Dynamics and physical parameters of the Lastarria debris avalanche, Central Andes

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JOURNAL OF VOLCANOLOGY AND GEOTHERMAL RESEARCH
Volumen: 402
Número de artículo: 106990
DOI: 10.1016/j.jvolgeores.2020.106990
Fecha de publicación: SEP 15 2020
Tipo de documento: Article
Ver impacto de la revista

Abstract

Volcanic debris avalanches are extremely destructive phenomena, with the potential to travel many kilometers from their source region, either as rockslides or as mass flows. Given that they may even be triggered at inactive volcanoes, their hazard is often underestimated. Understanding the dynamics of such mass movements is essential for evaluating and mitigating hazards. A number of case studies have been carried out around the world, but there is still a need for further studies of flow-dominated avalanches, which remain poorly constrained. These studies would have high educational value, providing striking examples to teach decision makers and at-risk populations about the hazard.

In this study, we investigate the 7500 cal. year B.P. Lastarria debris avalanche. It is a 7 km-long deposit, with exceptional preservation of both the flow structures and the collapse scar. Detailed fieldwork, morphometric mapping of over 600 surface features, and numerical modelling was carried out to constrain the avalanche's trigger and flow parameters. Numerical models and field scaling relationships are in good agreement, suggesting maximum velocities of 210 to 270 km h(-1), negligible basal friction, low cohesion (50 kPa) and an intermediate friction coefficient. Structures are dominantly oriented parallel to transport direction, suggesting minimal influence from a smooth paleotopography. Lastarria provides an example of a shallow flank failure, initiated along strati graphic planes, that allowed low strength pyroclastic strata to disaggregate rapidly and then quickly accelerate to flow as a granular material at high velocity beyond the base of the volcano. Overall, Lastarria provides excellent constraints on granular avalanche initiation and flow, which are valuable for hazard assessments and for the study of less well-preserved flow deposits elsewhere. The question of which precursory signs may warn of such a flank failure remains open, and is important to address in future studies.

Palabras clave

Palabras clave de autor: Avalanche dynamics; Volcanic debris avalanche; Physical parameters; Facies; Central Andes; Granular flow
KeyWords Plus:LAZUFRE VOLCANIC AREA; EDIFICE STABILITY; SLOPE INSTABILITY; LATERAL COLLAPSES; SECTOR COLLAPSE; CASITA-VOLCANO; CHILE-BOLIVIA; EMPLACEMENT; DEPOSITS; EVOLUTION

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Financiación

Entidad financiadora Mostrar más información	**Número de concesión**
Department of Geological sciences from Universidad Catolica del Norte (UCN)	
UNESCO Geosciences programme	692
French National Research Agency (ANR)	16-IDEX-0001 CAP 20-25

Ver texto de financiación

Editorial

ELSEVIER, RADARWEG 29, 1043 NX AMSTERDAM, NETHERLANDS

Información de la revista

- **Impact Factor:** Journal Citation Reports

Categorías / Clasificación

Áreas de investigación: Geology

Categorías de Web of Science: Geosciences, Multidisciplinary

Información del documento

Idioma: English

Número de acceso: WOS:000572979100008

ISSN: 0377-0273

eISSN: 1872-6097