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Morphometric analysis of glaciovolcanic edifices in Iceland

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Abstract

A broadscale morphometric analysis of Icelandic glaciovolcanic edifices is carried out. Topographic, slope and curvature data proves very successful in discriminating subaerial from subglacial edifices, and furthermore allows distinction of individual land elements based on breaks in slope, such as lava cap and hyaloclastite slopes and aprons. This enables us to resolve the passage zone, marking the junction between the lava cap and flank breccia, which records the englacial water level coeval with delta formation. Thus, we show that a simple geomorphometric analysis of glaciovolcanic edifices provides important paleoenvironmental parameters regarding ice thickness, paleoice surface and the paleoeruption environment.

1. Introduction

Morphometric studies of volcanoes based on remote sensing data allow analysis of remote and inaccessible volcanoes and provide important information on the geologic evolution of planets. Therefore, constraining the topographic characteristics of terrestrial volcanoes is an important step towards using volcano geomorphometry for comparative planetology, and therefore there is a strong need for further investigations.

1.1 Glaciovolcanic edifices

Since the very beginning of research on subglacial edifices, tuyas have been known for their morphometric characteristics being roughly equidimensional, steep-sided, flat topped mountains. In particular, the passage zone, which provides essential paleoenvironmental parameters, is morphometrically diagnostic and already in 1969 Jones [1] described that the passage zone for the tuya Skrida, Iceland, was noticeable by a conspicuous break in slope marking the transition from steep scree flanks to low sloping lava cap. Strangely, these morphometric characteristics have never been exploited for broad scale analysis of subglacial edifices based on geomorphometry.

2. Data and Methodology

We therefore started a broadscale geomorphometric study of the Icelandic neovolcanic zone to make a morphometric characterization of subglacial landforms using the IS 50V digital elevation model (20m/pixel). The edifice boundaries were delimited by concave breaks in slope around their bases and morphometric parameters such as volume, slope, base area, base width, edifice height, ellipticity and irregularity were calculated for each edifice by the MORVOLC program [2,3] (Fig. 1) .

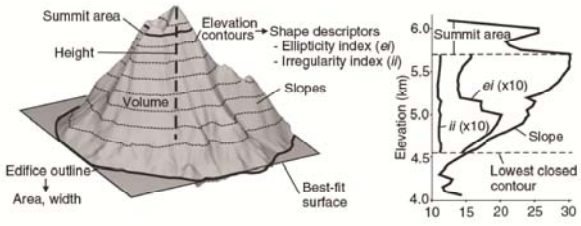

Figure 1: Illustration of morphometric parameters calculated by MORVOLC and corresponding diagram for slope and shape development as a function of height. From [2].

Subsequently, individual land elements were resolved by slope changes including the height of the passage zone. Furthermore, geologic maps [4,5] and aerial photographs (50cm/pixel) were used to investigate if lavas drained down the tuya edifice providing information on the stability of the englacial lake during the eruption.

3. Preliminary results

Slope values clearly differentiate between subaerial and subglacial landforms: subaerial shields have average slopes between 2.8°-6.5°, at least 6° less than the average slopes of subglacial edifices. Furthermore, small subglacial ridges can be distinguished from table mountains by size (volume is the best parameter), but it is not possible to distinguish pillow lavas (effusive) from hyaloclastite (explosive). Breaks in slope allow division of landforms into the following landform elements: lava cap, subglacial aprons (either hyaloclastite or pillow lava) and subglacial flanks (either hyaloclastite or pillow lava). This enables us to resolve the passage zone allowing an analysis of passage zone height in the Icelandic neovolcanic zone and its correlation to edifice volume and stability of the englacial lake during eruption**.**

4. Summary and perspectives

This study exploits volume, edifice height and the passage zone data for tuyas to make geomorphometric a broadscale investigation of tuyas from the Icelandic neovolcanic zone. The correlation of passage zone heights, volumes and information regarding englacial lake stability allows us to investigate several aspects of tuya formation. This includes examination of (1) spatial distribution of tuya sizes in rift and plume dominated volcanic systems, (2) estimation of paleoice surface height based on passage zone elevation, and (3) relationship between eruption size, approximate paleoice surface height and melt water drainage.

Acknowledgements

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References

[1] Jones (1969) Quarterly Journal of the Geological Society 124, 197-211.

[2] Grosse et al. (2009) Geology 37, 651-654.

[3] Grosse et al. (2012) Geomorphology 136, 114-131.

[4] Sæmundsson et al. (2010) Geological map of Southwest Iceland, ISOR, 1:100.000.

[5] Jóhannesson and Sæmundsson (2009) Geological map of Iceland, Icelandic Institute of Natural History, 1:600.000.