects of the damage are as follows. Although the earthquake occurred in a rural area, the loss of human lives and properties were fairly extensive because of the large landslides and debris flow.

1) Loss of lives (As of Oct. 13)
Killed: 13 persons
Missing: 16 persons
Injured: 10 persons

2) Damaged Buildings (As of Oct. 3)
Residential houses
Failed: 14 houses
Half-Failed 73 houses
Partially-damaged 528 houses

Non-residential
Damaged buildings 26 buildings

3) Affected Families (As of Oct 3)
No. of Families: 87 families
No. of persons: 302 persons

4) Damage to Civil Engineering Structures (As of Oct 3)
Road: 235 places
Bridge: 11 bridges
River: 14 places

5) Landslides and Slope Failures

Landslides and slope failures occurred at many places during this earthquake in the focal area. The total number of landslides and slope failures is not yet compiled. However, it is observed that large slope failures, which have been the main cause of the severe damage in the area, occurred at least at 4 places; 1) Failure at Denjoh River (or Ontake Failure), b) Failure at Takikoshi, c) Failure at Matsukoshi and d) Failure at Ontake Plateau.

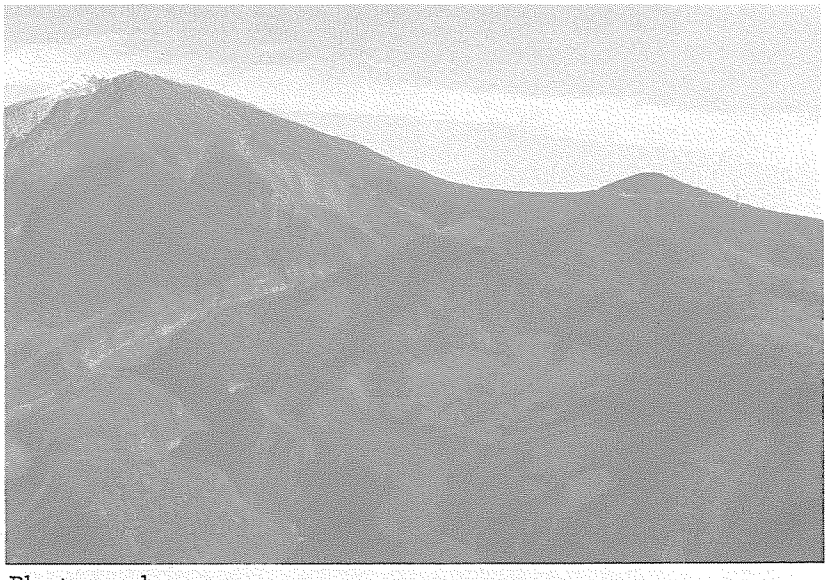

Photo - 1

A large landslide at Mt. Ontake slope

(Failured volume is about 36 million m^3)

Photo - 2

Source area of Mt. Ontake slope landslide

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Photo - 3

A large landslide at Matsukoshi

(The bridge seen below is a transportable built-up bridge errected after the damage)

Photo - 4

Slope failure along roadside slope and collapse of rock-fence

The failure at Denjoh River was the largest caused by this earthquake and is thought to be one of the largest earthquake-induced landslide ever experienced in Japan. The volume of the failure at the source area, which was a small ridge about 600 m below along the slope from the top of the Mt. Ontake, is currently estimated 36 million cubic meters, and the source material is composed of volcanic exploded materials.

Most of this failed masses caused a very rapid debris flow along the Denjoh river and the Nigorikawa river reaching to the Ohtake river which flows 8 km down from the source area. The length of the imbedded debris material at Ohtaki river is about 3.5 km and dammed up the stream of the river and creates a natural reservoir.

The source area and damage sites caused by the landslide and slope failure are shown in Photos 1-4.

6) Damage to Makio Dam (80 m high)

Makio dam of rock-fill type was slightly damaged. Shallow sliding near the shoulder of the downstream slope caused a minor gap at the shoulder. The settlement of the crest is reported to be around 15 cm, but it is reported that this minor damage does not affect the stability of the dam.

7) Damage to other structures

There were almost no failed buildings due to the ground motion but the partial damage such as dropdown of the rooftiles or break of window glasses were observed at buildings in the epicentral area. Failed buildings were mainly due to the landslides or debris flows.

The road in the epicentral area were damaged at many spots. The severest damage to the road was the loss of the Shin-Ohmatagawa Bridge due to the landslide at Matsukoshi. Large rock falls, collapse of retaining walls or fissures on the shoulder of the embankment are principal damages to the road.

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Photo - 5

Damage to the pier of the Matsubara Bridge

Photo 5 shows a crack of a pier-column of Matsubara Bridge.

(4) Concluding Remarks

1) Landslides occurred at several sites. Large landslides such as that at Mt. Ontake are to be clarified from points of view of the mechanics of origin, characteristics of source material, seismic effect and the characteristics of movement of the failed mass, since there are no sufficient knowledge about these phenomena to estimate the susceptibility of such landslides and to minimize the damage due to these phenomena.

2) Proper measures to drain emergently the water of the natural reservoir should be investigated, in order to avoid the flood due to the imbedment of debris in rivers caused by seismic induced landslides.

3) The existing detour road played important roles as the entrance to the damaged area just after the earthquake by the time of recovery of the main highway to the Ohtaki village. It should be realized that the existence of multi route connection to undamaged area is important for the urgent recovery from the seismic damage.

Reference: Y. Sasaki, K. Senoo, H. Yoshimatsu and N. Obinata; Fast Report on the Damage due to the Nagano-ken Seibu Earthquake of September 14, 1984, Civil Engineering Journal Vol. 26, No. 10, P.W.R.I.

The Public Works Research Institute of the Ministry of Construction sent the first investigation team composed of Y. Sasaki, K. Senoo, H. Yoshimatsu and N. Obinata to the damaged area by the earthquake of Sept. 14 from Sept. 17 to 19. And also it sent several investigation teams including the joint Japan-U.S. team headed by Dr. T. Iwasaki with Dr. E. L. Harp and Dr. D. K. Keefer of U.S.G.S. This report was prepared by Mr. Y. Sasaki utilizing the results of these investigations.

This post-earthquake investigation report is provided as part of the EERI Learning From Earthquakes (LFE) program. The Institute is indebted to Dr. Sasaki for his conscientious efforts. The Institute is also indebted to Dr. H. S. Lew of the National Bureau of Standards for his help in coordinating the report. Publication of this report was supported by the National Science Foundation under Grant No. CEE-8315659 to the Earthquake Engineering Research Institute.