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Mass architecture of a subplinian fall deposit: the 2006 tephra from Tungurahua volcano (Ecuador)

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Pyroclastic fall deposits record many aspects of eruption phenomenology and the study of tephra distributions, thickness, grain-size and vesicularity has proved of utmost relevancy to infer the size, intensity and dynamics of explosive volcanic eruptions. In particular, componentry analyses have great potential in deciphering eruption type, and magma-water and conduit processes. Yet, the detailed mass architecture of tephra fall deposits has remained poorly known, which prevents rigorous conversion of tephra volume to mass, and accurate determination of componentry mass distribution in tephra fall deposits. Using the tephra fall deposit of the 2006 subplinian Tungurahua eruption, we performed a high-resolution analysis of the eruptive mass budget, based on detailed quantitative investigations of density, componentry and mass distribution patterns in the 2006 Tungurahua tephra fall deposit. We show that density distributions of different componentry classes can be precisely described by a sigmoidal law and that the mass of the tephra layer is controlled by the proportion of each componentry class, which can be predicted from empirical laws evidenced for the first time in this work. We also present an improved volume-to-mass conversion protocol to infer the size of the eruptive event. Our data highlight the influences of density-driven fractionation within the plume and clast packing on lateral mass distribution in the deposit, and offer a detailed description of the lateral changes in the mass architecture of a subplinian tephra fall deposit. We finally state that the methodology developed here should be applicable to many other tephra deposits and for modelling purposes.