On-line image analysis of the Stromboli volcanic activity recorded by the surveillance camera helps the forecasting of the major eruptive events.

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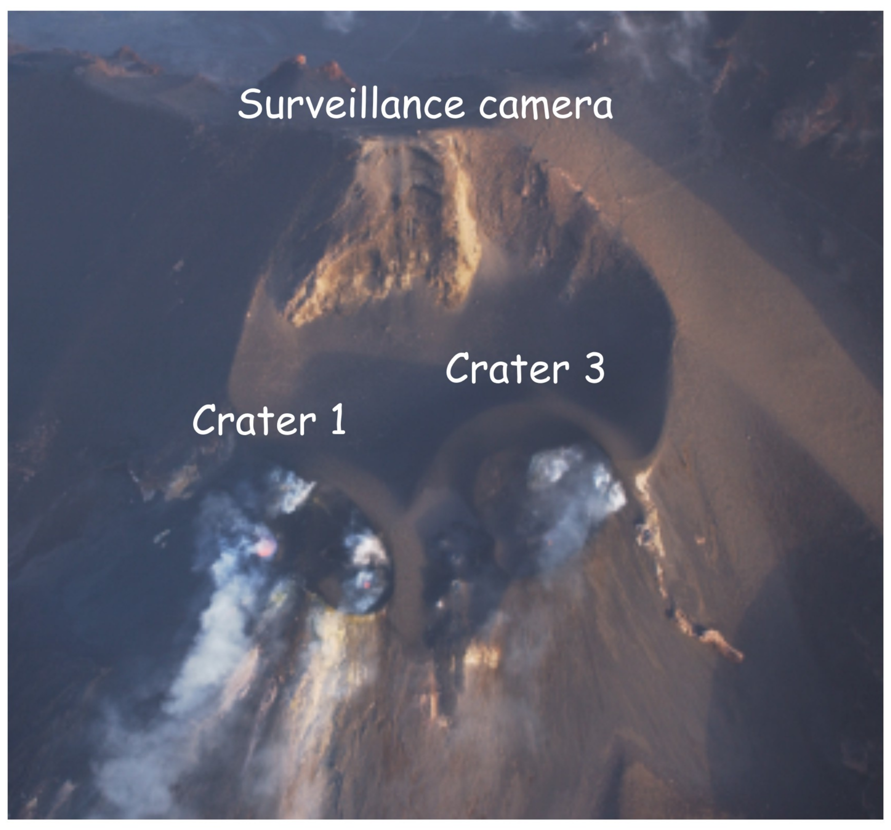
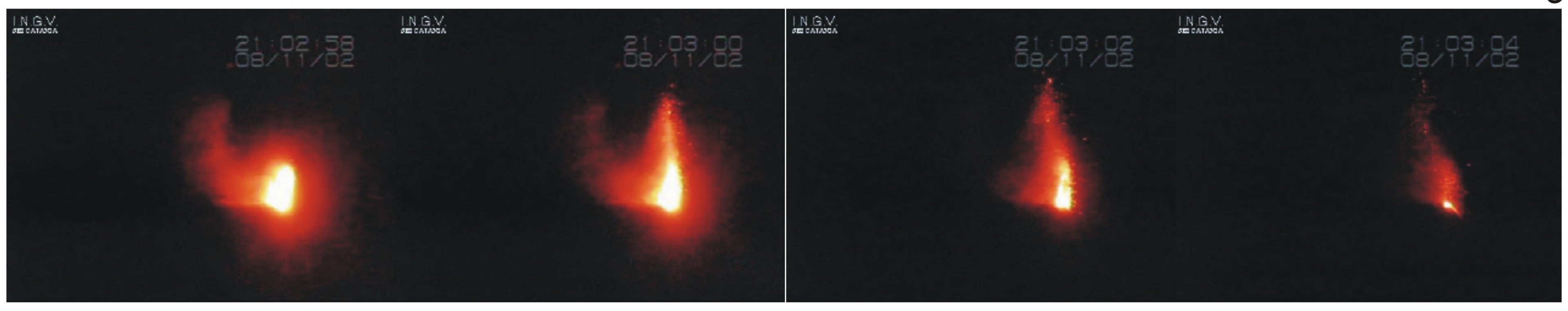
The typical activity of Stromboli consists of intermittent mild explosions, lasting a few seconds, which take place at different vents and at variable intervals, the most common time interval being 10-20 minutes. However, the routine activity can be interrupted by more violent, paroxysmal explosions, that eject m-sized scoriaceous bombs and lava blocks to a distance of several hundreds of meters from the craters, endangering the numerous tourists that watch the spectacular activity from the volcano's summit located about two hundreds meters from the active vents.



