International cooperation during volcanic crisis: an example from the Italy-El Salvador monitoring system installed at Chaparrastique volcano, El Salvador.

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MOTIVATION

On December 29th, 2013, after 12 years of inactivity, a new explosive eruption occurred at Chaparrastique volcano (San Miguel, el Salvador, Fig. 1) prompting the evacuation of more than 5000 people. The new eruption that occurred at the volcano has so far been an isolated single explosion of vulcanian type, and was the first eruption since 2002, when the volcano produced a small VEI 1 eruption. The explosion produced an ash plume of considerable (5-10 km) height, generating heavy ash fall in nearby areas downwind, such as in the towns of Chinameca and San Jorge. Pyroclastic density currents also affected the flanks, damaging the coffee plantations and small inhabited areas around the volcano.

On January 2014, following a request of support by the government of El Salvador, INGV (Istituto Nazionale di Geofisica e Vulcanologia), organized a task force, V-Emer (Volcano Emergency) to improve the existing monitoring network at Chaparrastque volcano in order to better constrain the possible occurrence of a new eruptive crisis.

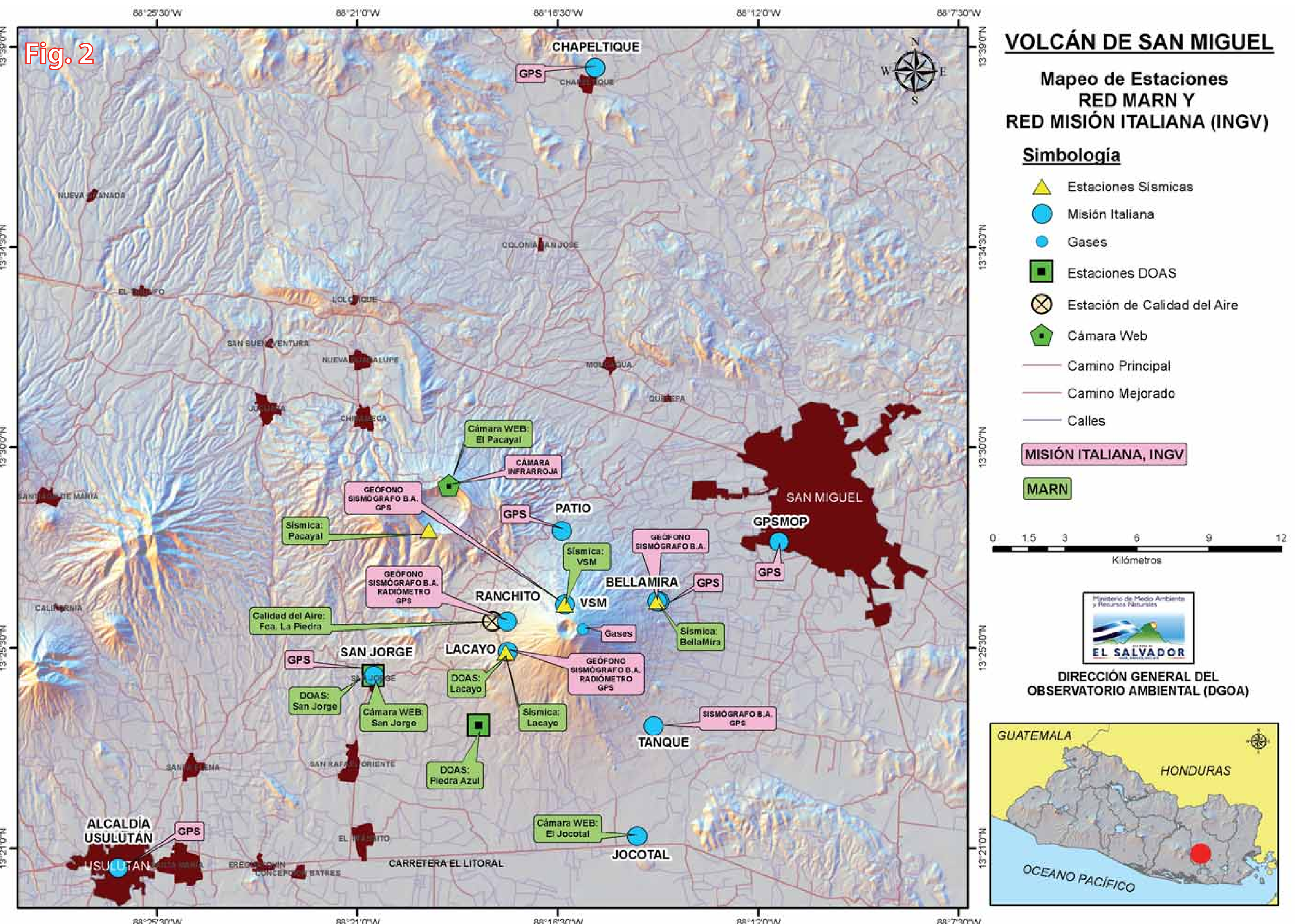
Fig. 1

A view of Chaparrastique Volcano behind the scanner spectrometer FLAME (Flux Automatic MEaSurements) installed at Lacayo site.

