25. *The Imaichi Earthquake of December 26th, 1949. General Description.*

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Introduction.

On the 26th of December 1949 about daybreak, at 6 h. 44 m. in the morning, most people in the Kwantō Plain were awakened from their sleep by a moderate earthquake originated in the south-western part of the Ibaraki Prefecture. Heralded however, by this non-destructive earthquake, severer shocks alarmed the district as well as the adjacent districts in less than two hours, at 8 h. 16 m. and 8 h. 25 m. respectively, the epicentral tracts of them being situated about 70 km. north-west of the first, near the northern border of the Kwantō Plain. Collapse of 299 dwelling houses and tremendous landslides took place taking a toll of 10 human lives and interrupting communication and railway lines in the neighbourhood of Imaichi Town, Tochigi Prefecture, which lies at 7 km. E. S. E. of the famous religious Town of Nikko.

As soon as the details of the earthquake were known, the Earthquake Research Institute organized a research party which started on the next morning for the disaster area. The party consisted of members who shared the work of inspections of general affairs, engineering aspects, geology, topographical and ground water changes and observations of aftershocks etc. respectively.

For these studies of our Institute, the Ministry of Education granted a sum of 100,000 yen from the Science Research Fund, by which our work was greatly promoted. Our thanks to the Ministry are hereby expressed gratefully. We must also mention with thanks the aids given by the official circles of the Prefectural Government and the inhabitants of the afflicted area, by which our work was much facilitated. Observational data at the Meteorological stations were also used, to which our thanks are also due.

Summarizing the results of these and other studies, general features of the present earthquake are described in the following.

Topography and Geology of the Epicentral Area.[1]

The present disaster area lies near the eastern margin of the Ashio mountain land, where the Chichibu (Permo-Carboniferous) system constitutes the back bone with many intrusions of biotite granite, granite-porphiry and quartz-porphiry. These paleozoic formations outcrop mainly in the southern part of the river Daiya which flows from the lake Chūzenji through the towns of Nikko and Imaichi and joins the river Kinu, a tributary of the Tone, at about 7 km. NE of Imaichi. Some remnants of the Tertiary volcanic activity such as green tuffs and some andesites are also seen in the south-eastern side of the district.

Around these hills develop fluviatile beds, consisting of rounded gravels of andesitic rocks cemented by fine volcanic materials. These fluviatile beds are covered by younger deposits of pumice and other volcanic ejecta, derived from a group of Diluvial volcanoes called the "Nikko Volcanic Group", which stand to the north of the lake Chūzenji and the Daiya River on the basement of the eroded older complex as we have seen in the southern area. Of the nine volcanoes, (1) Gassan (1,278 m), (2) Nyohō-Akanagi (2464 m), (3) Komanago (2,323 m), (4) Ōmanago (2,375 m), (5) Nantai (2484 m), (6) Tarō (2,368 m), (7) Sannōbōshi (2,073 m), (8) Mitsudake (1945 m), and (9) Shirane (2,578 m), the last and highest Shirane alone is known to have been active in historic times, the eruptions of which being recorded in 1625, 1649, 1872, 1873 and 1889. Among the rest extinct volcanoes, the Nantai, a beautiful conide standing by the side of the lake Chūzenji, was active to latest times and its ejecta are broadly deposited over the present district. The Shirane and the Nantai are respectively distant about 30 and 18 km. in the W by N direction from the Imaichi Town. These volcanoes together with the Akagi and Haruna in the SW and the Takahara, Nasu, Bandai, Azuma and Zaō etc. in the NE constitute the Nasu Volcanic Zone which extends as far north as to the Usu volcano in Hokkaidō. The readers are referred to the description of the topography and geology of the present area by R. Morimoto in the next article.

Seismic History.[2]

The earthquakes of these districts are recorded for 500 years almost perfectly in the diaries of the Buddhist temple Tōdera in the adjacent Aizu district and the Tōshōgu shrine at Nikko, as well as in the chronicles of the

1) S. TSUBOI, & SUGI; Guide Book for the Excursion 1926.

2) Table of Great Earthquakes in Japan since Historic Times, published by the Association for the Prevension of Earthquake Disasters.

F. OMORI. (*Rep. Imp. Earthq. Inv. Comm.*) 88 (C). (1920). 42.

feudal government in Yedo. In the following table are tabulated remarkable shocks originating within a hundred km. together with those earthquakes in the adjacent area which were felt strongly and accompanied by some damage in the Nikko area.

Table I.

Historical Earthquakes Arround the Nikko Area.

1. 1433 XI 7 (Eikyō 5 IX 16) M_k=3.
   The Tōdera Hachiman shrine in the Aizu district was demolished. On the same day a great earthquake took place in Sagami Bay which caused demolition of temples and shrines at Kamakura and Ōyama, Sagami Province. It was accompanied by a tunami by which the river water of the Tone, then flowing into the Tokyo Bay, was compelled to flow upward.
2. 1555 IX 14 (Kōzi 1 VIII 19) M_k=3.
   Landslides and demolition of houses were caused in the lower reach of the river Tadami around Takidani village.
3. 1611 IX 27 (Keichō 16 VIII 21) M_k=4.
   Strongest earthquake ever recorded in the Aidzu district, by which most part of the district, about 50 km. in diameter, were badly shaken with heavy landslides and depression forming a lake which lasted about 30 years. About 20,000 houses were destroyed and more than 3,700 lives were lost.
4. 1644 IV (Shōho 1 III–) M_k=2.
   Stone walls of the Tōshōgu shrine were slightly destroyed.
5. 1646 VI 9 (Shōho 3 IV 26) M_k=5.
   An earthquake originated off the Pacific coast of the Rikuzen, which caused destruction of the castle in Sendai. Stone fences and walls were also damaged at Nikko.
6. 1649 VII 29 (Keian 2 VI 20) M_k=4.
   There was a severe earthguake in Yedo and it destroyed the stone walls and gates of the castle. Many houses in the city were destroyed causing loss of human lives. It was also strongly felt at Nikko and caused damage to stone walls etc.. Probably the epicentre was some 40 km north of Yedo. The volcano Shirane erupted in this year.
7. 1658 V 5 (Manji 1 IV 3) M_k=2.
   A slight damage was caused at Nikko.
8. 1659 IV 21 (Manji 2 II 30) M_k=3.
   309 houses collapsed with loss of 28 human lives in the Aizu district.

