



Seismic tremor evidence for a deep gas trigger of the 5 April 2003 paroxysmal explosion on Stromboli volcano, Italy

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In addition to strombolian-type mild-explosive activity, Stromboli volcano intermittently produces discrete paroxysmal blasts (2-3 per year) that constitute a major hazard for tourists, volcanologists, and occasionally the local population. These events have no recognized activity precursors, are currently unforecasted, and their triggering mechanism remains poorly elucidated. An emblematic example of such events has been the 5 April 2003 explosion, which happened during a period of lava flow outpouring and a few months after a tsunami-generating flank collapse. Here we report the first evidence of a progressive and then rapid increase of seismic tremor within the few hours that just preceded this event. We show that this seismic signal is compatible with the collapse of a deep-seated bubble foam layer, followed by adiabatic and fast ascent of large blobs of CO₂-dominated gas + liquid, in agreement with the triggering mechanism proposed by Allard (2007, and in press) for most of the paroxysms on Stromboli. We develop a quantitative approach encompassing geochemical, petrologic and seismic data, which points that the 5 April 2003 explosion resulted from the accumulation of a huge CO₂-dominated gas amount at great depth and its sudden discharge from a small-size sill-like magma body or reservoir. A main fall of our seismic data and our modelling is that the timing of gas coalescence and slug ascent to the surface can be estimated quite accurately. Therefore, this work provides new perspectives for a combined seismic and geochemical forecasting of future large paroxysms on Stromboli.