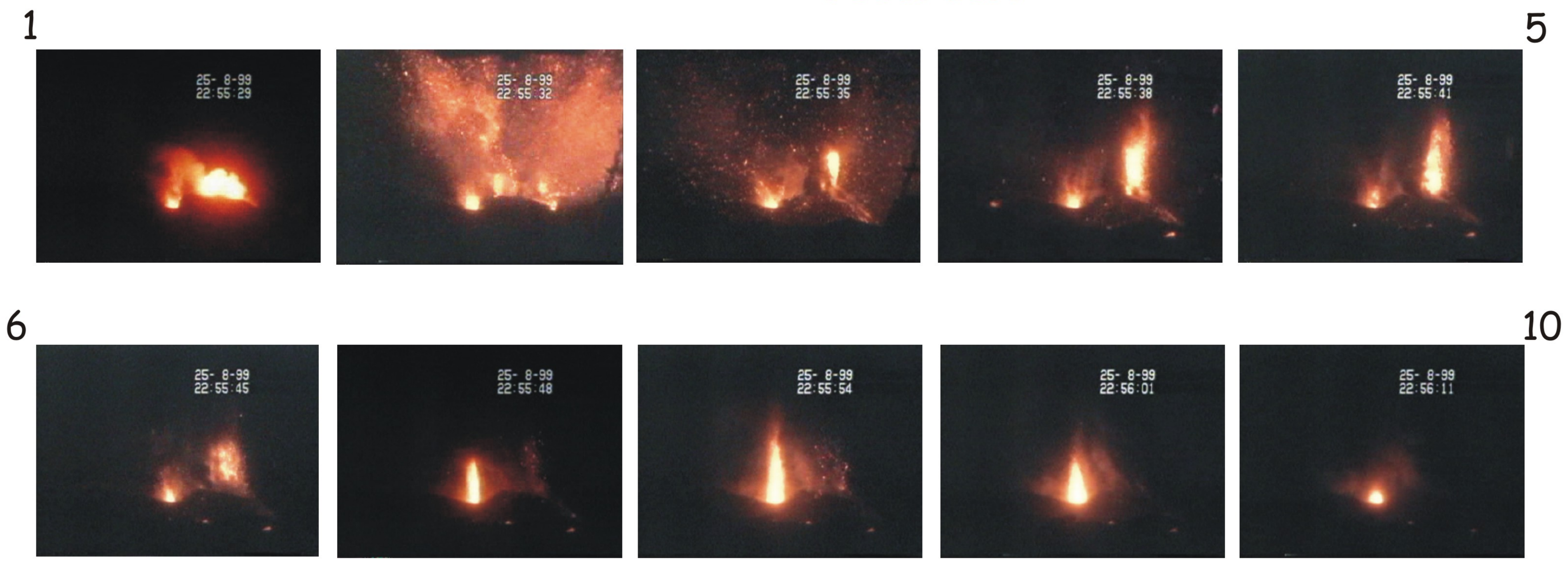
Aerial photo of summit area of Stromboli

View of crater terrace from surveillance camera (the average camera-terrace distance is 240 metres)

From summer 1994 a remote surveillance camera works on Stromboli recording continuously the volcanic activity. It is located on Pizzo Sopra la Fossa, 100 meters above the crater terrace where are the active vents. The images are transmitted using a broadcast video link to Observatory of Lipari where are digitalized and then transmitted to INGV in Catania by Internet and back upped in an analogical time-lapse video recorder.

