

## On the Bokusekikaku and Basshisho (Formosa) Earthquake of January 11, 1908

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# On the Bokusekikaku and Basshisho (Formosa) Earthquake of January 11, 1908.

By

F. OMORI, Sc. D.,

Member of the Imperial Earthquake Investigation Committee.

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With Pls. XXXV and XXXVI.

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1. *Introduction.*\* The disastrous earthquakes in Formosa generally occurred in the densely populated south-western part of the Island, where the ground is flat.\*\* The different places on the eastern coast are also by no means free from the visitation of strong shocks, although the amount of the seismic damage was there always insignificant. The latter circumstance is probably due to the mountainous nature of these districts and the scarcity of inhabitants, the seismic disturbances occurring, in many cases, under the ocean. The following three earthquakes were the strongest felt in the recent years along the Pacific side of Formosa.

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\* The times are all given in the 1st Normal Japan Time, or that of longitude 135° E of Greenwich.

\*\* See my paper on the Formosa earthquake of March 13, 1906. The *Bulletin*, Vol. I, No. 2.

(a) *Giran Eqke of June 7, 1901; at 9h 05m am.* The shock which was quite local, was felt strongly and caused some slight damage at the town of Giran and the vicinity:—

Giran. 5 or 6 houses had mud walls cracked, and a few roof tiles thrown down.

Shokei. One house had the roof damaged. In one case, a mud wall was thrown out of the vertical.

Hachirisha. 6 houses slightly damaged.

Suihenkyaku. 56 native houses damaged.

Taikakan. One native house destroyed.

This earthquake, which was not felt at Taito and Koshun, was *slight* at Tainan and Hokoto, *moderate* at Taihoku, and *strong* at Taichu.

(b) *Taito Eqke of Sept. 7, 1903; at 4h 14m pm.* The disturbance was felt strongly at Taito, where 92 after-shocks were recorded in the course of the following 30 days. No damage was done, the origin being sub-oceanic.

(c) *Karenko Eqkés of Aug. 26 and 28, 1905.* The earthquake of Aug. 26, which occurred at about 4h 52m pm., was felt slightly at Taihoku and Taichu, but insensible at Tainan, Taito, Hokoto, and Keelung. It was, however, strong at Karenko and was followed by several minor shocks. The earthquake of Aug. 28, at about 1h 23m pm., was much severer, causing at Karenko partial destruction of one ware-house and 6 native houses, besides some damage to two houses in Japanese style. This shock was also very local, the area of severe motion being limited only to the immediate vicinity of the above mentioned town. At the Gozenjo, about 10 km to the south-west of the latter, the motion was strongly felt but caused no damage. At Basshisho, about 42 km further on in the same direction, the intensity was

slight. The motion was sensible and slight at Taihoku, Taichu, and Taito, but was insensible at Tainan, Hokoto, and Keelung.

The earthquake of Jan. 11 of this year, which originated near the towns of Bokusekikaku and Basshisho in the Taito prefecture, was the strongest felt in the Island since the destructive shocks of Kagi in March and April, 1906.

*Earthquake of Jan. 11, 1908.*

**2. Time of occurrence.** The observations at the different meteorological observatories in Formosa were as follows:—

Station.	Geographical Position.		Intensity of motion.	Duration of Preliminary Tremor.	Time of Occurrence.
	Latitude (N).	Longitude (E).			
Taihoku.	25° 02'	121° 31'	Moderate.	sec. 18.8 (?)	<sup>h</sup> 0 <sup>m</sup> 35 <sup>s</sup> 14 pm.
Taichu.	24 09	120 42	Do.	—	0 32 57 (?)
Tainan.	22 59	120 12	Strong.	18.9	0 36 14
Taito.	22 45	121 09	Do.	13.9	0 36 46
Koshun.	22 01	120 44	Moderate.	25.9	0 38 30 (?)
Hokoto.	23 32	119 33	{Moderate (rather weak),	23.2	0 36 08
Keelung.	25 09	121 45	Do.	—	0 36 00
Karenko.	24 00	121 33	Strong.	—	0 36 00

The observations at the 5 stations of Taichu, Tainan, Taito, Koshun, and Hokoto, were each made with an Omori horizontal pendulum of 6 times magnification; Tainan being also furnished with an ordinary Gray-Milne-Ewing type macro-seismograph. At Taihoku the pointer of the horizontal pendulum, of 10 times magnification, got out of the smoked paper soon after the commencement of the shock, and the duration of the preliminary tremor at this place estimated from the macro-seismograph record, namely, 18.8 sec., seems to be too short. Karenko had no seismological instrument, while Keelung had simply a macro-seismograph.

