Towards fast and routine analyses of volcanic ash morphometry for eruption surveillance applications

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Abstract

The morphometry of volcanic ash produced by explosive eruptions yields ample information on fragmentation processes (e.g. magmatic vs magma–water interactions), and on transport and sedimentation mechanisms. Most previous works on volcanic clast morphometry focused on the Apparent (2D-) Projected shape of ASH grains, here termed APASH, to infer processes and eruptive styles. However, textural analyses of ash grains has remained a long and tedious task that made such approaches inappropriate for eruption surveillance duties. In this work we show that new technological advances on automated dispersion of granular materials imaged with a camera-coupled microscope and enhanced computer capabilities enable fast and high resolution image acquisition of thousands of ash grains that resolve this limitation. With a morpho-grainsizer designed for such fast and routine measurements we perform a series of APASH analyses on selected ash fractions of tephra deposits from known eruptive styles. We record the size, aspect ratio, circularity and convexity of APASH images and assess resolution, reproducibility, minimum population size, and total analytical duration, and offer recommendations for the reporting of APASH data for inter-laboratory comparisons. To avoid fractal geometry concerns, our analyses are carried out at constant size range (250–300 µm) and optical magnification (× 5) on ~ 3000 grains per samples collected from homogenized samples. Results from the andesitic 1999-ongoing eruption of Tungurahua volcano (Ecuador) show that ash particles from the moderate 2001 phase are relatively equant and convex in shape, while the stronger 2006 subplinian phase produced ash grains with more elongated, less circular and less convex APASH signatures. Ash grains from a basaltic scoria cone-forming eruption show even more ragged APASH characteristics. Overall, our protocol allows obtaining accurate and reproducible morphometric measurements that reveal subtle variations of the morphological signature, and the short duration (1.8 hours) of the whole analytical process renders high resolution analyses of ash shape achievable for volcano surveillance applications. This research ultimately aims to set up a morphometric database of APASH results for well-defined eruptive styles, in order to interpret on a short term basis any APASH data from active volcanoes for monitoring purposes.

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