Characteristics of tephra thickness distribution in steep regions of Aso Volcano and their origin

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Heavy rainfall associated with the seasonal rain front on July 2012 triggered huge number of shallow landslides on steep, tephra-mantled slopes, resulting severe sediment disasters in northern part of Aso Volcano. Rainfall-triggered landslides repeatedly occurred almost every decade (1990, 2001, and 2012 in the last 30 years) in this region. To avoid and mitigate such disasters in steep regions close to active volcano(s), it is important to know thickness distributions of accumulated tephra layers as potential source of landslide materials.
By using a spline interpolation method, we estimated thickness distribution of accumulated tephra layers, which include ash, scoria, and loam/kuroboku soil layers overlying Ojodake scoria (OjS; 3.6 ka) layer, from an isopach map of Aso Volcano developed by Miyabuchi et al. (2004). We compared the estimated thickness with actual thickness measured in following two sites: Takadake area, which is located on the northeastern side of central cones, and Saishigahana area, which is located on eastern part of the caldera rim. We also analyzed relationships between tephra thickness and slope topography (i.e., slope angle and curvature), then discussed characteristics of present tephra thickness distribution in steep regions of Aso Volcano and their origin.
By assuming tephra thickness estimated from the isopach map is equal to total amount of tephra fallout after the eruption producing OjS, ratio of measured and estimated thickness means residual ratio for total amount of tephra fallout during the last 3,600 years. Residual ratios ranged from 0.25 to 0.31 (25-31%) in Takadake area, and from 0.12 to 0.22 (12-22%) in Saishigahana area, respectively (Fig. 1). As shown in Fig. 2, the residual ratios had significant negative correlation with curvature (correlation coefficient r: -0.60, p-value: 0.05), while no significant correlation was found with slope angle (correlation coefficient r: -0.35, p-value: 0.29).
Averaged residual ratio (±S.D.) was estimated to 0.22±0.06 (22±6%), thus, about 70 to 90 % of tephra fallout had already eroded in steep regions of Aso Volcano. In addition, the residual ratios had declined as slope curvature increase, suggesting tephra layers at convex slopes more prone to erode. From our outcrop observations, following features of tephra stratigraphy were observed: (i) OjS layers were most found as disturbed block deposits, (ii) Nakadake N2 scoria (N2S; 1.5 ka) was found as well-preserved layers, (iii) loam/kuroboku soil layers above and below N2S layers were found as thin and discontinuous layers. Therefore, the present thickness distribution of accumulated tephra layers can be attributed to the shallow landslide occurrences just after the eruption producing OjS, in the middle to latter term between 3,600 and 1,500 years ago, and from after the eruption producing N2S until the present time.

Keywords: Aso Volocano, tephra-mantled slope, isopach map, thickness distribution, shallow landslide

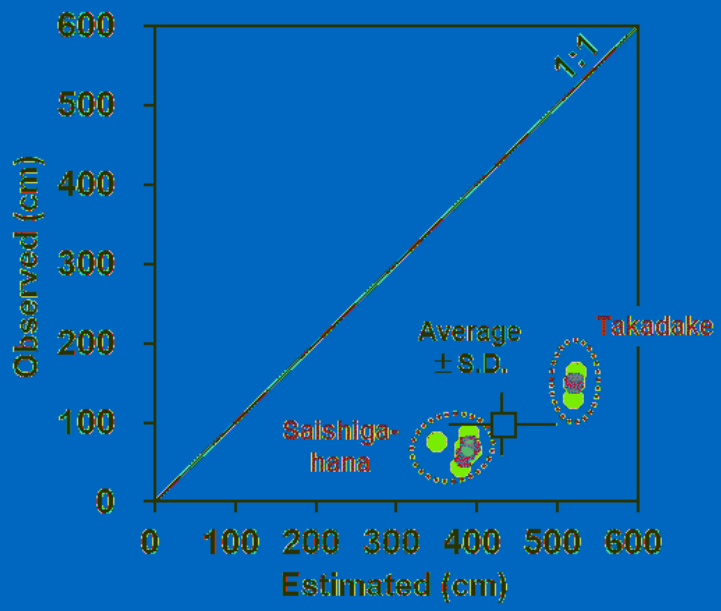

Fig. 1 Comparison between estimated and measured thickness.

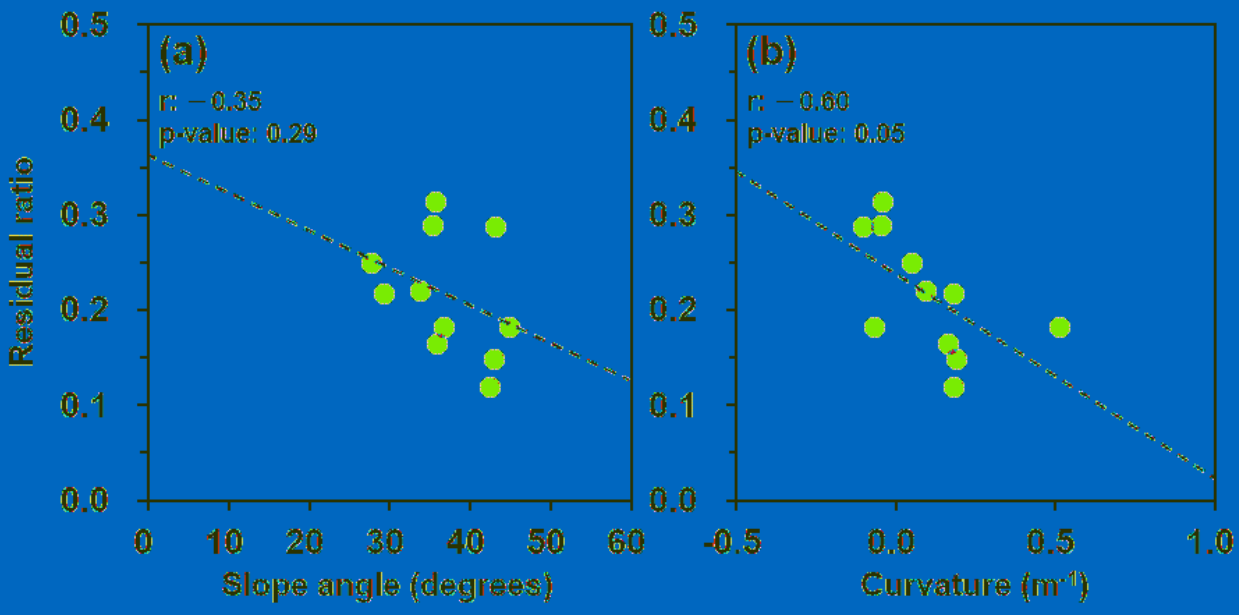

Fig. 2 Correlations of measured thickness with (a) slope angle and (b) curvature.