The times of the earthquake occurrence at the different stations are only approximate, except that at Taihoku; the probable time of occurrence at the origin itself being about 0h 35m 00s pm.

**3. Area of disturbance.** The earthquake was sensible all over Formosa and in Hokoto (Pescadores). The shock was also felt slightly at Ishigaki-jima (Lyukyu) at an epicentral distance of about 302 km, so that the radius of the area of sensible motion was probably a little over 300 km. As shown in Fig. 2, (Pl. XXXV), the land area of moderate and strong motion was, for Formosan shocks, unusually large and had a length and breadth of 210 and 100 km respectively; the longer axis being in the direction of NEN and SWS and coinciding with the Taito longitudinal valley. Within this area, whose western boundary was formed by the line joining the cities of Toroku and Tainan, pendulum clocks were generally stopped. According to Mr. H. Kondo, who happened to be at Karenko at the time of the earthquake, the motion there was strong and lasted 25 seconds, causing the houses to be shaken considerably, although no damage was produced. At Karenko there were some after-shocks and *jinari*.

The area of severe motion, within which seismic damage was done, included the villages of Bokusekikaku, Suibi, and Basshisho, forming probably an ellipse of length and breadth respectively of about 75 and 50 km. According to the reports from the different rain-gauge stations, the shock was preceded or accompanied by sounds, in the western half of the Island, at the four places of Suiteiryō, Nanto, Doko, and Seimojū, where the intensity of motion was moderate or slight.

**4. Earthquake damage.** The villages of Bokusekikaku and Basshisho are situated among the districts inhabited by the

aboriginal tribes, whose dwellings are of the simplest construction with thatch roofing, and do not show signs of seismic damage; there being only a very few houses of "dokaku," or mud construction, prevalent among the native (old Chinese) population of Western Formosa. To these circumstances was partly due the small amount of the seismic damage to the buildings. There were at Bokusekikaku and Suibi three old houses totally overthrown, besides a number of the cases of partial destruction. Still there is no doubt that the intensity of motion in the epicentral area was much smaller than that on the occasion of the Kagi earthquake of March 17, 1906. At Suibi, the "byo" (native temple), the only *dokaku* building in the village constructed some 5 years ago, had its back wall entirely thrown down, while the damage to the front side facing S80°E was limited to cracks of the walls and the falling down of some roof tiles. (See Fig. 3, Pl. XXXVI). The walls of the sub-prefectural office at Bokusekikaku were much cracked, but the plasters did not fall down. The *dokaku* house of the chief official of the village of Chuka, constructed in the preceding year, was only cracked at the junctions of the walls. The newly built sub-prefectural office of Seiko-o was practically undamaged, except some slight separation of the timbers and walls.

Some landslips were caused by the shock in the vicinity of Basshisho, Suibi, Bokusekikaku, and Sangenya; part of the water of the river Shukoran-kei having been temporarily stopped by the falling of a soft rocky cliff. At a place about  $2\frac{1}{4}$  km distant from Basshisho and among the valleys of the central mountain range the stream waters were from a similar cause stopped for a few days. Again, at Bokusekikaku and Chuka the ground was cracked, in some cases to a width of 1 foot.

