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On the fractal dimension of the fallout deposits: a case study of the 79 A.D. Plinian eruption at Mt. Vesuvius

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Abstract

We investigated the existence of a fractal law (power law) distribution of size pyroclastic fragments erupted during the fallout phase of the 79 A.D. Plinian eruption at Mt. Vesuvius. In particular, we performed a particle size distribution analysis on 18 white and grey pumice samples collected in six sites distributed in the SW sector of Mt. Vesuvius. Our measurements show that the fragmentation of samples in the investigated range (from 32 mm to 850 μm) follows a power law, guaranteeing the scale invariance of the process. The relationship frequency – size distribution of the fragments is verified independently from the nature (i.e., pumices and lithics) and stratigraphic height of the considered samples in the pyroclastic deposit. Therefore, the fractal fragmentation theory can be indicated for evaluating the relationship between the intensity of fragmentation (fractal dimension D) and eruption energy. In this way the apparent chaotic distribution of the particles in the fallout deposits hides a self-organized complexity revealed by the retrieved power law distribution. We further remark that a key aspect of our analysis is the founded evidence that the fractal dimension of the lithics is systematically greater than that of the pumices.

Keywords: Fragmentation, Power law distribution, Fractal dimension, Scale invariant, Mt. Vesuvius, Plinian eruption.