Shape measurements of volcanic particles by CAMSIZER

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The shape of volcanic particles is an important parameter holding information related to physical and geochemical processes. The study of particle shape may help improving knowledge on the main eruptive processes (fragmentation, transport and sedimentation) during explosive activity. In general, volcanic ash is formed by different components, namely juvenile, lithic and crystal particles, each one characterized by peculiar morphology. Moreover, quantifying the shape of pyroclasts is needed by the most recent dispersal models that consider shape parameters as input data to simulate tephra dispersal. However, measuring and quantifying the particle shape of volcanic particles are hard challenges especially when the number of the particles to investigate is high and the size small (e.g. sub-millimetric). Several methods are currently used in volcanology, the most common probably being quantitative shape analysis by Scanning Electron Microscopy (SEM), based on the acquisition and subsequent analysis of digital images.

Here, we describe a new methodology to measure the shape of volcanic particles by CAMSIZER®, a compact laboratory instrument developed by Retsch Technology (see http://www.retsch.com) for the simultaneous measurement of particle size distribution and particle shape of incoherent materials in the range of 30 µm to 30 mm, based on digital image processing. The sample is fed in from a vibrating feed channel that controls particles falling through the measurement field, where images of the particle are recorded by two digital cameras (Basic and Zoom) with different resolutions. Software, created by Retsch Technology, enables digital image processing to provide grain-size and shape parameters. This instrument, very common for quality control in industry, research and production monitoring of very different kinds of materials, has been installed at Istituto Nazionale di Geofisica e Vulcanologia, Sezione di Catania (INGV-CT) to measure and validate grain-size distribution of volcanic particles (Lo Castro and Andronico, 2008; 2009).

Recently, we made a new study to assess its use in analysing the shape of volcanic particles. Size and shape of particles are calculated by applying a number of mathematical models related to different geometric parameters that influence the final results. Measures of shape parameters (e.g. Feret diameter, roundness, symmetry, width, length) are performed under a high resolution scanning of each particle in 64 different directions. In order to study volcanic particle shape characteristics, we performed different tests on volcanic and non-volcanic materials, considering the most commonly used shape parameters. Finally, we compared and validated the obtained results with those carried out by binocular microscope image analysis on the same samples. Furthermore, on the basis of these measurements, a clustering analysis is proposed. In particular, the Self Organized Map (SOM) and the K-means algorithm have been used jointly in order to partition a generic sample of volcanic ash particles into subsets sharing some common shape features. A fuzzy c-mean analysis has also been used to verify and compare results. These analyses were aimed at developing an automatic shape clustering of the volcanic ash particles. Preliminary results of both image analysis and statistical testing are shown to understand if CAMSIZER is a suitable tool for quantifying and characterizing volcanic particle shapes.

References

Lo Castro D., Andronico D., 2008. Operazioni di base per la misura della distribuzione granulometrica di particelle vulcaniche tramite il CAMSIZER. Rapporti Tecnici INGV, 79.

Lo Castro D., Andronico D., 2009. Grain size distributions of volcanic particles by CAMSIZER. Conferenza Rittmann, Nicolosi (Ct), Italy, 11-13 June 2009.