More than 100 houses were also destroyed at Nasu in Shimotsuke Province causing loss of 11 lives.

9. 1683 V 1 (Tenna 3 IV 5) M_k=2.
Fissures in the ground and some landslides were observed around Nikko.

10. 1683 VI 17 (Tenna 3 V 23) M_k=3.
The district around Nikko became seismically very active since the 11th of the month and on this day a strong shock occurred in the northern vicinity, accompanied by heavy landslides on the slope of the Volcano Akanagi. Stone walls and stone towers in the Tōshōgu shrine were badly destroyed.

11. 1683 VI 18 (Tenna 3 V 24) M_k=4.
A stronger shock than that of the previous day occurred in the same district causing more damage to the shrine so that the shrine had to be almost rebuilt. Dwelling houses at Nikko were badly shaken down while the shock was strong enough at Yedo to damage some houses within the castle.

12. 1683 X 20 (Tenna 3 IX 1) M_k=3.
The epicentre of this shock was about 20 km north of Nikko in the upermost part of the river Kinu. Heavy landslides blocked the course of the rivers Kinu and the Inari, a tributary of the Daiya river which joins at Nikko. The Tōshōgū shrine which had hardly completed repairing was again damaged.

13. 1693 II 26 (Genroku 6 I 22) M_k=2.
The Tōshōgu shrine was slightly damaged.

14. 1703 XII 31 (Genroku 16 XI 23) M_k=6.6.
The great Kwantō earthquake which exceeded the 1923 earthquake in magnitude. The earthquake was only moderate at Nikko, and only the doors of the Tōshōgu shrine were shaken open, and some stone lanterns were overturned.

15. 1710 IX 13 (Hōei 7 VIII 20) M_k=3.
Some destruction of houses are recorded in the Aizu district, but details are lacking.

16. 1725 V 29 (Kyōho 10 IV 18) M_k=3.
Some stone lanterns and stone fences were overturned at Nikko.

17. 1735 IV 6 (Kyōho 20 III 14) M_k=2.
Only a small portion of stone walls at the Tōshōgu shrine were destroyed.

18. 1746 V 14 (Enkyō 3 III 24) M_k=4.
Some houses in Yedo were damaged, while at Nikko stone fences were overturned slightly. The hypocentre might have been nearer to Yedo with a depth of about 50 km.

19. 1755 IV 21 (Hōreki 5 III 10) M_k=2.
Three strong shocks took place at Nikko, and stone fences and stairs were badly shaken, and some stone and bronze lanterns were overturned, but buildings suffered little damage.
(The chronicles and diaries of Nikko after the year 1762 have not yet been published so that some moderate shocks which might have occurred since remain unknown. But it is certain that no severe earthquakes have originated there until the 1949 earthquake.)

20. 1821 XII 13 (Bunsei 4 XI 19) M_k=2.
A small local destructive shock afflicted the villages around the lake Numasawa. 130 houses were demolished and some human lives were lost. Heavy landslides and numerous aftershocks terrified all the people to leave their hamlets.

21. 1855 XI 11 (Ansei 2 X 2) M_k=4.
Demolition of 14346 houses and loss of 7000 human lives and great conflegration were caused in the city of Yedo. The epicentre was in the suburb NE of the City.

22. 1859 III (Ansei 6 II) M_k=2.
Castle at Iwatsuki in Musashi Province was damaged.

23. 1894 VI 20 (Meiji 27) M_k=5.
It originated in the north-eastern part of Musashi Province. 90 houses were levelled to the ground and 24 lives were lost.

24. 1923 IX 1 (Taishō 12) M_k=6.
The great Kwantō earthquake. It was accompanied with subversion of 128,266 houses and loss of 142,807 lives. Great conflagrations and tunami followed by which 447,128 houses were burnt and 868 washed away. In the present disaster area this earthquake was felt somewhat strongly, but no material damage was caused.

25. 1943 VIII 12 (Shōwa 18) M_k=2.
Landslides occurred and were accompanied by slight damage to the walls of houses around the town of Tazima, in Aizu district.

From the above table we see that the earthquakes which seem to have originated within the present area were Nos. 4 (1644), 7 (1658), 9, 10, 11 (1683), 13 (1693), 16 (1725), 17 (1735), and 19 (1755), of which only the earthquakes of 1683 and 1755 were strong enough to cause some damage to wooden buildings. F. Omori[3] pointed out in 1920 that those earthquakes originating in the Nikko region are volcanic in origin so that we have no need of expecting severer shocks than those of 1683 and 1755. This anticipation proved true so

3) F. Omori: *loc. cit.*

far as the present earthquake is concerned, although the hypothesis of the volcanic origin still remains destitute of crucial testimony. To this point we shall return later.

Seismometrical features.

