15. *Land-slides at Nōdani and Nechi in 1947.*

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Introduction.

Nōdani and Nechi are both situated in the Kubiki district, Niigata Pref., known for frequent land-slides from ancient times[1]. The localities of these two are shown in Fig. 1. In May 19, a fairly rapid land-slide attacked the Village Maseguchi in Nōdani, destroying more than 50 houses. Fortunately, it having occurred in the daytime, no human life was lost. At Nechi, another very slow land-slide was then progressing.

1. Nōdani land-slide.

Topography and geology. The topographies of Maseguchi and its vicinities can be seen in Fig. 1. The village is situated on the slope (20°–10°) between Mt. Gongen and the river Nō. Profile of the slope is somewhat stepwise and contour-lines around the slope show a horse-shoe-form. Thinking of geographical features of land-slide-region studied by Terada and Miyabe[2], they should be traces of past land-slides. In fact, about forty years ago, occurred a land-slide at the same place as today.

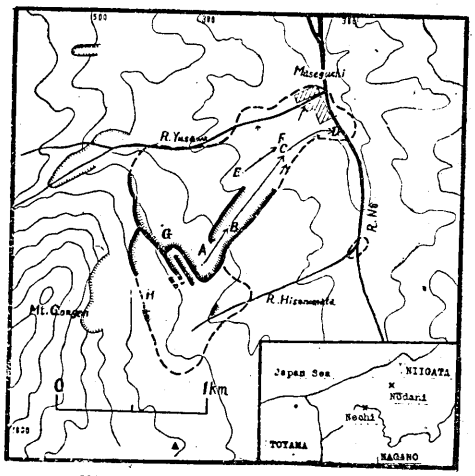

Fig. 1. Land-slide at Nōdani.

The Kubiki district is known for much snow, and at Nōdani the snow fell unusually in January and February in 1947 and still remained

1). T. Terada & N. Miyabe, *Bull. Earthq. Res. Inst.*, **10** (1932) 192, (In Japanese) K. Nakamura, "Yama-Kudure" (In Japanese).

2) T. Terada & N. Miyabe, loc. cit.

as deep as 4 m in March yet.

According to a geological map, Mt. Gongen is a huge block of hornblende-basalt, surrounded by sandy shales of tertiary formation which cover almost all of the Kubiki district. The boundary between them is about 500 m above sea-level, where the slope also changes abruptly. The upper end of the present land-slide coincides fairly well with this line.

Progress of the land-slide. Since two years ago, in spring, after the snow had melted away, it was noticed that the surface of rice-fields on the slope had tilted mainly towards the Yusawa. On April 14 of this year, an earthquake occurred, the epicentre of which was 4 km east of Maseguchi, where the seismic intensity was 4–5 of the C. M. O. scale. Due to the earthquake many cracks appeared on the snow, and springs and wells in the village became unusual and showed fluctuations in quantity and transparency since then. They say that mineral spring Shimamichi stopped and the temperature of hotspring Sasakura rose. These phenomena suggest that paths of underground-water changed at the time of the earthquake. After the snow had melted away, many cracks were found on the rice-fields. Especially to the south of line A-B-C in Fig. 1, north sides of cracks were found subsided. From the night of May 18, the water of springs in Maseguchi became unusually muddy. At dawn of the following day (19th), villagers were alarmed at finding that cracks had appeared during the night at the foot of Mt. Gongen. At 9h a. m. the ground near A and B crept down trees on it with a velocity of about 30 cm/min, but near the village no sign of slide was seen. At noon, surface-soil of land-slide broke into pieces at the end of a terrace near C (made by a past land-slide), mixed with water and flew down over the southern part of the village and arrived at the riverside in 30–60 minutes. Northern part of the mud-flow also arrived at the riverside in a few hours and dammed up the Nō. Houses on its way were destroyed and carried away to the river. In the evening a new layer of rather soft shale thicker than 6m appeared from beneath the soil which accumlated on the riverside. On the following day (20th), northern part of the village continued to slide down with a velocity of 1.0–1.5 m/hour, and new cracks were reported near Tamugidaira. On 23rd, one part of a cliff at the upper-reaches of the Hisonomata fell to pieces, ran down to Tamugidaira and dammed up the Nō again. Landslide wholly ceased on 24th.

