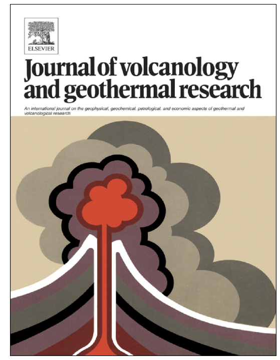
Accepted Manuscript



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PII: S0377-0273(17)30081-1
DOI: doi:10.1016/j.jvolgeores.2017.11.015
Reference: VOLGEO 6242

To appear in: *Journal of Volcanology and Geothermal Research*

Received date: 1 February 2017
Revised date: 10 November 2017
Accepted date: 18 November 2017

Please cite this article as: John V. Smith , Susceptibility of lava domes to erosion and collapse by toppling on cooling joints. The address for the corresponding author was captured as affiliation for all authors. Please check if appropriate. Volgeo(2017), doi:10.1016/j.jvolgeores.2017.11.015

Susceptibility of lava domes to erosion and collapse by toppling on cooling joints

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ABSTRACT

The shape of lava domes typically leads to the formation of radial patterns of cooling joints. These cooling joints define the orientation of the columnar blocks which plunge toward the center of the dome. In the lower parts of the dome the columns plunge into the dome at low angles and are relatively stable. Higher in the dome the columns plunge into the dome at steep angles. These steeply plunging columns are susceptible to toppling and, if the lower part of a dome is partially removed by erosion or collapse, the unstable part of the dome becomes exposed leading to toppling failure. Examples of this process are provided from coastal erosion of lava domes at Katsura Island, Shimane Peninsula, western Japan. An analogue model is presented to demonstrate the mechanism. It is proposed that the mechanism can contribute to collapse of lava domes during or after emplacement.

Key words: lava dome, collapse, toppling, cooling joints

Introduction

The collapse of lava domes is a well-known hazard (Fink and Kieffer, 1993; Melnik and Sparks, 1999). Examples which have been studied include Merapi volcano Indonesia (Voight et al., 2000; Beauducel et al, 2006; Gertisser et al., 2012). These eruptions are characterised by the formation and collapse of lava domes (Ratdomopurbo et al., 2013; Walter et al., 2013; Pallister et al., 2013). Lava domes of the Soufriere Hills Volcano, Montserrat have also been studied in detail (Sparks et al., 2000) and show “steep, eroded canyon-like walls, along inherent weakness planes” as have been described (Calder et al., 2002, p. 189). During and after emplacement, lava domes are typically unstable as indicated