

## The source and age of the Awakawa Pumice Bed in Urizura Hills, Ibaraki Prefecture

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Awakawa Pumice Bed (AWP) composes the top of Urizura Hills, in the middle of Naka River area, Ibaraki Prefecture. Although the AWP has been described as a volcanic secondary deposit, its source volcano, detailed age and sedimentary processes remain unclear. We carried out geological and petrological investigations to reveal the source and age of the APW.

AWP covers Tokoronuki Gravel Bed with an erosional contact at Urizura Hills. The thickness of AWP is approximately 5 m. The deposit can be divided into block facies (DB) and matrix facies (DM). DB is composed of pieces of pyroclastic flow deposits, maximum diameter of which is 6 m. DM consists of very poorly-sorted, un-stratified mixture of angular andesitic lavas, pumices, scoriae, pebbles and cobbles. These field occurrences suggest that the AWP is a debris avalanche deposit.

Yosagawa and Kuroiso Debris Avalanche deposits (YDA and KDA, respectively), which are the largest debris avalanche deposits derived from Nasu Volcanic Group, are distributed in the upper area of Naka River. We can observe the relationship between YDA (lower) and KDA (upper), interbedded by a gravel bed at Batou and Kurobane, Tochigi Prefecture. A pumiceous sand bed is recognized beneath YDA at Kurobane. DB of YDA are composed of not only peaces of pyroclastic flow deposits but also andesitic lavas showing jigsaw cracks at Kurobane. Maximum size of the DB of YDA (10 m) is larger than that of KDA (3m), although the thicknesses of both YDA and KDA are approximately 4-5 m.

We determined petrological features of contained andesitic lavas for identification of debris avalanche deposits. More than 20 largest fragments were sampled from AWP at Urizura Hills, and KDA/YDA at Kurobane. All samples of AWP are pyroxene andesite to dacite, except for one sample of qz-bearing pyroxene andesite. Almost of samples in YDA is pyroxene andesite to dacite, but 2 samples are qz-bearing pyroxene andecite and another is qz-bearing olivine pyroxene andesite. Samples of KDA are pyroxene basaltic-andesite to andesite with one exception of olivine pyroxene andesite. Whole rock compositions of the samples of AWP is similar to that of YDA within a range of SiO<sub>2</sub>=58-63 wt. % and FeO\*/MgO=1.7-2.1. In addition, mineral assemblage and glass chemistry of pumice sand, overlain by YDA at Kurobane, are the same as those of Kanewazaki Pyroclastic Flow deposit (KN-pfl).

We discuss the source and age of AWP on the basis of geological and petrologic data. In general, travel distance of debris avalanches would be increase with their scales, that is, volumes. Geological data of well-documented debris avalanche deposits show a tendency that larger scaled debris avalanches show larger maximum size of DB at a given distance from the source. The review and our geological data infer that the scale and travel distance of YDA is larger than those of KDA. There exist no debris avalanche deposits under AWP in Urizura Hills, indicating that AWP can be correlated with YDA, which might be the largest debris avalanche in this studied area. This conclusion is consistent with the petrologic correlation of included andesitic lavas between APW and YDA. The YDA had been derived from Nasu Volcanic group, suggesting that AWP had traveled long-distance (> 90 km) from the source volcano. On the assumption of collapse height of 2,500m, the H/L ratio is estimated to be 0.03. The age of APW, correlated with YDA, can be also constrained as after 0.64 Ma, which is the reported age of KN-pfl.

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