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Usability of the morphometry of hummocks to estimate the volume of catastrophic sector-collapses

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To conduct risk assessments for low-frequent but large-scale physical processes, such as catastrophic volcanic sector-collapse and associated rockslide-debris avalanches, data from similar events serve as useful reference points. This study investigates hummocky topography as a tool in the estimation of the volume of volcanic sector-collapse events, i.e., the magnitude of the collapse-to-avalanche events. The topographical differences in the debris avalanche fields that might affect the formation of hummocks are examined so as to assess the application of morphometric analysis of hummocks to estimate the volume of the sector-collapses.

Yoshida et al. (2012; Geomophology) described the functional relationship between the size (plane area) and horizontal distances from the source of the hummocks on debris avalanche depositional surfaces using a regression with the equation $A = a \exp(-bD)$. Each avalanche has distinctive intercept and slope values. The intercept coefficient indicates the average initial size of hummocks at distance = 0 km, and show a high correlation with the volume of collapsed masses. Therefore, there is a high potential to calculate the initial average size of hummocks at the source area from the volume of the collapsed mass of the volcanic body. This indicates that the reverse is also possible: we can estimate the possible collapse volume solely from the hummock distributional pattern of a certain avalanche. This study assesses the applicability of the abovementioned a-to-volume relationship to other examples from different topographical settings.

Examples of the ”wide-spread (freely spreading)” type of debris avalanches similar to those in Yoshida et al. (2012), the 1888 and the Okinajima Bandai volcano debris avalanches, were analyzed (Yoshida, 2012, 2013; TJGU). Their a-to-mass volume relationships are accurately described by the empirical relationship of Yoshida et al. (2012). For a similar type of avalanche, the Yotei debris avalanche, the actual a value is slightly larger than the a value calculated from the known collapse volume using Yoshida et al. (2012) equation. However, the volume of Yotei collapse may be underestimated. The author also examined a ”valley-filling” debris avalanche: the Kannongawa debris avalanche. The Kannongawa debris avalanche is accurately described by the Yoshida et al. (2012) equation. Therefore, the empirical relationship proposed by Yoshida et al. (2012) can be considered applicable to many of debris avalanches, albeit with some exceptions. One of the exceptions is the Kisakata debris avalanche. The empirical relationship can be not applied to the Kisakata debris avalanche, where the hummocks are strongly regulated by the topographical complexity of the debris avalanche route.

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