5. *Approximate position of the earthquake origin.* The epicentral distances of the four meteorological observatories of Taito, Koshun, Tainan, and Hokoto, calculated by Equation (3) given on page 146 of this Number, from the durations of the preliminary tremor, are as follows :—

Station.	Epicentral Distance = $x$ . Calculated by Equation (3), p. 146.
Taito	103 <sup>km</sup>
Koshun	186
Tainan	138
Hokoto	167

Drawing on the map of Formosa (Fig. 2), four circles about the different stations as centres and with radii respectively equal to the calculated epicentral distances given in the above table, we find that their points of intersection are near each other, enclosing a small quadrilateral in the vicinity of Basshisho. Taking also the isoseismal lines into consideration, the approximate position of the epicentre, marked in the figure by a small cross ( $\times$ ), seems to be at about

$$\begin{cases} \varphi = 23^{\circ} 37' \text{ N,} \\ \lambda = 121^{\circ} 15' \text{ E.} \end{cases}$$

The epicentre thus located is about 52 and 96 km distant respectively from Karenko and Taito, being nearer the former by 44 km. Now, by a curious coincidence, it happened that one Mr. Wakamatsu, in the service of the post office at Taito, happened to telephone to Karenko just before the occurrence of the earthquake in question. He received for answer the information that a strong earthquake was taking place at Karenko and was requested to wait for a moment; some noisy sounds being simultaneously perceived through the telephone. After a short

time interval, while he was wondering what was the matter, a strong shaking began to be felt also in Taito. This circumstance illustrates in a practical manner the fact of the transmission of the seismic waves. As the propagation velocity of the vibrations composing the principal portion of the earthquake motion is about 3.3 km per sec., the time difference between the occurrence of the shock at Karenko and that at Taito would have been about 13 seconds, for the distance difference above assumed.

**6. Relation of the earthquake of Jan. 11, 1908 to that of March 17, 1906.** The cause of the disastrous Kagi earthquake of March 17, 1906, was the formation of the Baishiko and Chinsekiryō faults, in the main direction of west-slightly-south and east-slightly-north, over a distance of  $13\frac{1}{2}$  km from Baishiko on the east to Dabyo on the west. It was further pointed out, firstly, that the fault was probably continued westwards to the vicinity of the town of Shinko for a further distance of about 12 km, making up a length of  $25\frac{1}{2}$  km; and, secondly, that this latter length corresponded only to the western half of the line of dislocation and the eastward continuation passed among the mountains for a further distance of 20 or 25 km, the total extension of the fault being some 50 km.\*

From the map (Fig. 2), in which the western and the probable eastern halves of the above mentioned fault are indicated respectively by thick full and dotted lines in red, the further eastward prolongation of the same line of disturbance seems to pass through the epicentre (×) of the Bokusekikaku and Basshisho earthquake of this year. My supposition is that the latter shock was a continuation of the Kagi catastrophe of 1906, the formation of the fault having been extended eastwards.

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\* See the *Bulletin*, Vol. I, No. 2.

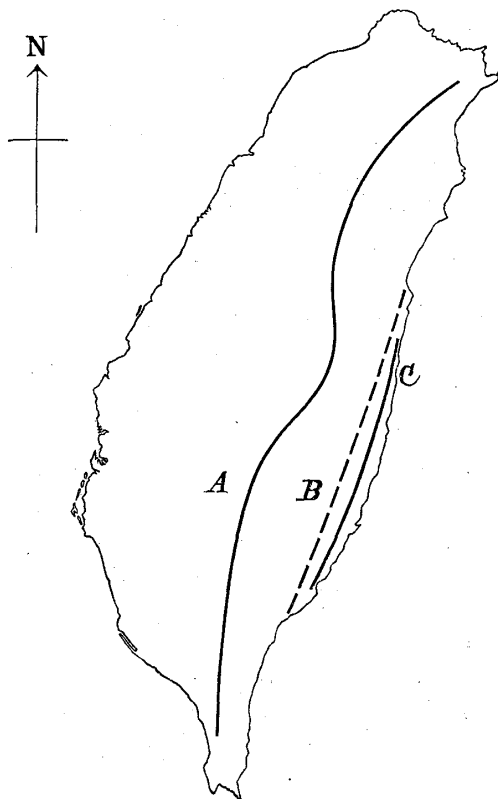


If the above supposition be correct, the process of dislocation must have proceeded downwards in the eastward extension, as the focal depth of the Bokusekikaku and Basshisho earthquake was evidently great. The intensity of motion in the assumed epicentral district was not greater than in the case of the very local Karenko shock of 1905.

