Abstract

Physical parameters of explosive eruptions are typically derived from tephra deposits. However, the characterization of a given eruption relies strongly on the quality of the dataset used, the strategy chosen to obtain and process field data and the particular model considered to derive eruptive parameters. As a result, eruptive parameters are typically affected by a certain level of uncertainty and should not be considered as absolute values. Unfortunately, such uncertainty is difficult to assess because it depends on several factors and propagates from field sampling to the application and interpretation of dispersal models. Characterization of explosive eruptions is made even more difficult when tephra deposits are poorly exposed and only medial data are available. In this paper, we present a quantitative assessment of the uncertainty associated with the characterization of tephra deposits generated by the two largest eruptions of the last 2,000 years of Cotopaxi volcano, Ecuador. In particular, we have investigated the effects of the determination of the maximum clast on the compilation of isopleth maps, and, therefore, on the characterization of plume height. We have also compared the results obtained from the application of different models for the determination of both plume height and erupted volume and for the eruption classification. Finally, we have investigated the uncertainty propagation into the calculation of mass eruption rate and eruption duration. We have found that for our case study, the determination of plume height from isopleth maps is more sensitive to the averaging techniques used to define the maximum clast than to the choice of dispersal models used (i.e. models of Carey and Sparks 1986; Pyle 1989) and that even the application of the same dispersal model can result in plume height discrepancies if different isopleth lines are used (i.e. model of Carey and Sparks 1986). However, the uncertainties associated with the determination of erupted mass, and, as a result, of the eruption duration, are larger than the uncertainties associated with the determination of plume height. Mass eruption rate is also associated with larger uncertainties than the determination of plume height because it is related to the fourth power of plume height. Eruption classification is also affected by data processing. In particular, uncertainties associated with the compilation of isopleth maps affect the eruption classification proposed by Pyle (1989), whereas the VEI classification is affected by the uncertainties resulting from the determination of erupted mass. Finally, we have found that analytical and empirical models should be used together for a more reliable characterization of explosive eruptions. In fact, explosive eruptions would be characterized better by a range of parameters instead of absolute values for erupted mass, plume height, mass eruption rate and eruption duration. A standardization of field sampling would also reduce the uncertainties associated with eruption characterization.