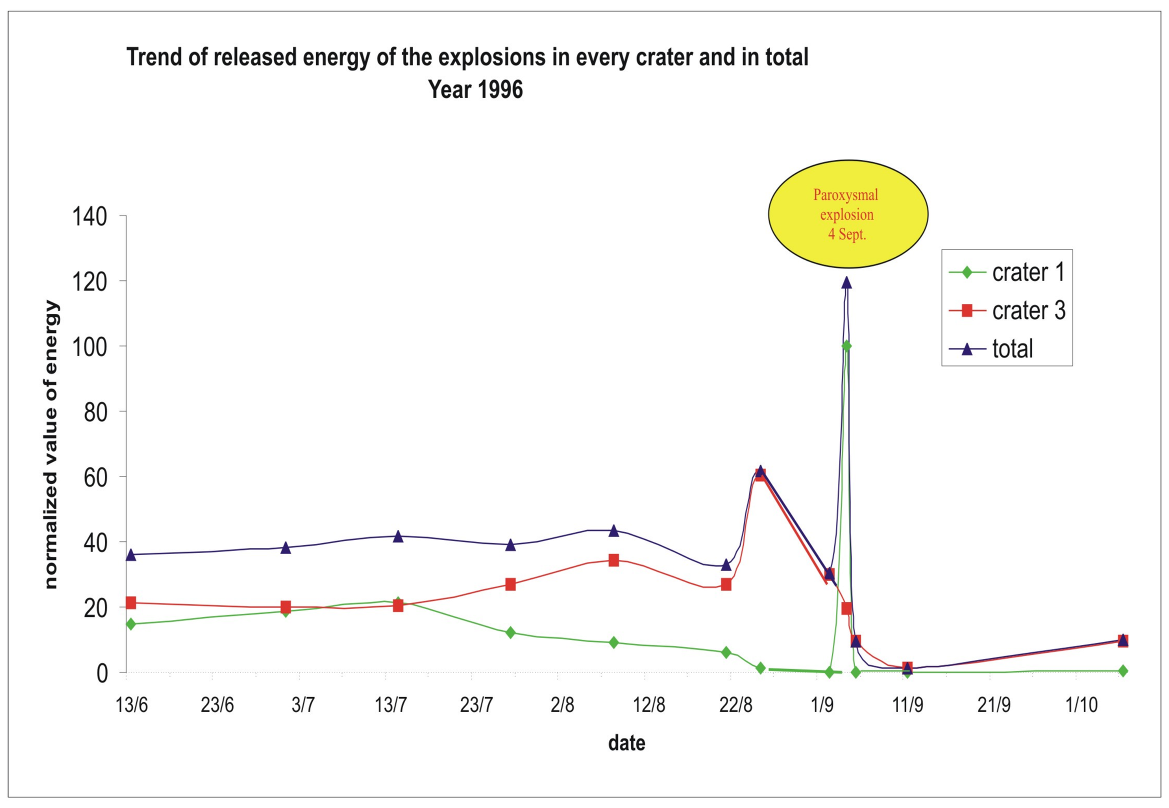


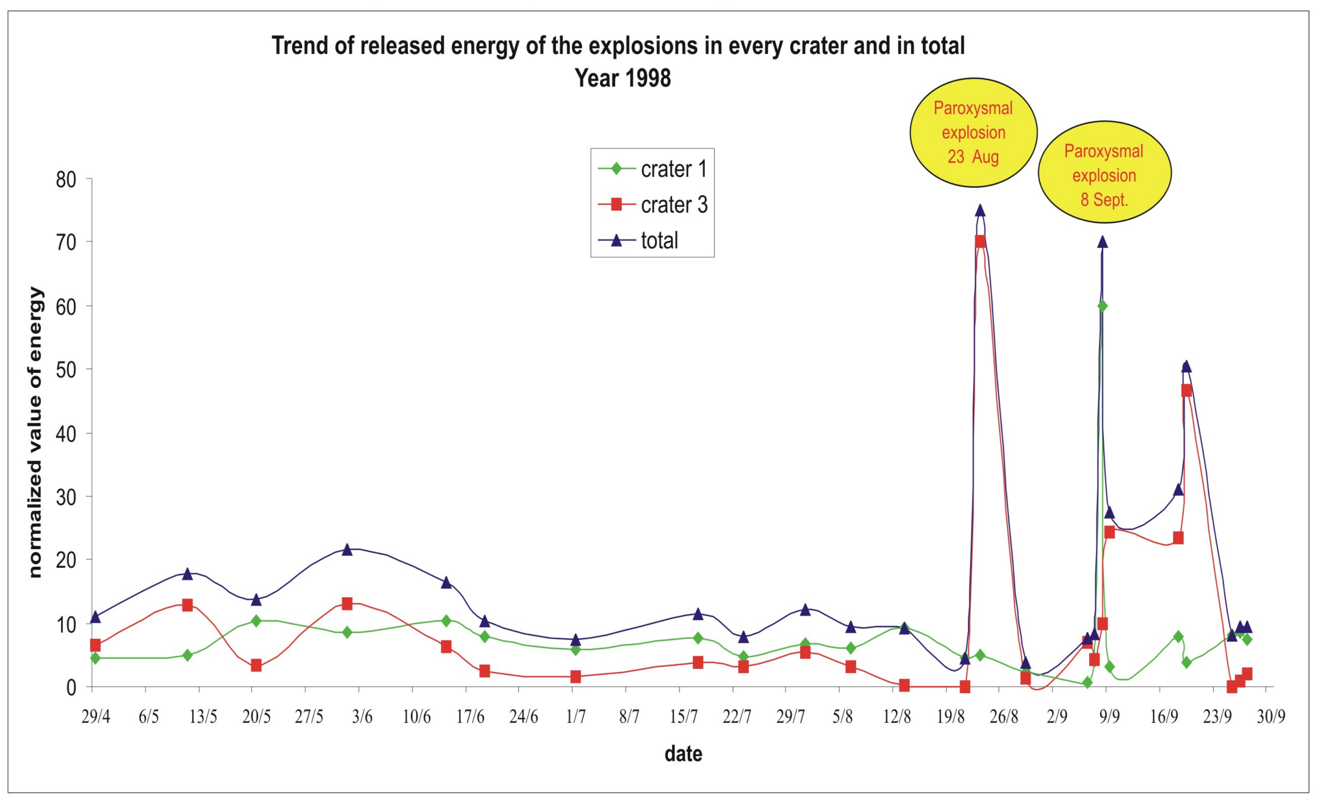
Typical Strombolian type explosion



Paroxysmal explosive sequence

Video records of surveillance camera collected between June and September 1996, and between May and September 1998 include three important paroxysmal explosive episodes. Image analysis of these frames allow us to recognize a typical trend of the explosive activity that precedes every paroxysmal events. Some geometric parameters of the image are measured and a normalized value is assigned to every explosion on the base of tephra dispersion and kinetics energy relaxed. The plot of daily average values from each crater versus time shows a cyclic behavior with max and min of explosive activity that precede paroxysmal events from a some days to a few weeks.