The epicentres of the first and second shocks were determined by Y. Koshikawa[4] from the arrival times of various phases by means of the least square method. The results were

1st shock

$\varphi=36°41.1\,\mathrm{N}$, $\lambda=139°39.9\,\mathrm{E}$; from $\bar{S}$,

2nd shock

$\varphi=36°43.6\,\mathrm{N}$, $\lambda=139°38.8\,\mathrm{E}$; from $\bar{P}$.

The values determined from P^* for the first shock were 1′ larger in longitude and latitude, while those for the second shock as determined from P^* were 0′.1 larger in latitude and 1′.1 larger in longitude than those determined from $\bar{P}$. At any rate the positions thus determined from time observations at remote stations are remarkably concordant with the macroseismic observations as described in the following. They also coincide with the area in which aftershocks originated as revealed from observations at near stations set up temporalily by our Institute.

The hypocentral depths of these shocks could not be determined by Koshikawa definitely, but was estimated tentatively by him to be about 15 km. for the first shock and 10 km. for the second one. The times of occurrences of these shocks worked out by Koshikawa were 8 h 17 m 29.1 s and 8 h 24 m 51.9 s on the 26 th day, in Japanese Civil Time or 23 h 17 m 29.1 s and 23 h 24 m 51.9 s on the 25 th day in G. M. T. respectively.

The first impulsions as observed at meteorological stations around the epicentres were rarefactional i. e. directed to the epicentre except at remote northern stations in both earthquakes. The distribution may be explained by the mechanism of conical type, in which the wave of condensational front is radiated within the cone surface. According to Hagiwara and Kasahara[5] the axis of the cone was inclined 30° southward and the apical angle was about 140°.

Foreshocks and aftershocks.

According to the naratives of the inhabitants in the afflicted area, they had heard sounds like explosions in mines occasionally since about five months,

4) Y. KOSHIKAWA, *Bull. Earthq. Res. Inst.*, 28 (1925), 369.

5) T. HAGIWARA and K. KASAHARA, *Bull. Earthq. Res. Inst.*, 28 (1950), 393.

and at Nakai Hamlet, Ochiai Village it is said that they heard the same sounds two times at about 20 h. in the previous day and a sound in the morning of the calamitous day. These sounds were similar to the earthquake sounds which accompanied infallibly the aftershocks. It is therefore presumable that foreshocks had already existed for a few months.

Aftershocks were observed at temporal seismic stations, set up by our Institute[6] at Imaichi, Nikko, Kanuma, Funyū and Nishiōashi and later at Nagahata as well. The epicentres thus worked out cluster around the Keimei mountain situated at 6 km. S. W. of Imaichi Town within an area of about 100 sq. km. The hypocentres of these aftershocks were also confined to depths less than 10 km. The number of the earthquakes felt at the Utsunomiya Meteorological Station at about 24 km. from the epicentral tract declined regularly as shown in Fig. 1. Needless to say, the number at nearer points was much larger. We felt at Nikko 34 earthquakes in less than 14 hours from 19 h. on the 27 th to 9 h. on the next morning.

Moichirō Fukuda at Nagahata Taziri Hamlet of the Ochiai Village, the very centre of the epicentral tract, observed the aftershocks without aid of instrument since the 3rd of January and recorded 283 earthquakes in January, 182 in February, 80 in March, 41 in April, 26 in May, 16 in June, 4 in July and 14 in August. Even the above mentioned number amounts in the total to as much as 646, and if supplemented with those which occurred 8 days prior to the beginning of his observation, the total number in 2/3 year might have reached 1000. Compared with the total number 652 of felt aftershocks of the Fukui earthquake[7] in one ensuing year, the higher frequency of aftershocks of the present earthquake may be noteworthy.

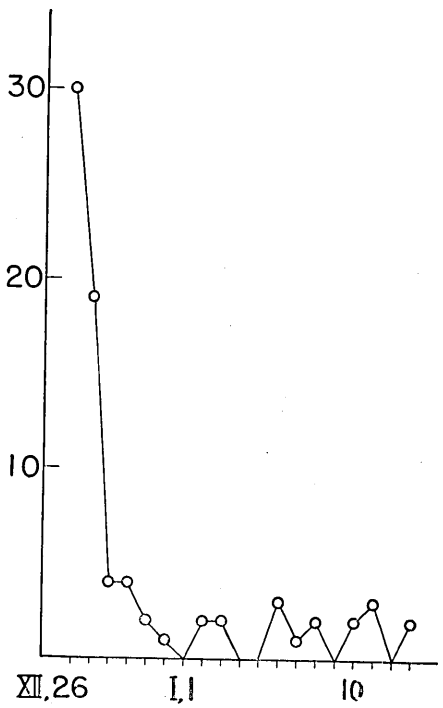


Fig. 1. Daily number of aftershocks felt at Utsunomiya of the Imaichi Earthquake, 1949.

6) *Earthq. Res. Inst. Bull. Earthq. Res. Inst.*, 23 (1950), 471.
7) S. OMOTE, *Rep. of Fukui Earthq.* (1950), 37.

Macroseismic features.

The intensity of these shocks as observed at the meteorological stations indicate that the magnitudes (M_k) in the writer's scale of the first and second shocks were about 2.8 and 3.2 respectively, while the mean intensity-distance curve deduced by the writer and Y. Satō from the replies gathered by the postcard method for the second larger shock was

$$I'=6.4-0.0178\,\Delta \qquad (\Delta \text{ in km}),$$

where: I' is the intensity in the international scale in 12 degrees. (Fig. 2).

