

## Large landslides and their implications for Quaternary geology and geomorphology in the northern Japanese Alps

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Recently, landslide maps based on field geological survey and airphoto interpretation in northern Japanese Alps have been published by the authors, NIED, and the others. Consequently, it has become clear that large landslides spread much wider than previously thought in this area. In this presentation, we describe some examples of large landslides, and then point out their implications and issues related to Quaternary geology and geomorphology in this area.

[Case 1: Kitamatairi River basin, Mount Shirouma-dake] This area is one of a type locality for the Pleistocene multiple glaciations in central Japan. Previous authors thought low-relief mounds and hills as moraines. Our reevaluation, however, showed that large landslides were the final and essential cause of these topographies. For example, latero-terminal moraine-like mounds in the Shiroumajiri area consist of well-fractured bedrock with a jigsaw-brecciated structure.

Radiocarbon ages of topsoil of these mounds indicated that the slope movement took place around 5.7-5.1 cal ka. Similar instances were also found from an adjacent area.

[Case 2: Odokoro River basin, Mount Asahi-dake] It has been considered that this drainage basin possesses Pleistocene glacial landforms in its uppermost zone. We found that some moraine-like topographies consist of thick fluvial gravel beds dated 3.0 cal ka, probably induced by a landslide dam in Shirakochisawa area. Another thick gravel beds and lacustrine deposits dated as MIS4-3 were also found from the west Renge Spa area. These gravel beds and lacustrine deposits would have been related to large landslides and/or eruptions by a nearby volcano.

[Case 3: Kagogawa River basin, Mount Harinoki-dake] MIS4 moraines and outwash terraces were reported from this catchment. However, new measurements of 14C samples from the outwash sand in Narusawa indicated 9.0-8.6 cal ka. According to general features of the late Pleistocene paleoenvironments of the northern Japanese Alps, presence of glaciers near the main ridge of the northern Japanese Alps during the early Holocene seem to be difficult. Deposition of river bed suggested by sand layers would have been induced by abundant debris supply from tributaries to the main stream.

[Case 4: Chozawa River basin, Mount Chogatake] Previous authors identified the middle to late Pleistocene cirques and moraines, but other researchers took up a controversial concept based on landslide. Our reevaluation showed that these topographies consist of well-fractured bedrock with crackle clasts, more than 100 m thick, suggesting large landsliding. Specific geologic and geomorphic conditions such as strike/dip and slope aspect would provide favorable conditions for generating a large landslide. Although no numerical age for the landslide has been obtained, the late Pleistocene to Holocene epoch is probable.

The followings are issues and subjects remain to be solved : (1) revision of the structured features for Pleistocene paleoenvironments and geomorphic developments in the northern Japanese Alps, (2) establishment of a distinguish method between glacial sediments and landslide sediments, (3) volumetric evaluation and risk management of large landslide topographies and sediments for erosion control in this area, (4) estimation of landslide triggers such as paleoearthquake and climate changes as well as paraglacial modification of slopes, and (5) introduction of new dating methods alternative to 14C and tephra.

Keywords: historical geomorphology in mountain region, landslide, paleoenvironment, paraglacial slope modification