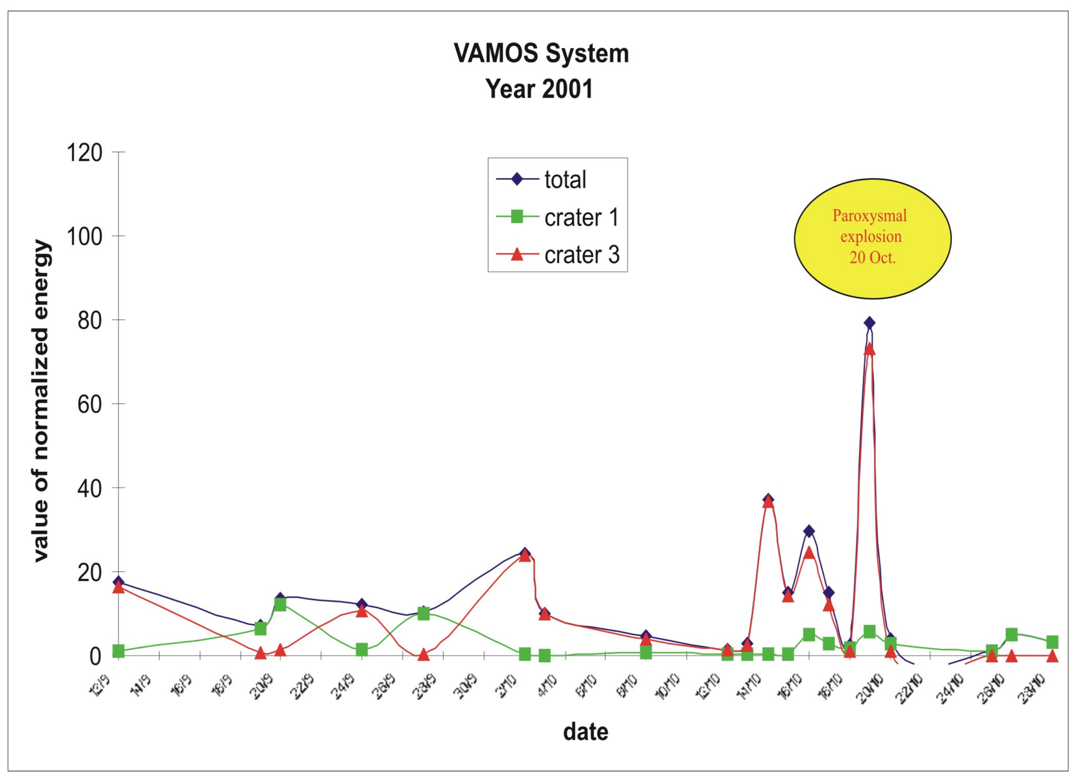


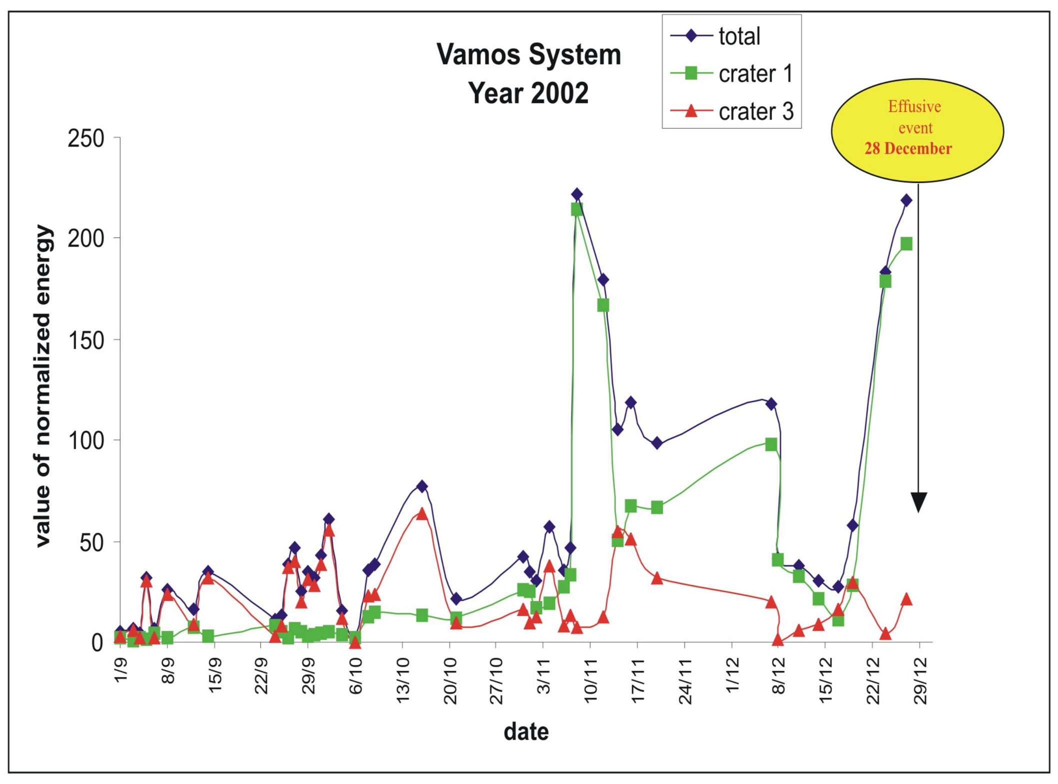
Plot of the of normalized energy values for the studied periods in 1996 and 1998 (note: the value of the paroxysmal events is only indicative)