THE INTEGRATED MONITORING NETWORK

The temporary network installed by INGV is composed of: five broadband seismic stations, equipped with three Trillium Compact (120 sec.), and two Guralp CMG 40T (60 sec.) sensors, 3 acoustic microphones (G.R.A.S. 40AN with a 50 mV/Pa sensitivity in the 0.3–20,000 Hz frequency range), 2 radiometers, 10 GPS stations, 1 thermal camera, 1 MultiGas geochemical station, equipped with a Gascard NG spectrometer for CO_2 (range 0–3000 ppm) and an electrochemical sensor (CiTiCel, City Technology Ltd., range 0–50 ppm) for SO_2 measurement, 1 ultraviolet scanning spectrometer FLAME for SO_2 measurement. The temporary stations implement the existing permanent network, run by the volcanologists of MARN, composed of: 4 seismic stations, 3 DOAS, and 3 webcams, 1 air quality station.

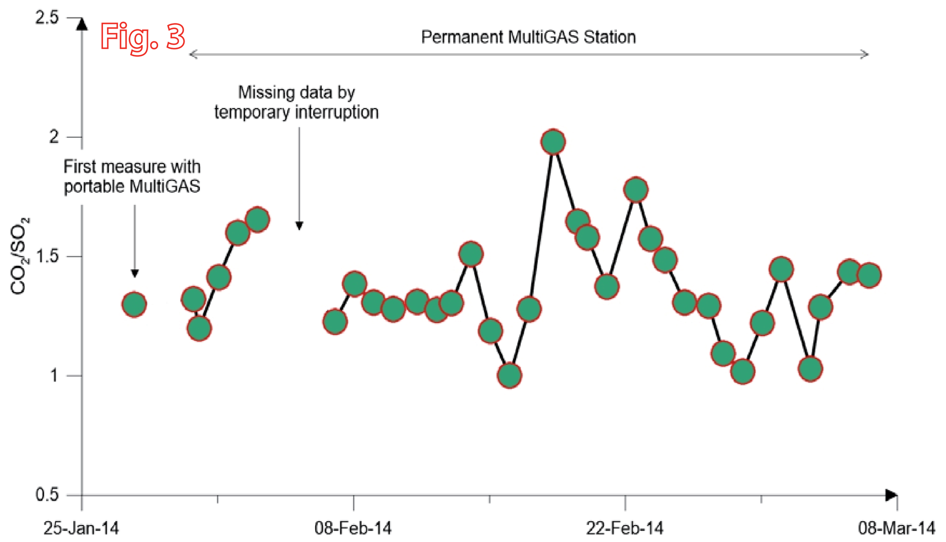
Fig. 2



SOME DATA FROM THE INTEGRATED NETWORK

GAS MEASUREMENTS

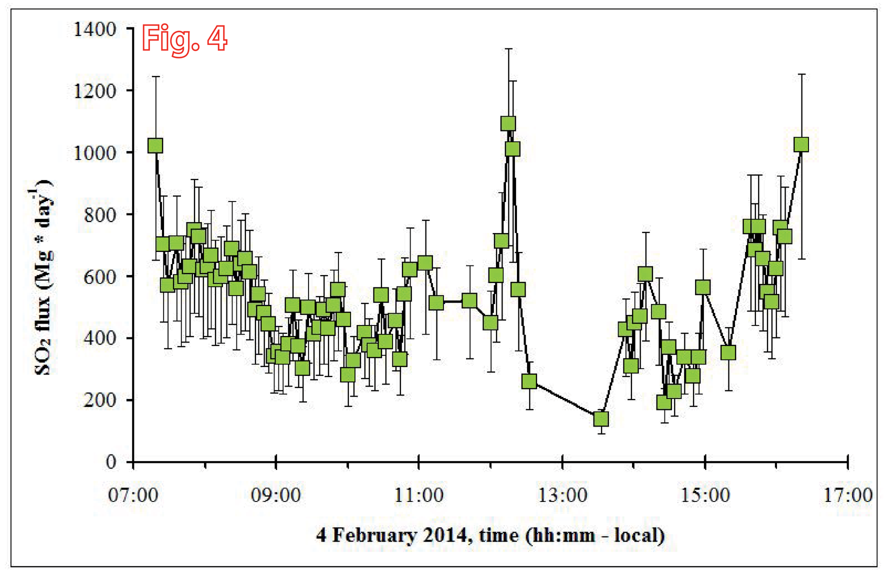
Fig. 3



The MultiGAS monitoring station consists of a fully-automated instrument for the determination of CO2 and SO2 concentrations in the volcanic plume. Daily average ratio of CO_2/SO_2 from the plume of the Chaparrastique volcano are automatically retreived (Fig. 3).

The whole data show a trend of general stability of the CO_2/SO_2 ratio with an average value of 1.3. During the monitored period, the minimum value recorded is of 0.6, and the maximum is of 2.5 ($\sigma = 0.39$).

