Taisho lahar as a cohesive lahar in 1926 eruption of Tokachidake Volcano, Central Hokkaido, Japan: Implications for generating mechanism of cohesive lahars

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Understanding generation mechanism of hazardous lahars is important for hazard assessment. The Taisho lahar (TL) (>0.69-1.9 *10^7 m^3) that occurred in the 1926 AD eruption of Tokachidake volcano, Central Hokkaido, killed 144 people in towns more than 25 km away from the volcano. The lahar has been considered as a typical snow-melt lahar caused by the runout of hot debris on a snow-covered slope, the mechanism similar to that caused the huge mud flow during 1985 eruption of Nevado del Ruiz. However, the origin of the water in the lahar remains a controversial topic because the calculated water mass based on the assumption that all of the snow on the runout area of the TL was melted is much less than the estimated water volume in the TL. In addition, the lahar deposit had not been adequately reinvestigated. Thus, we reexamined proximal deposits of the TL, along with their paleomagnetic characteristics, to investigate the sequence of the eruption and the formation process of the TL.

The proximal deposits of the TL are divided into three units: A, B and C in ascending order. Unit A and C are composed of hydrothermally altered rocks with a muddy matrix showing features of debris avalanche deposits, indicating a relatively low emplacement temperature (<100 ℃). In contrast, unit B consists of hydrothermally altered gravel and sand without clay-size fine and sometimes shows cross-laminas, indicating that the deposits can be considered as surge-like deposit, showing a relatively high emplacement temperature (approx. 350 ℃). At the downward gully, unit B changes to a debris flow deposit. Moreover, this can be also recognized to be one of cohesive lahar induced by collapse of hydrothermally altered pyroclastic cone because the deposits contain more than 3-5 wt. % clay in fragments smaller than 2 mm.

The presence of unit B indicate that the TL was caused not by a simple collapse of a cinder cone but by a phreatic explosion resulting in a sector collapse, suggesting that the hydrothermal water system was related to the eruption. This inference is consistent with the geophysical monitoring of the present state of the volcano, suggesting that a considerable portion of the hydrothermal water system has already been in existence beneath the active crater. In conclusion, the TL can be not only recognized the snow-melt lahar but also the cohesive lahar with hydrothermal water system explosion. This case study implies three points for the generation mechanism of cohesive lahar as follows: 1) Hydrothermal system explosion triggers a cohesive lahar, 2) hydrothermal water and snow melt water are important water sources in a cohesive lahar, 3) water sources plays a role to make a cohesive lahar fluid. The case also suggests that it is important for forecast of catastrophic lahar to monitor hydrothermal systems and to estimate hydrothermal water beneath volcanoes.