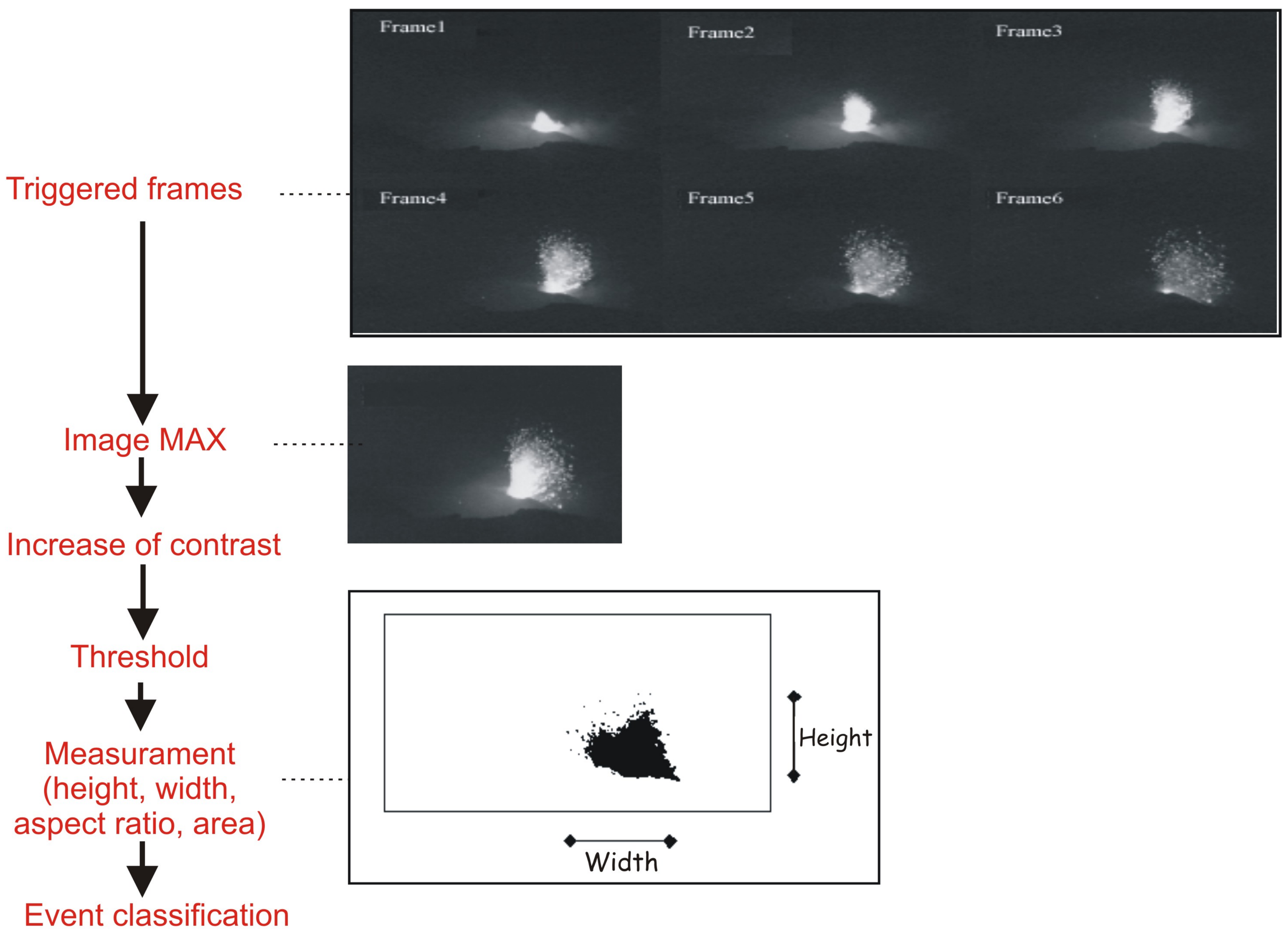
On-line analysis

From September 2001 an on-line image analyzer called VAMOS (**V**olcanic **A**ctivity **MO**nitoring **S**ystem) operates detection and classification of explosive events in real-time. The system has automatically recorded the change in the energetic trend that preceded the 20 October 2001 paroxysmal explosion that killed a woman, and the unusual very-strong explosive activity that preceded the onset of 28 December 2002 lava flow eruption.

The principal limitation of this system is the use of a visible range camera that allows frame acquisition only during the night hours and in condition of optimum visibility. It is in progress the installation of a thermal (infrared range) camera that will allow frame acquisition freely from sunlight and visibility, to obtain an true early-warning system of the paroxysmal explosive events.







VAMOS on-line image analyzer system acquires continuously the video signal and records the frames of very explosive event in real-time when they occur. Then an algorithm, realized in LABVIEW with some routine in ANSI C, automatically sums all frames of an explosive event (Image MAX) and measures some geometric parameters (Measurements) to valuate the tephra dispersion and then assign a normalized value (Event Classification) to every event on the base of kinetics energy dissipated by the explosion.