The sources of landslides occurred by the 2018 Hokkaido Eastern Iburi Earthquake

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An earthquake of M6.7 was occurred at 37km depth in East Iburi, Hokkaido, on September 6, 2018. This earthquake caused numerous landslides in Azuma town with seismic intensities of 7 or 6+. The number of landslides reached 8000 in area of 20km by 20km. The type of these landslides is almost debris slide on the base of tephra layers, excluding rock slide and rock fall near the epicenter.

1 Distribution of tephra layers

Thick tephra layers interleaved with kuroboku, cover on hill slopes in the area of numerous landslides. The tephras derived from Shikotsu caldera and surrounding volcanoes, about 50 km west of Atsuma town. Main tephra layers in the hillslope are Spfa1 pumice of 48ka from Shikotsu caldera, En-a pumice of 20ka from Eniwa volcano, and Ta-d pumice of 9ka, Ta-c pumice of 3ka, Ta-b pumice of AD1667, and Ta-a pumice of 1739 from Tarumai volcano. En-a layer is thick, 1m more, in the northern area with numerous landslides, and Ta-d layer is thick, 1m more, in the southern area. These tephra layers are the main parts of landslides by this earthquake.

2 Tephras on hillslope with geomorphological evolution

Slope surficial deposit moved active affected by solifluction due to freeze-thaw cycles in the last glacial period, more than 10ka. For the reason, Spfa1 and En-a could not remain on hillslopes, except for valley head slopes and the foot of the slope accumulated surficial deposits, or crest slopes. On the other hand, the lower part of slopes was eroded by increased fluvial activity related to warmer and wetter during the late glacial period. Therefore, Spfa1 and En-a from the last glacial period do not cover on the lower valley-side slopes, but Ta-d covers on slope deposits on weathered rock there.

En-a covering the slope, for example valley head slope, is underlain by the reworked Spfa1. The volcanic soil with Spfa1 contains easily water and has slippery. On the other hand, Ta-d often is underlain by reworked En-a on the lower valley-side slope. These reworked tephras and the unit of the base of Ta-d layer with high absorbability, described below, would be slide layers in this earthquake.

3 Cases of landslides

Cases of landslides of thick Ta-d in the southern area of the disaster area and of thick En-a in the northern area are shown below.

3.1 The southern part covered thick Ta-d

A landslide at Asahi, located at the west side of Yoshino at the most severe disaster, was occurred on a flat slope at the lower valley-side slope. The collapse was occurred from the lower convex break of slope. It is 35m high, 35m wide, and 90m long. The vertical surface of the 3m thick soil layers with tephras, is exposed at the both sides of the landslide. Pale yellowish water-rich volcanic ash with striations adhere to the slip surface on thin slope deposit on weathered rock. The sliding surface was in a fine-pumice layer containing much moisture at the lowest part of Ta-d layer, according to outcrop observation of both sides of this failure. The upper part of Ta-d layer of 130cm thick, is redish brown pumice with weathered clay, and the lower part of it is dull gray coarse pumice with high permeability. The moving body slid and deposited as almost kept stratigraphic structure.

3.2 The northern area covered thick En-a

A landslide at the right bank of the upper Abira river is at 80m high, 45m wide, and 230m long. The collapsed debris buried the Abira river. The landform of the slope was divided into upper and lower parts

by a break line of inclination. The source of collapse was mainly the upper, a valley head slope, shaped shallow flat slope which is covered by En-a. The lower part was a V-shaped valley before the earthquake. The moving body run on the upper of V-shaped slope along the valley and deposited over the Abira river. Acording to observation of the exposed outcrops by the failure, thin Ta-d and the above layers cover on En-a of 130cm thick. En-a is pumice of 1-2mm diameter with rich-pyroxene. The sliding surface was on the lower volcanic ash, mixed glassy Spfa1, beneath En-a.

4 Shapes of slope failures in each southern and northern area of the disaster area

In the southern part of the disaster area, almost slopes except of steep are covered thick Ta-d. The main source of collapses is thick Ta-d by the earthquake. Therefore, the collapses were occurred numerous on the slope covered by thick Ta-d, especially the lower valley-side slope, which is steep. On the other hand, in the northern area of disaster area, because Ta-d layer is thin, even though it is on the lower valley-side slope, the collapse of Ta-d is rare. The collapses of thick En-a on the valley head slopes are unevenly distributed. Because each geomorphological unit at the source of collapses in the northern and the southern is different, their shapes are different in each region.

Keywords: the 2018 Hokkaido Eastern Iburi Earthquake, tephra layer, valley head slope, lower valley-side slope

