

## **The fractal nature of fragment size distributions of pyroclastic fall deposits from Cretaio eruption, Ischia Island (Italy)**

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The principles of fractal theory have had a strong influence on the understanding of many geological processes. Combining laboratory experiments on natural deposits generated by explosive volcanic eruptions along with statistical fractal analysis allows us to characterize precisely pyroclastic deposits and opens the possibility for substantial advances in the quantification of fragmentation processes during explosive volcanic events. A set of samples from the Cretaio eruption (1.86 Ka B.P.) was analyzed using fractal geometry to characterize the particle size distribution (PSD) of pyroclastic fragments erupted during its fallout phase. PSD analyses were performed on ten samples corresponding to ten different explosive episodes during the eruption. Samples were divided in juvenile fraction, (JV) and lithic fraction, (LC). Each fraction was analyzed separately. The results for the investigated size range (3mm to 300 $\mu$ m) showed that the fragmentation process is well characterized by a fractal distribution, exhibiting a multi-fractal behavior, explained by different and sequential processes of fragmentation. Frequency-size distribution of JV and LC fractions exhibit opposite behavior: for JV-fraction smaller particles (<1mm) shows a higher dimension of fragmentation relative to the bigger particles, a feature that can be related to a secondary process of fragmentation; the opposite behavior is observed for the LC fraction (smallest dimensions of fragmentation correspond to the smaller particle sizes). These differences can be explained by the different rheology of the fragmented materials and/or the occurrence of different fragmentation processes. These results highlight the importance of fractal statistics as a tool for addressing volcanic risk based on the analyses of natural grain size distributions and allow discriminating different fragmentation processes occurring inside the conduit during the volcanic explosions.

**Keywords:** volcanic fragmentation; juvenile fraction, lithic fraction, multifractal behavior, sequential fragmentation.