Piedmont Geomorphology of Iwaki Volcano

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1 Introduction

The term "volcanic mudflow", which has been commonly used with various meanings, causes not only inconveniences but also ambiguity in many cases. Sharp and Nobles (1953) once suggested that another term "debris-flow" should be given in the case where the volcanic deposits are composed of rock fragments larger than sand.

In the previous paper the author presented a classification. First, he classified volcanic deposits into "fall" and "flow" deposits; and then the flow deposits excluding lava flow into those of essential materials and of accessory materials. The former were further divided into nuée ardente deposits and pumice flow deposits, which were separated into mudflow and debrisflow deposits, the latter subdivided into two types, avalanche and flow types (Mizuno 1964a).

The author has surveyed the piedmont landform of volcanoes in Tohoku and Hokkaido, and revealed that debrisflow took a predominant part in forming their piedmonts (Mizuno 1958, 1960, 1961, 1962, 1964a, 1964b).

In this paper he tried to classify the characteristics of debrisflow landform and the volcanic fans widely distributed in the piedmont of Iwaki Volcano located in the northern end of Honshu. This study was mainly based on the results of the field survey, supplemented sometimes with photo-interpretation.

2 Iwaki Volcano

Iwaki Volcano (1652 m above sea-level) is situated about 15 km northwest of Hirosaki City, Aomori Prefecture, and one of the typical conide type volcanoes as is suggested by another name "Tsugaru Fuji" because of its view from the city exactly like Mt. Fuji.

The piedmont extends down to the hills of Miocene formation from south to west, and the Nakamura, Iwaki and Taiaki rivers flow on the boundary. In the north and the east it is in contact with the upland of Pleistocene formation, or in some parts it extends farther down to Tsugaru Alluvial Plain. Stratigraphical relations reveal that the volcano was active in Late Pleistocene, roughly in three stages (Kawano, Aoki and Kadowaki 1961). In the first stage it erupted an

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enormous quantity of volcanic breccia, forming a greater part of the volcano; in the second the lava completed the present form of the volcano, and at the end of the second stage an almost circular crater about 1 km in diameter was formed near the top. There is no crater-rim left, except its remains still observed on the north and the south sides of the crater, in which a central cone was formed in the third stage. In the later third stage a large number of explosion craters were created without extravasating any lava. In the historical age its activity was recorded at least six times since 1597, and the latest explosion occurred in 1863 without any lava eruption.

3 Debrisflow Deposits

The author once reported briefly on various volcanic flow deposits on the piedmont of Iwaki Volcano, and pointed out that debrisflow deposits cover the area from north to northeast, and designated them "Ōdaino Debrisflow Deposits" in the north, and "Tozurasawa Debrisflow Deposits" in the northeast after the typical place names (Mizuno 1961) (Fig. 1).

Ōdaino Debrisflow Deposits are distributed in the north piedmont, and their

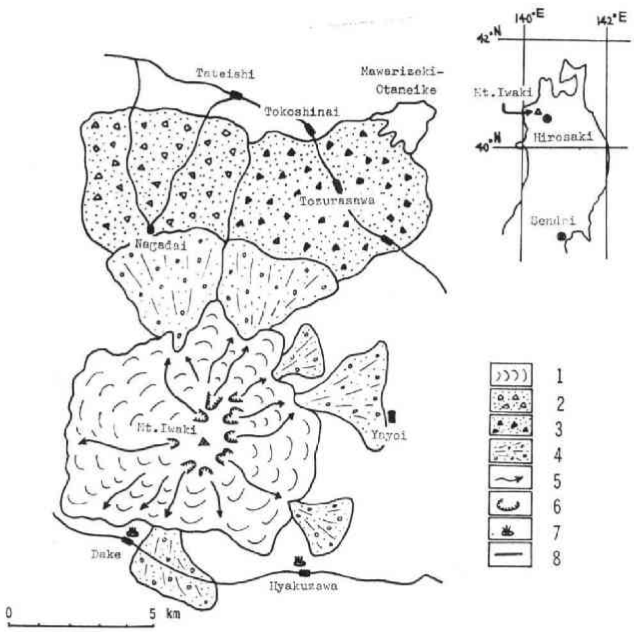

Fig. 1 Geomorphological map
1: Lava flow 2: Ōdaino debrisflow 3: Tozurasawa debrisflow 4: Volcanic fan
5: Dissected valley 6: Explosion crater 7: Hot spring 8: Road

