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Reproducing collapse caldera processes: Analogue vs. numerical models

A. Geyer (1), J. Martí (1), A. Folch (2)

(1) Department of Geophysics and Geohazards. Institute of Earth Sciences "Jaume Almera", Barcelona, Spain, (2) Observatorio Vesuviano, Instituto Nazionale di Geofisica e Vulcanologia INGV, Napoli, Italy (ageyer@ija.csic.es / FAX: +34 93 411 00 12)

Collapse calderas are defined as the volcanic depression that result from the disruption of the geometry of the magma chamber roof due to down faulting during the course of an eruption. Although caldera-forming events are rare, they are the most destructive volcanic events. In fact, large pyroclastic eruptions and associated caldera collapse structures represent one of the most catastrophic geologic events that have occurred on the earth's surface in the Phanerozoic time and more important in the historical time, e.g. Tambora, 1815 and Pinatubo, 1991. Evidently, field studies have provided a large amount of information concerning caldera-forming eruptions and related structures and deposits. Besides, analogue models allow us to reproduce structural features observed on the field and numerical results help us to understand some aspects of the origin and structure of caldera collapses. Analogue experiments are useful to identify, investigate and visualize processes that cannot be directly observed in nature, and in some cases, they help us to establish the guidelines to be followed when applying computational models. In general, analogue models indicate us how processes of caldera collapse take place but are not able to quantify them to indicate (from the view of rock mechanics and fluid dynamics) when the collapse will take place and why. Contrary to analogue models, numerical models are useful to quantify variables, to predict semi-quantitative general conditions for fracture and fault formation and to reproduce and take into account the physical properties of host rock and magma. In this work we describe the different restrictions and limitations found in analogue and numerical models applied to the study of collapse calderas. Additionally, we reproduce numerically some analogue experiments to compare the results obtained using numerical or analogue models and consequently, to detect additional restrictions of

both methodologies. Although nowadays, the number of studies combining numerical and analogue models is very low, this seems to be the most appropriate way to a better understanding of collapse caldera processes. Evidently, the numerical models have to reproduce the most important components of the experimental set-ups: the host rock analogue (dry-quartz sand), the magma chamber analogue (latex balloon) and the rigid walls of the tank where the analogue models are performed. A difficult task when trying to reproduce numerically analogue models is the definition or assignment of the boundary conditions, since results obtained are partially dependent on the selected conditions. Discrepancies and similarities appear when comparing the results obtained with the experimental and numerical approach. We try to infer the main reasons for both discrepancies and similarities and their corresponding implications when interpreting obtained results.