Outline of deformation. The total area where cracks and slide were seen amounts to 1.2 km^2 (surrounded by broken lines in Fig. 1). Main

cracks are indicated by heavy lines. Main part of the present land-slide was the southern half, especially the area about 200m wide along A-B-C, where the surface soil was broken to pieces and no small crack remained. Beneath the new cliff, a new basin "A" in Fig. 1 was produced after the soil moved away. In the northern region, a number of cracks were seen, most of which showed that the lower part subsided and dragged the higher. Displacement of surface soil varies from place to place. From distances which trees and houses travelled, directions and absolute values of displacements were determined by simple triangulations with the aid of a handcompass. Results are shown with arrows in Fig. 1. Displacement amounts to 600m in maximum.

In the middle of Mt. Gongen, a band-shaped trace of slide of weathered soil could be seen on andesite (about 10m in width), which occurred after the basin "A" was produced. To the northwest of "A" another small basin (G) was noticed. Though no villager could tell when it was made, inferring from severe stone-rollings from cliffs above the place which happened in the afternoon of 19th, another land-slide might have occurred there at that time.

Possible causes of the land-slide & Conclusion. On the mechanism of the land-slide, the explanation presented by Miyabe[3] seems most suitable. That is, a land-slide occurs at the time when the pull of gravity of soil exceeds its friction and cohesion. It is found through many experiments[4] that coefficients of cohesion and friction of soil change greatly as water-content varies.

At the upper end of the land-slide there remained fragments of shale and at the lower end a layer of shale was seen beneath the broken soil. These facts suggest that shales contributed to the land-slide. Taking this into account, the course of this land-slide may be explained as follows. The shales became weathered and water-rich chiefly by slush-water, so the ground at the foot of Mt. Gongen slid little by little in every spring (at least for these three years). In addition to much snow of this year, the severe earthquake loosened the soil (consisted of weathered andesite) and changed paths of undergroundwater. Consequently, water permeated easily into the surface soil and a part of shale. And a slow land-slide occurred resulting fluctuations in the watersupplies. Meteorological phenomena which might acceralate the slide, for instance rise of air-temperature or rainfall, could not be pointed out. Land-slide of the northern region were caused by changes in paths of water and dragging

3) N. Miyabe, *Bull. Earthq. Res. Inst.*, **13** (1935), 85.
4) *Report of Soil Investigation Commitee*, Vol. 2 (In Japanese).

due to the southern land-slide.

Generally speaking, the land-slide belongs to Type 3 associated with Type 2 in the classification of Miyabe[5].

2. Nechi Land-slide.

Topography. Ōkubo in Nechi has been threatened by land-slides for many years. At the foot of a fairly steep mountain Togura runs a low-pitched slope (10°–20°) down to a branch of a river Hime. The tertiary shale covers the slope and it inclined about 20° to the riverlet.

The land-slide. For these three years, the ground of the village continued to slide, so slowly that people became aware of it merely by cracks, deformations of their houses, changes of watersources and tilting of rice-fields. However, houses deformed more largely than before and long cracks were found on the slope in spring of this year. According to the result of a survey, sliding-region is 100–200m wide and 1.5km long. General features of deformations are subsidence of the higher side and lifting of the lower side. Maximum vertical dislocation amounts to 6m at southeastern side of the region. Horizontal movements were comparatively small and various in direction. One interesting proof of slide was traces of slippers of iron rails which passed through the sliding region and remained unremoved. As their traces on the soil went more or less out of shape by melting snow, ratio of displacement before and after spring could be roughly determined. According to that, velocity of slide increased to twice of the last year in this spring.

The mechanism of this land-slide seems to be the same as that of Nōdani.

In conclusion, the writer wishes to express thanks to Dr. Minakami for his encouragement.

5) N. Miyabe, loc. cit.