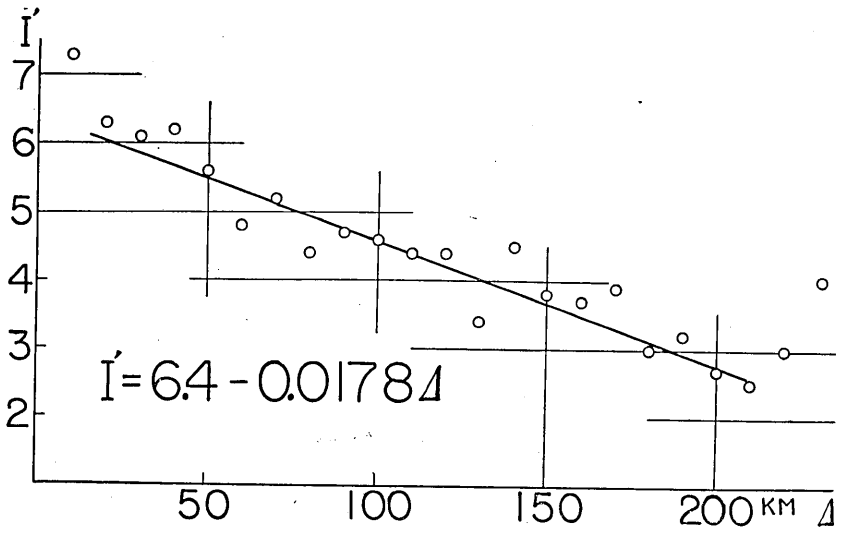


Fig. 2. Mean intensity-distance curve in the international scale of the Imaichi Earthquake. (After Kawasumi and Satō.)

Thus the energy of the present shocks as compared with the previous large earthquakes are rather small. They were about 1/100 and 1/30 respectively in energy of the Fukui earthquake of 1948, which ranked low among the destructive earthquakes.

Althoug the present earthquake was small in magnitude and the disaster area was very narrow in consequence, the intensity in the epicentral area was very high owing to the proximity to or shallowness of the hypocentre. A mine owner's wife residing at Nakai Hamlet, Ochiai Village, the very centre of the epicentral tract, observed that a stone implement, called "ishiusu" (Fig. 9 a Pl. XIII) in Japanese, which was about 50 cm. in diametre, and placed before her house, was tossed upward about 20 cm. a few times like a rebounding rubber ball. The shock, being accompanied by a very loud detonation, at this place was

confined to vertical motion so that even objects upon the shelves did not fall at all. Therfore, she as well as her husband did not believe it to be an earthquake and went to her neighbour's to ask whether it was not the result of a bombardment or an explosion. It seems in itself wonderful that the house suffered no damage and tomb stones near by (Fig. 9 b) remained standing in the very centre of the epicentral tract, while the subversions of tombs at more distant places (Fig. 9 c) were as severe as in the epicentral tract of the Fukui earthquake[8] where acceleration of more than 0.6 times of gravity was observed. The writer was also informed that iron kettles were thrown off from hooks by which they were hung on fireplaces from the ceilings at Imaichi Town and Itabashi Hamlet in Ochiai Village. Moreover, it is said that at Shitone Hamlet in Toyooka Village a kettle placed on the ground was also overturned by the earthquake motion. These phenomena may be evidences of the fact that the acceleration of the earthquake motion in the epicentral tract was as large as that of gravity.

It is, therefore, no wonder that the fissures in the ground and landslides in the mountainous region within the disaster area were so severe as will be seen in the map to be presented by the writer and R. Morimoto in the following. But the writer, who had learned the landslides accompanied with the Calabrian earthquake of 1783 from Lyell's Principle of Geology, could really understand the severity of the landslides in Italy when he saw the large landslides at places where the slopes before the earthquake were as low as 7 or 8 degrees in the present earthquake district. (See Figs. 6, 7 & 8.)

The landslides in the present disaster area were greatly facilitated, on the other hand, by the existence of a very slippery stratum of much weathered white pumice which was ejected from the Nantai Volcano.

It was also found out that the strata of about 6 m in thickness above the slippery pumice layer which formed the base of the Imaichi Town slid bodily about 6 cm. eastward relative to the substratum. The fact was revealed from the discontinuity of the vertical walls of the wells throughout the town. The ground surface in the town was inclined only about 1 degree eastward from the horizon. Although such a phenomenon like this might have been of rare occurrence, the fact itself has an important bearing to the geodesy as well as the geophysics in the interpretation of crustal deformations.

It is also to be remarked that even in the southern part of the epicentre where the slipperry pumice layer was lacking, the landslides were also conspicuous at steep mountain sides, and at many places they turned into mud avalanches and destroyed houses and buried several persons to death at

8) H. KAWASUMI, *Rep. of Fukui Earthq.* (1950). 24.

several places. Indeed, most of lives lost and missing in the present earthquake were the result of these landslides. (cf. Figs. 7, 8.)

Another fact to be mentioned on the landslides is that, almost none have occured on the northern side of the Daiya River, making marked contrast to the case of the 1683 earthquakes.

Damage and Casualties.

As has been stated already, the acceleration of the present earthquake was exceedingly large in the central part of the present disaster area, which, instead, was comparatively narrow owing to the smallness of the magnitude and the hypocentral depth. However, it is a wonderful fact that wooden dwelling houses in the meizoseismic area were but slightly ruined and levelled to the ground, although the joints of pillars and beams etc. were badly broken. But it is no wonder that the stone and brick buildings and stone plates which were nailed to the outside of wooden store house were almost completely shaken down in most part of the disaster area. The apparently slight damage of wooden dwelling houses were probably due to the smallness of duration and period of the principal part of the earthquake motion.

The statistics, prepared by the state police, of the damage and casualties are tabulated in Table 2.

