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# Numerical reconstruction of the 472 AD (Pollena) eruption at Vesuvius (Italy): implications for hazard assessment

Rosanna Bonasia (1), Giovanni Macedonio (1), Antonio Costa (1,2), Daniela Mele (3), and Roberto Sulpizio (3)

(1) Istituto Nazionale di Geofisica e Vulcanologia, Osservatorio Vesuviano, Naples, Italy (bonasia@ov.ingv.it), (2) Department of Earth Sciences, University of Bristol, UK, (3) CIRISIVU - Dipartimento Geomineralogico, Universita' degli Studi di Bari, Bari, Italy

Volcanic eruptions can produce several hazardous phenomena, such as tephra fallout, pyroclastic density currents, lavas and lahars. In particular tephra fallout can be responsible of severe damages to buildings, infrastructures, viability, agriculture, livestock and humans. Moreover, airborne ash may significantly affect air traffic. The analysis of tephra deposits allows for estimating some important parameters characterizing the eruption, such as the erupted mass, the column height and the bulk grain-size distribution. However the preservation of tephra deposits is often incomplete, especially for ancient eruptions, because the deposits can be buried or eroded. For these reasons, it is very useful to develope procedures that allow to estimate reliably the parameters listed above, by using a minimum amount of data on the thickness and the grain-size distribution of the deposits. Computational models based on an analytical solution of a simplified advection-diffusion-sedimentation (ADS) equation for volcanic tephra can be used to this purpose for their simplicity of the physical parameterization which allows high computation speed. These advantages allow for the solution of the inverse problem, which consists in a best-fit with field data, by carrying out thousands of runs in a relatively short time even on an ordinary Personal Computer. In order to obtain the solution of the inverse problem, other quantities need to be estimated such as the bulk granulometry, the mass distribution inside the column (e.g., column shape parameters), the wind profile (which is needed for ancient eruptions), and the turbulence diffusion coefficient. This implies that there are several free parameters needed to be determined. Hence for constraining all these parameters it would be ideal to know deposit thicknesses, together with grain-size and component distributions, in a large number of well distributed sites.

Unfortunately it is not always possible to have all this amount of information, especially for ancient eruptions. Independent analytical methods can help for estimating a reliable range of values for column height, wind intensity and total mass. In addition, in order to reduce the number of degrees of freedom the bulk granulometry can be reconstructed independently from individual analyses of field data. Here we propose a new procedure that allows for improving the fitting
results when only few points are available. The procedure is based on the assumption that quantities such as i) column height, ii) column shape, iii) wind profile and iv) diffusion coefficient do not depend on the granulometry classes, i.e. on the settling velocity classes. Therefore, in a first step we estimate these parameters, that we consider independent among them, using a restricted range of settling velocity classes having the baricenter of the corresponding deposit inside the "convex hull" delimited by the sampled sites. Then, in a second step, we extend the inversion to all the other classes by maintaining fixed the parameters determined in the first step. In this way, the first step allows us to estimate the column height, the wind velocity and the diffusion coefficient using a reliable range of settling velocity classes, while the second step allows for estimating the bulk grain size distribution and the total erupted mass.

This method is applied to reconstruct and analyze the tephra deposit and the bulk grain-size distribution of the sub-Plinian 472 AD (Pollena) eruption of Vesuvius, Italy. This eruption is chosen for two main reasons. Firstly because it is of the same scale of the reference eruption in case of renewal activity of Vesuvius, and secondly because, since it was previously studied using classical methods, it is possible to carry out a comparative study. In the application to the Pollena eruption the fitting was satisfactory despite only 14 sampling points were available. The lowest bias in the best-fits was obtained using a statistical weighting factor. Best-fit results of the erupted mass were also in good agreement with estimations carried out through classical methods.