surface is undulating and slopes down from 200 m to 40 m in altitude, bordered by a Pleistocene upland in the north. Their surface has been fairly dissected for a long time since the flow, but not so deeply, and it is impossible to observe the basement. Debris are andesitic, and small in size, mostly 5 to 20 cm in diameter, at largest 60 to 70 cm. They contain a large quantity of matrix, and are observed to have contained water. They are for the above evidences identified as flow-type deposits. Characteristic landform of debrisflow deposits is many flow mounds. More than 70 flow mounds are counted in this area. Viewed from their distribution the area can be divided into two, a section along the Tateishi-Nagadai road (100 to 50 m in altitude), and another along the Nagadai-Narusawa road (200 to 100 m in altitude).

Tozurasawa Debrisflow Deposits are distributed in the northeastern piedmont at the altitude of about 180 m, and their downward fringe is in contact with Alluvial plain near Mawarizeki-Ōtameike. Most of andesitic debris in flow deposits are generally larger in size than those of Ōdaino Debrisflow Deposits, and there is no trace of water contained. And the rate of debris to matrix is higher than that of Ōdaino Debrisflow Deposits. These facts suggest that the deposits are of avalanche type. Characteristic landform of these deposits is also a large number of scattered flow mounds, amounting to about 120. The Nagamae river flows on the boundary between the above two debris-flow deposits areas.

4 Flow Mounds

There are nearly 200 flow mounds in both the areas, Ōdaino and Tozurasawa. Their distribution is wider and more numerous in the east than in the west (Fig. 2). As for the landform, undulation is conspicuous in the east and gentle slope in the west. Such characteristic landforms are related to the distribution range of flow mounds. Debrisflow types are other factors to the flow mound distribution, for in general, avalanche type brings wider distribution than flow type.

Roughly speaking, their plans are circular or elliptic in shape, but if combined together, they are somewhat deformed. Their long profiles are asymmetrical, 5° to 20° on one side and 15° to 45° on another, but their cross sections are symmetrical.

These profiles are classified into some patterns, related with the flow direction (1) normal pattern: the flow direction coincides to that of steep slopes; (2) reverse pattern: contrary to the above; (3) side pattern: the flow direction perpendicular to the long axes (Mizuno 1958).

As for the relationships between landform and pattern distribution, the side pattern is prevalent on flat; the normal pattern on gentle upslope; and the reverse pattern on gentle downslope. This suggests that there were some relations

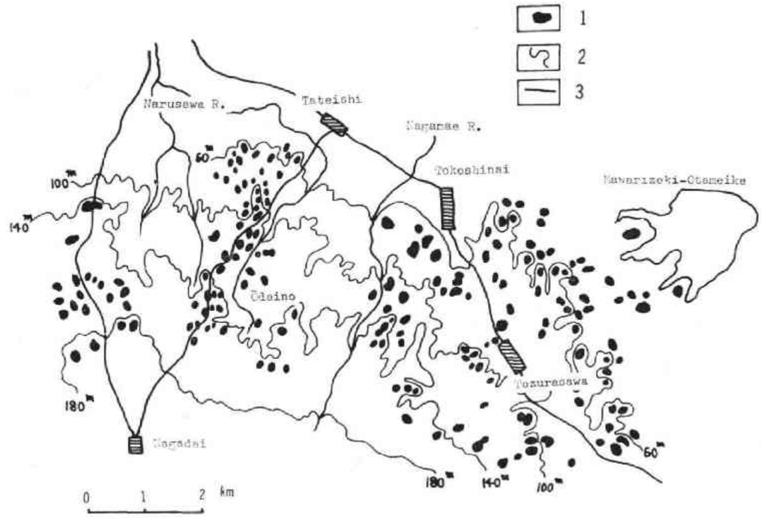

Fig. 2 Distribution map of Flow-mounds 1: Flow-mound 2: Contour line 3: Road

between the forms of flow mounds and the land inclination.