The distribution of the number of totally collapsed houses, as shown in Fig. 3. is in accordance with the positions of epicentres instrumentally determined.

The principal damage done to the government railway line was between the stations Fubasami and Imaichi while that done to the Tōbu company line was between Shimokoziro and Kami-Imaichi. The main damage was subsidence, fissuring and slumpage of railroad embankments. The approaches of bridges also suffered subsidence and some abutments of them were sheared off and displaced. Some cars between the above intervals were derailed.

A word on the damage at Nikko may also be added for the sake of comparison with those of historical earthquakes. According to the authorities of the Tōshōgu and Futarasan shrines and the Rinnōji temple, the stone walls (520 sq. m.), stone fences (550 m.) and 2 stone stairs were badly shaken or shattered and 40 stone or bronze lanterns (tōrōs) were overturned, while the buildings in the shrines and the temple were scarcely damaged, although masonry buildings in the Town was badly shaken. It is also to be remarked that at the copper refinary plant at Kiyotaki, about 5 km. SW of Nikko, a brick chimney was broken down and a concrete chimney cracked badly.

Thus the damage due to the present earthquake at Nikko is lighter than

Table 2. Statistics of the damage and casualties caused by the Imaichi Earthquake of Dec. 26, 1949.

Locality	Casualties				Dwelling houses			Not-dwelling houses			Rice paddies		Dry field		Forest		Road damaged	Bridges destroyed	Houses afflicted	Men afflicted
	Dead	Missing	Wounded Heavily	Wounded Lightly	Totally collapsed	Half destroyed	Slightly damaged	Totally collapsed	Half destroyed	Slightly damaged	Buried	Fissured	Buried	Fissured & slid	Buried	Slid down				
1. Imaichi Town	5		1	158	228	2820	496	303	713	146	5.15 h.a.		6.3 h.a.		30 h.a.		22	3	3606	14436
2. Ōsawa Village		1			1	9	134	58	163	212							3		377	1156
3. Ochiai V.	1				49	49		137	52	47			0.1		20		3		236	944
4. Nikkō Town		1			6	22	66	2	13	4						20 h.a.	10		93	358
5. Itaga Village						2	200	9	49	250	0.4	1 h.a.	0.6			50	10	3	260	1184
6. Sinoi V.						1	13	7	65										65	324
7. Toyooka V.						62	750	82	1200	2200							3	4	812	2450
8. Okurugawa V.					4	6		1	25	100		0.2	0.1				12	1	84	382
9. Higasiōasi V.					2	8		10	16								1		36	148
10. Nisiōasi V.	1					13											7	1	14	56
11. Kaso V.								5	8								3	1	13	48
12. Funyū V.	1		1	3			1	3	2	20									30	123
13. Ōmiya V.						2													2	13
14. Kikuzawa V.								1	1										2	11
Total	8	2	2	161	290	2994	1660	618	2307	2979	5 55 h.a.	1.2 h.a.	7.1 h.a.		50 b.a.	50 h.a.	74	13	5630	21633

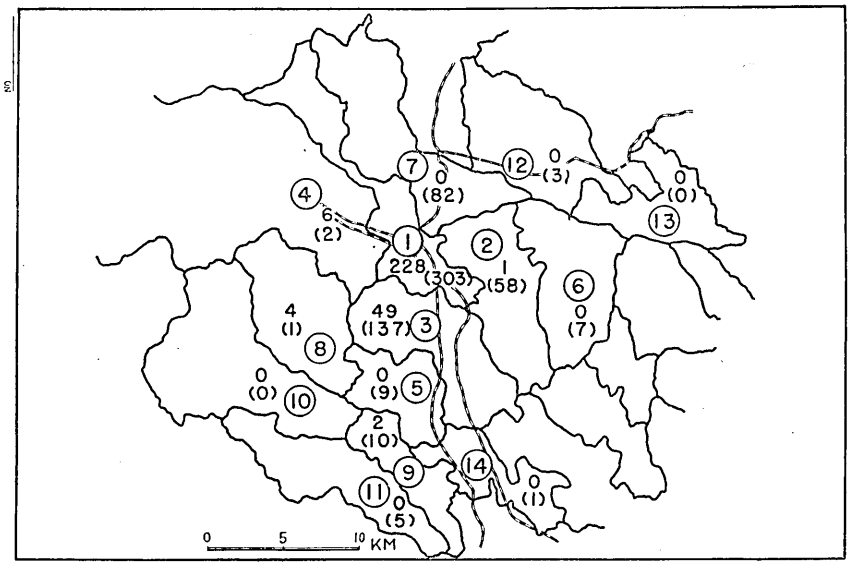


Fig. 3. Distribution of totally collapsed dwelling houses. The numbers in the brackets are those of not-dwelling houses. The number within the circle denote the locality in the Table 2.

in the case of 1683 earthquakes. This difference is due to the larger magnitude and to the proximity of the epicentres of the 1683 earthquakes, which might have occurred in the northern vicinity of Nikko. The 1755 earthquake was almost equal in intensity at Nikko, while the other shocks were inferior as compared with the present earthquake. At any rate the present earthquake is the strongest earthquake in the Nikko area in 194 years.

Summary and Remarks.