**7. Mutual relation of the different strong earthquakes along the eastern coast of the Island.** The back bone of Formosa, whose geographical feature is rather simple, is formed by the heavy mountain chain, which runs parallel to the longer axis, and is nearer to the eastern coast, of the Island. It begins in the Koshun peninsula at the southern extremity, and takes the NEN direction, till the great height of over 3,000 metres is reached among the peaks in the vicinity of Mt. Sylvia. Thence the direction of the range is turned toward ENE and reaches the sea at the neighbourhood of So-o; forming the tremendous steep cliffs along the eastern coast between the latter place and Karenko. Mt. Niitaka (Mt. Morrison) is the highest peak, not only in Formosa, but in the whole of Japan and attains the altitude of over 4,000 metres. The eastern side of the main

Fig. 1. Map of Formosa.

- A.... General course of the Principal Mountain Range.
- B.... Taito-Karenko Longitudinal Valley.
- C.... Taito Coast Range.



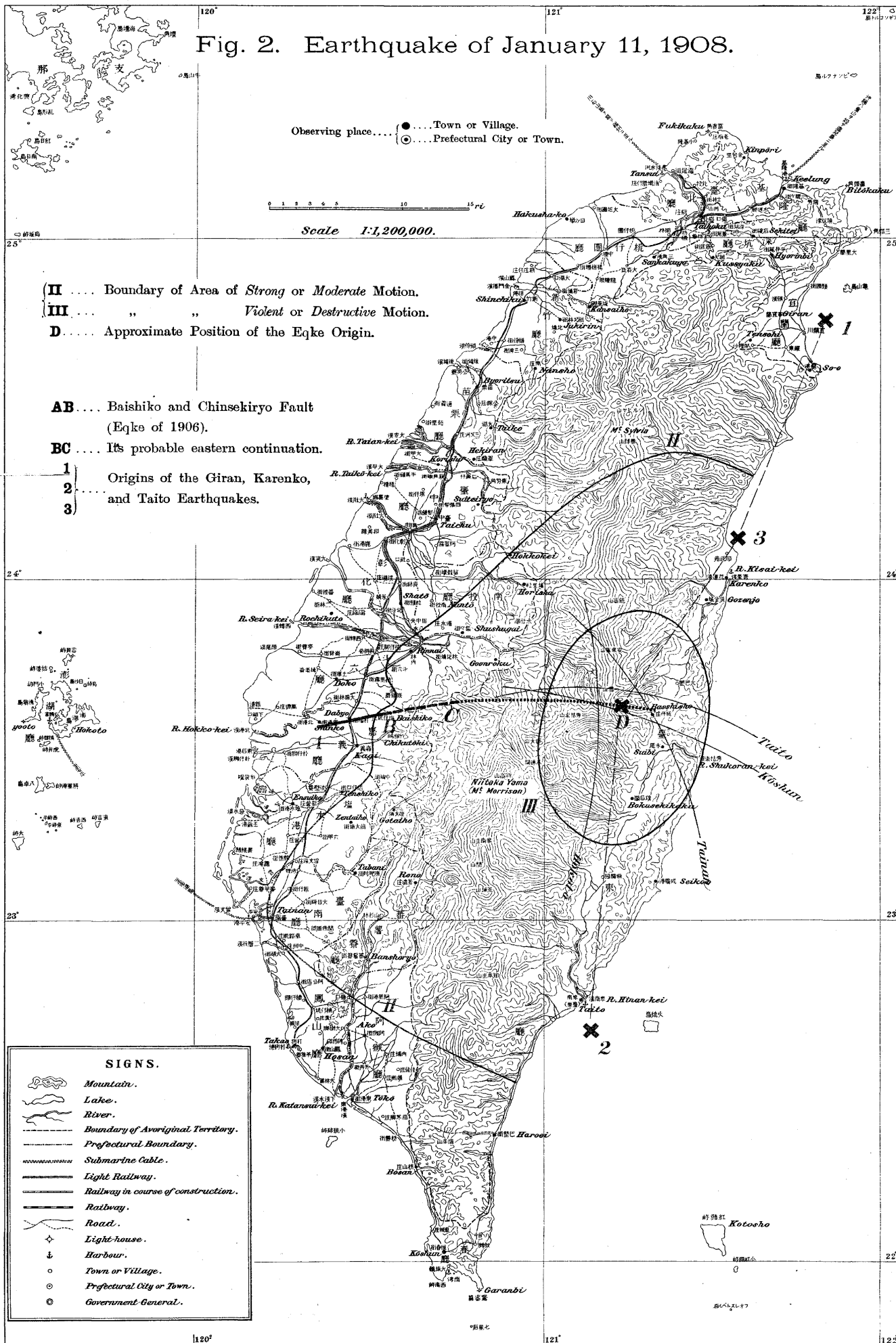
axis, and is nearer to the eastern coast, of the Island. It begins in the Koshun peninsula at the southern extremity, and takes the NEN direction, till the great height of over 3,000 metres is reached among the peaks in the vicinity of Mt. Sylvia. Thence the direction of the range is turned toward ENE and reaches the sea at the neighbourhood of So-o; forming the tremendous steep cliffs along the eastern coast between the latter place and Karenko. Mt. Niitaka (Mt. Morrison) is the highest peak, not only in Formosa, but in the whole of Japan and attains the altitude of over 4,000 metres. The eastern side of the main