Inside the flow mounds, the cores are generally composed of angular andesite fragments, whose size and arrangement have no regularity. Flow mound deposits are not stratified. There are close relations between the average size of mound and rock fragments contained. As a general rule, the larger the mound is, the larger rock fragments are contained.

5 Volcanic Fans

Naturally the primary deposits composed of various kinds of volcanics are covering most of the piedmont of volcano, however, the secondary deposits of gravel formation transported through the dissected valleys are widely distributed as volcanic fans on the piedmont of some volcanoes (Shiki 1970).

The volcanic fans of secondary deposits are easily distinguished from the original piedmonts of primary volcanic deposits by drainage density of sequential formation. Their apexes are generally located at the points where steeper volcanic slopes joins to the piedmont, and easily read from topographic maps or aerial photographs. In the piedmont of Iwaki Volcano, such volcanic fans are widely developed (Fig. 1).

Ōnarusawa and Akakurasawa valleys made two large volcanic fans in the northern piedmont. They are 2.5 to 3 km in diameter and their apexes are about 500 m in altitude and their fringes are 200 m, and their average gradients are about 6 degrees. Near Yayoi there is another fan almost as large as the above two. Smaller ones 1.5 to 2 km in diameter are observed in the northeast and southeast. They were formed by Mizunashizawa and Ushironaganezawa valleys, and their average gradients are about 6 to 7 degrees. So far as the gradient is concerned, smaller fans are slightly steeper than larger ones. Shibagarazawa valley deposited another fan in the south, which was deformed by the surrounding landforms.

The materials of volcanic fans are subrounded or subangular boulders, some 10 cm in diameter, in contrast with those of the volcanic debrisflow, which are angular or subangular boulders. They are surely more than 5 m in thickness, but impossible to observe their bases.

Many dissected valleys have their own explosion craters at their heads without exception. These valleys, especially in the case of having additional explosion craters along their drainage areas, are easy to form volcanic fans, provided a huge quantity of waste originated from the crater walls.

The author reported in the previous paper that the explosion craters of a volcano have close relations with the formation of the secondary landform on its piedmont (Mizuno 1964b). It is the case with the piedmont of Iwaki Volcano. Moreover, the older the volcano proper is, the larger the occupance of volcanic fans is, because the fans are the secondary surface created by the dissected valleys. Therefore the occupance can be adopted as a criterion for the chronological comparison of volcanoes.

6 Conclusion

The results of geomorphological survey on Iwaki Volcano are summarized as follows:

(1) Volcanic debrisflow deposits on the north and east piedmont of the volcano were divided into Ōdaino debrisflow deposits in the west and Tozurasawa debrisflow deposits in the east. The former is of the flow type, and the latter of the avalanche type.

(2) There are many flow mounds on the debrisflow area, accounting about 200. These mounds are distributed more widely and densely in the east than in the west. Such a difference in their distribution is thought to have been caused not only by the landforms at that time but also by the types of debrisflow, flow type or avalanche type. The shape of flow mounds, especially their profile, has close relations with land feature, size of mound and size of rock fragments contained.

(3) Wide volcanic fans, 3 km ~ 1.5 km in diameter, are distributed in the piedmont of the volcano. Their average gradient is 6 to 7 degrees. These fans

have respectively dissected valleys upstream, which have explosion craters without exception. This means that explosion craters were greatly responsible for the formation of volcanic fans.

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