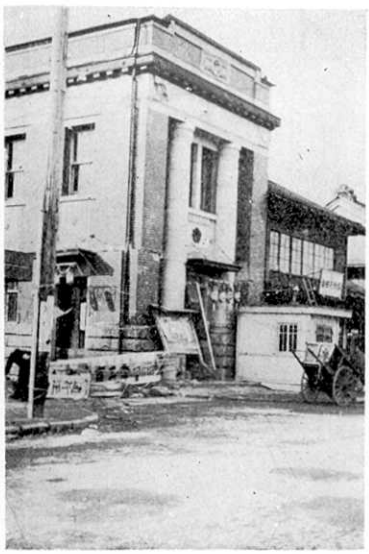
The Imaichi earthquake of Dec. 26, 1949 was the severest earthquake felt in the Nikko area in last 194 years. It originated in the southern vicinity, within several km. of the Imaichi Town. The hypocentral depth might have been under 20 km. The principal shock was preceeded 7 min. by a severe shock. The energy of the principal shock was estimated to be 10^{21} ergs, while that of the first shock was about 1/3 of the latter one.

Numerous aftershocks followed, but they decreased regularly. One aftershock at 17 h. 54 m. on the 27 th was so severe as to do slight damage again to the railway line.

Maximum intensity within the epicentral tract was so great as to exceed the acceleration due to gravity. Landslides were conspicuous in consequence, and the foundation of about 6 m. in thickness of the Imaichi town, which in-

Fig. 4. Damage of houses at Imaichi Town.

a. Town office.



b. Police station.

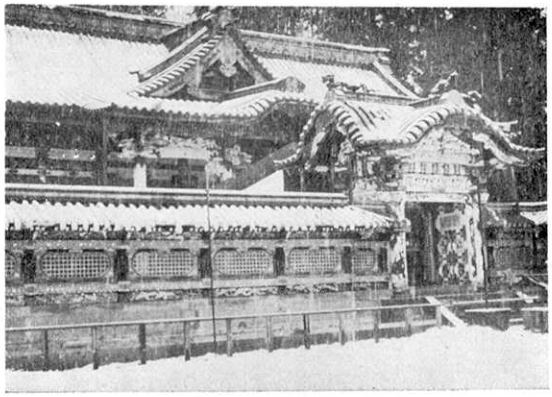
c. Wall of storehouse.

d. Wooden dwelling house.

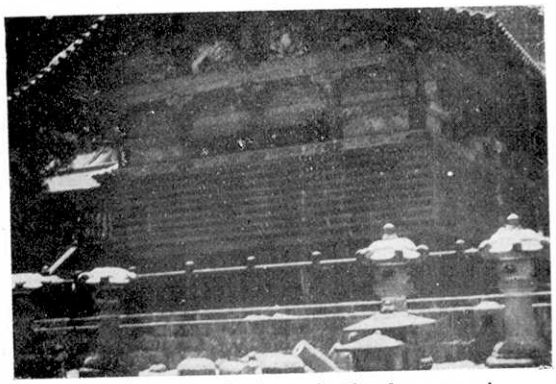
e. Subversion of smaller constructions at the Takinowo Shrine.

Fig. 5. Effect of Earthquake at Nikko. Wooden buildings suffered almost no damage.

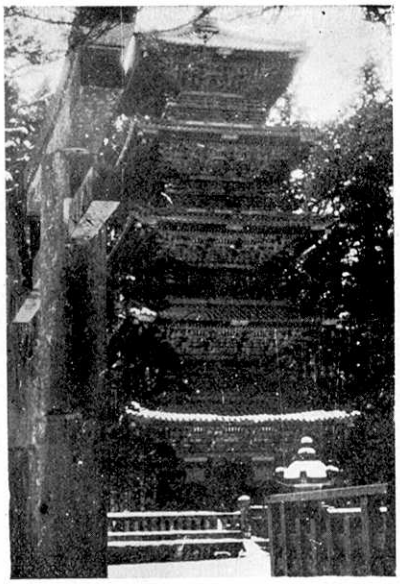
a. The Yōmeimon (gate).



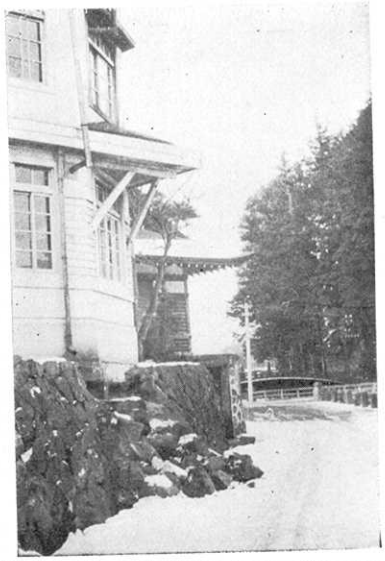
b. The Shrine and Kara-mon.



c. A few stone-lanterns in the foreground were overturned



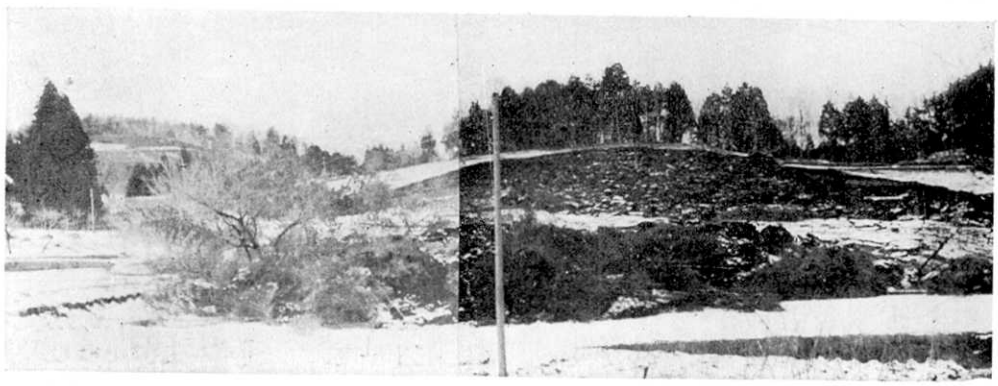
d. The pagoda suffered no damage. The upper part of *torii* (above the crack) was twisted a few cm.



e. The stone wall of the town office was destroyed very slightly.