mountain range, which is much steeper than the western side, descends abruptly into a straight longitudinal valley which extends between Karenko and Taito. To the east of this valley there is along the coast a small mountain range of about 1,000 metres height, called the Taito Coast Range. It seems probable that the Karenko-Taito longitudinal valley, whose northern and southern continuations may be supposed to run off the coast, is as explained below closely connected with the seismic phenomena in the whole eastern part of the Island. (See Fig. 1.)

Again from the maps (Pls. XXXIII and XXXIV) showing the earthquake distribution in Formosa, it seems that the more frequently disturbed regions about Giran, Karenko, Basshisho and Bokusekikaku, Taito, and Garanbi (southern extremity of the Island), belong to a continuous earthquake zone, which runs along the eastern coast of the Island, or rather along the eastern side of the main mountain range. In the northern part, between Giran and Karenko, this zone is probably some little distance off the coast, while its middle part, between Karenko and Tainan, is probably situated inland and coincides with the Karenko-Taito longitudinal valley. The southern part of the zone, between Taito and Garanbi, is again a little distance off the coast.

Now the Bokusekikaku-Basshisho earthquake of Jan. 11, 1908, may be taken also to belong, together with the three previous strong shocks mentioned in § 1, (a), (b) and (c), to the longitudinal seismic zone along the eastern coast of Formosa as above supposed. In other words, the stress was gradually increasing along the zone in question and produced strong disturbances at the different places, in the following order :—(1), Vicinity of Giran in the north ; (2), off the coast of Taito in the south ; (3), Vicinity of Karenko, between (1) and (2), but nearer to the former ; (4),

Fig. 2. Earthquake of January 11, 1908.



This map has been reduced from one of scale 1 : 600,000, published in 1904 by the Civil Engineering Department of the Government-General.