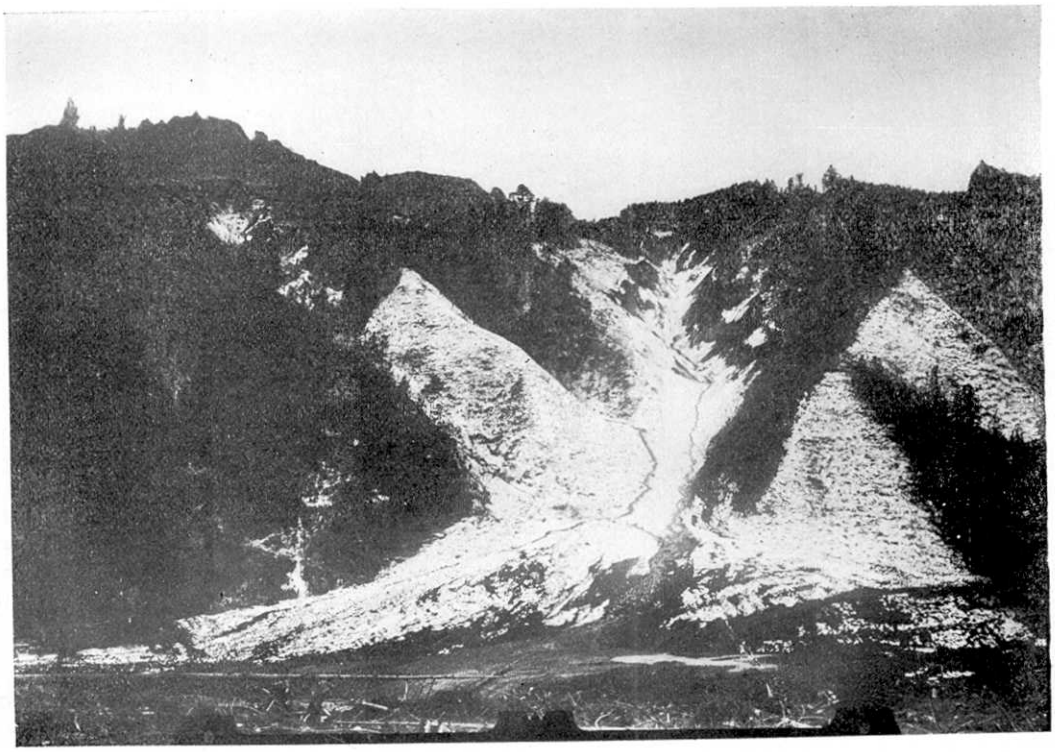
Fig. 6.

a. Low angle landslide at Tsuchizawa, Imaichi Town. Land before the brack fissure in the central part slid bodily with forrest almost undisturbed. The ridge in the foreground is the result of upthrust at the margin of the slid land.



b. Low angle land slide at Numauchi, Nikko Town (above), c. with temporary pond at the right margin. (left).

Fig. 7. a.



b.

High angle landslide (a) and the debris flowed down from it and buried 2 houses and 4 men and 1 horse (b). Murose-Namekawa, Imaichi Town.

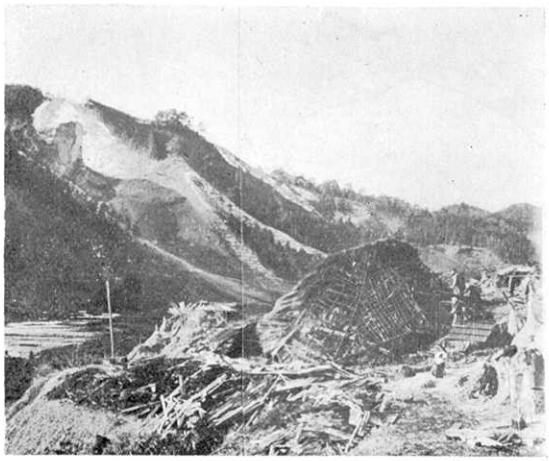
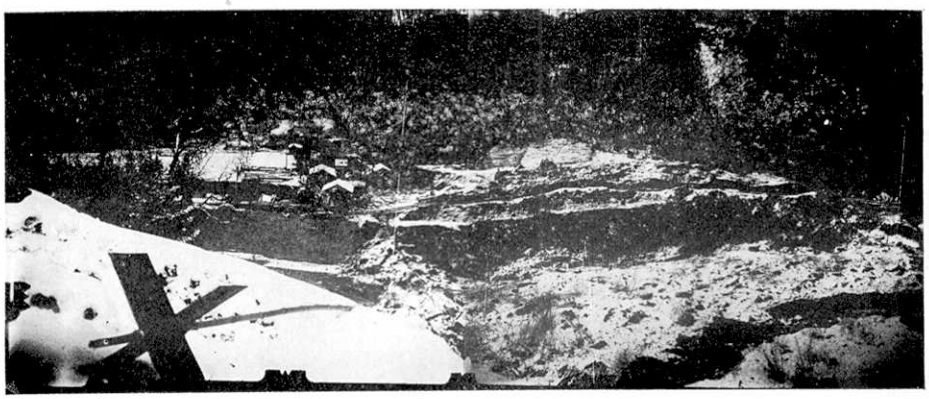


Fig. 7. c. The house pushed down and half buried by the mud flow. A horse was buried to death under the house. Stream line of the mud-avalanche is seen on the slope of the valley side in the back-ground.