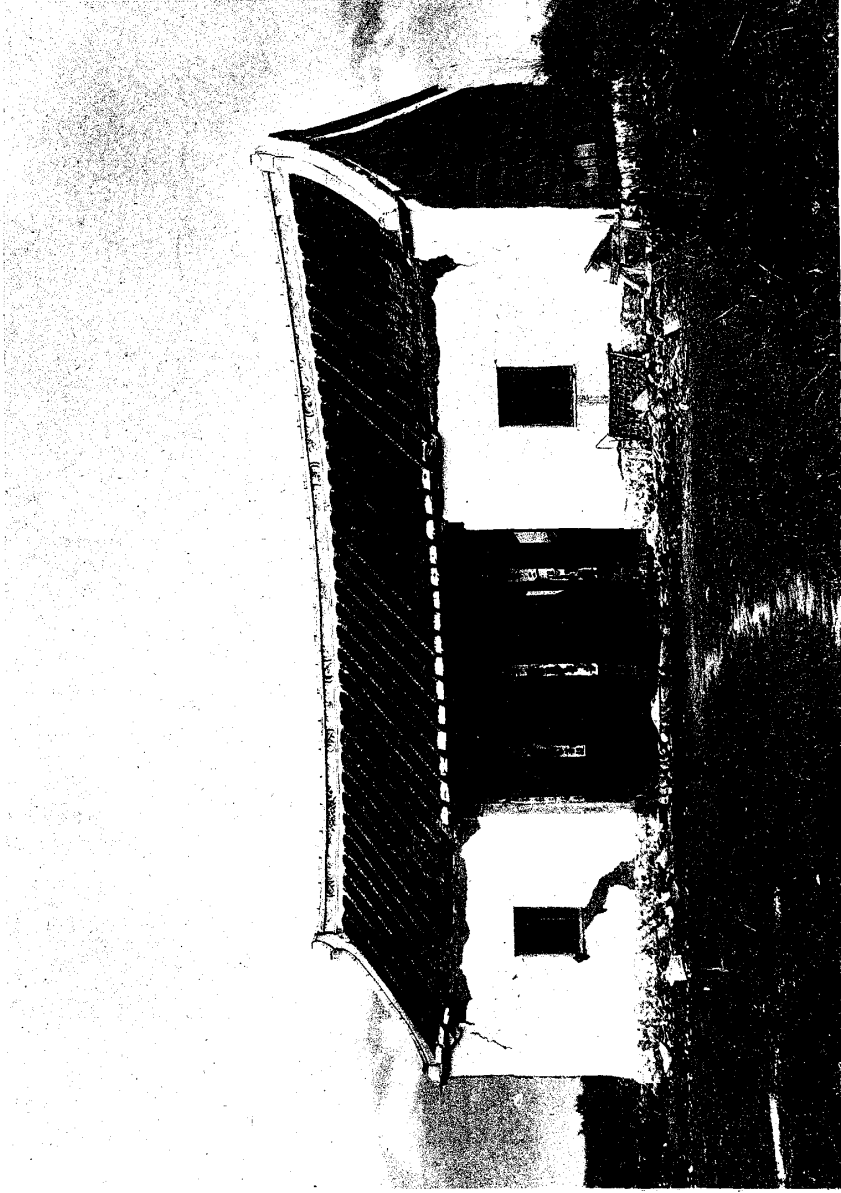


Fig. 2. The *Byo* (Temple) at Suibi, damaged by the Earthquake of Jan. 11, 1908.

vicinity of Bokusekikaku and Basshisho, between (3) and (2). (See Pls. XXXIII and XXXIV.) For other cases of the successive occurrence of strong or destructive shocks along an earthquake zone the reader is referred to the "*Bulletin*," Vol. I, Nos. 1 and 3.

**8. After-shocks.** At Basshisho the number of the after-shocks felt till 10 am. on the following day was 20 or 30, and there were several *jinari*, or earth sounds which seemed to proceed from some distance. At Bokusekikaku there were also a number of after-shocks. The following is a list of the shocks and sounds subsequent to the initial disturbance, observed by Mr. H. Kondo during his travel in the Taito prefecture :—

(January 1908)

11th.	Karenko.	Slight shock at 0.38 and 0.50 pm.
12th.	„	„ „ 0.34 pm.
13th.	Gozenjo.	„ „ 7.30 and 8.42 pm.
14th.	In the vicinity of Gozenjo.	<i>Jinari</i> at 11.25 am.
„	Bataian.	<i>Jinari</i> at 7.16 pm.
„	„	„ „ 0.09 am.
15th.	Basshisho.	Sound and slight shock at 0.54 pm.
„	Suibi.	Sound and slight shock at 8.02 pm.
„	„	Slight shock at 8.19 pm.
16th.	Sanganya.	Moderate earthquake at 6.07 pm., followed by others.
17th.	„	Moderate shock at 2 am. After the 17th, the shocks became rarer.

In conclusion I must express my thanks to Mr. H. Kondo, who have kindly put at my disposal the materials and the results of his observations respecting the earthquake.