Fig. 8. a. High-angle landslide at Matsunokiuchi, Nikko Town.



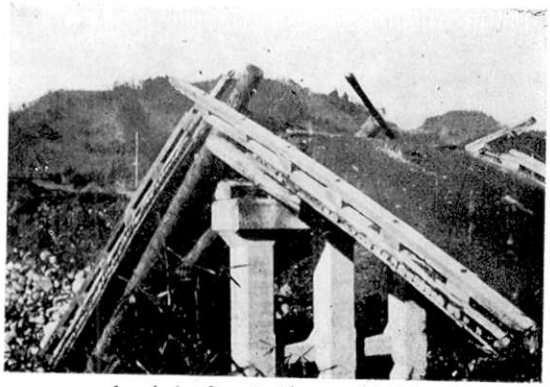
b. The mud flow flowed down the slope across the river in the foreground and leaped over the road and destroyed and buried a house standing at the higher level. The present road runs on the debris.

Fig. 9.

a. An "ishiusu", a stone implements for making rice cake, which was tossed some 20 cm several times like bounding rubber ball by the earthquake motion. At Nagahata, Ochiai Village.

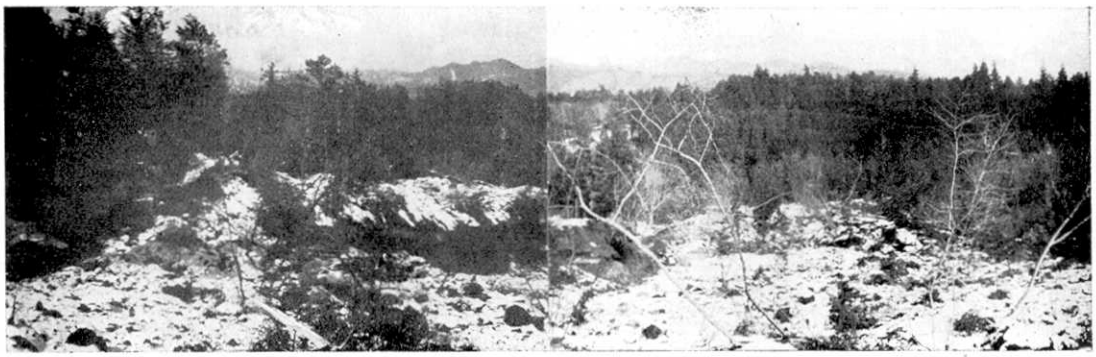
b. The tomb stone in the vicinity was disturbed but slightly.

c. The tomb at the Imaichi Town was much disturbed and only very few tomb stones remains standing.



d. A broken bridge at Myōjin, Ochiai Village.

Fig. 10.



a. Devastation of a forrest at Yamakubo, Nikko Town.

b. The trees pushed together compactly at the terminus of the mud flow.

clines only 1 degree eastward from the horizon, slid bodily eastward by about 6 cm. But the subversion of wooden houses in the meizoseismic area was rather slight owing perhaps to the shortness of duration and period of earthquake motion.

The mechanism of occurrence of the shock, as seen from the distribution of the first impulsions, was of conical type. And in harmony with this mechanism, we could not find any topographic changes which suggest the appearance of earthquake fault, while the provisional result of the levelling rerun after the earthquake, by the Geographical Survey Institute along the route from Utsunomiya to Nikko, revealed an upheaval more than 30 cm. in the vicinity of Imaichi with no indication of faulting.

Distribution of the first impulsions of the conical type was ascribed by M. Ishimoto to the mechanism of magma intrusion, and F. Omori attributed the earthquakes in this area to the volcanic earthquakes, but there is nevertheless no positive testimony to affirm the volcanic origin of the present earthquake. Although the writer has no intention to stress the volcanic hypothesis, since no Nikko earthquakes on record were acompanied by similar phenomena as follows, the apparent simultaneous activities of near volcanoes with the present earthquake must be mentioned. The Azuma, belonging to the Nasu volcanic zone, at 120 km. NE of Nikko manifested a slight activity on Feb. 10 and 13, and the Mihara at Oosima Island in the Sagami Bay which is 220 km. south of Nikko began its strong activity on July 16 and continued till Sep. 23 the Stronmolian phase forming a new central cone and emitting abundant lava, and recently the Asama at 100 km. SW by W made an unusually big explosions on Sept. 23, and Oct. 4, 1950.

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25. 今市地震概説

地震研究所　河角　廣

昭和24年12月26日朝8h 16m及8h 25mに栃木縣上都賀郡今市町附近を中心とする小區域破壊的地震が起り，死者8，行方不明2，全潰住家299戸半潰住家618戸の被害を生じた．

此の地震の震央附近の震度は極めて強かつたようであるが，振動週期極めて小なりし爲か石藏家屋の外は全潰（現建築費50%以上の損害）とは云へ倒潰と云ふやうなものは少かつた．從つて火事の發生を見なかつたのは幸であつた．然し山崩，地辷りは極めて著しく，山地田畑の荒廢著しく，人命の損失の大部分もこれによるものであつた．余震の頻發した事，及び初動の圓錐型分布，及び所謂地震斷層と思はれる如きものの見へなかつた事も本地震の特徴と云ふべく，今市町全體に亙る地震後井戸壁の變形から約6mの厚さの地層が東方に約6cm移動した事が判明したが，之は測地學上重要問題を指唆するものである．尙水準測量の結果は今市町近傍數粁の間だけ約30～40cmの隆起があつた由である．震後の火山活動との關係も興味ある問題であらう．