Fig. 4



SO2 flux, measured robotically by FLAME on the south-western flanks of the volcano in (Lacayo) at an altitude of ~980 m a.s.l. The device scanned the sky for almost 9 h per day, intersecting the plume at a mean distance of ~2.5 km from the summit craters and acquiring a complete scan in ~5 min.

SO_2 column amounts were retrieved applying the DOAS technique using a modeled clear-sky spectrum (Salerno et al., 2009a; Platt and Stutz, 2008). Emission rate was derived from the SO2 cross-section profiles using wind-plume transport speed by WRF and NOAA model. Uncertainty in computed emission rate ranges between −22 and +36% (Salerno et al., 2009b).

Fig. 4 shows bulk intraday SO2 flux measured from the volcanic plume released from Chaparrastique volcano on 4 February 2014 (solid green-square); error bar indicates the uncertainty in the computed emission rate.

SEISMICITY

The seismic and acoustic station were removed at the beginning of May, 2014, thus recording about 100 days of seismic and infrasonic signals.

Fig. 5

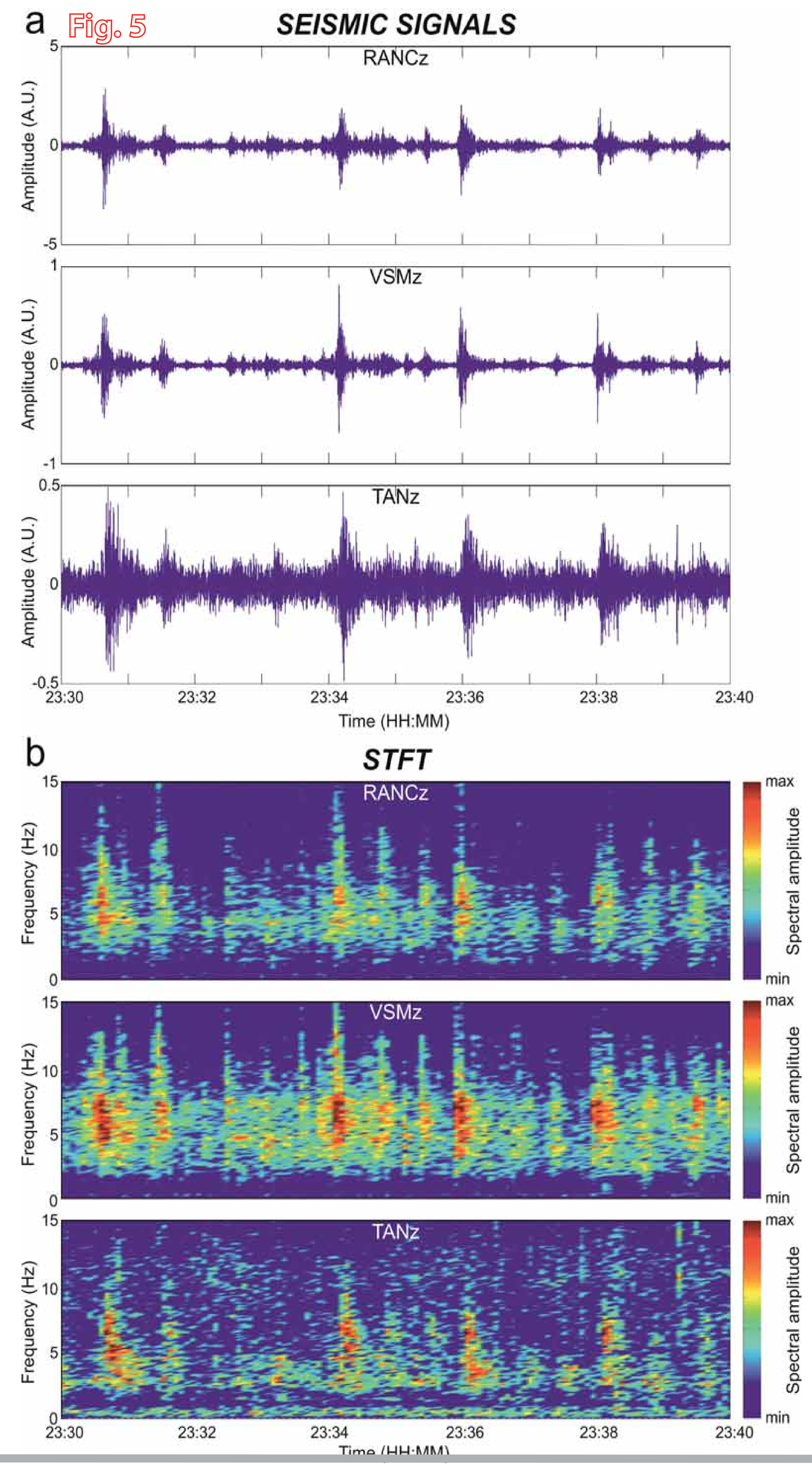
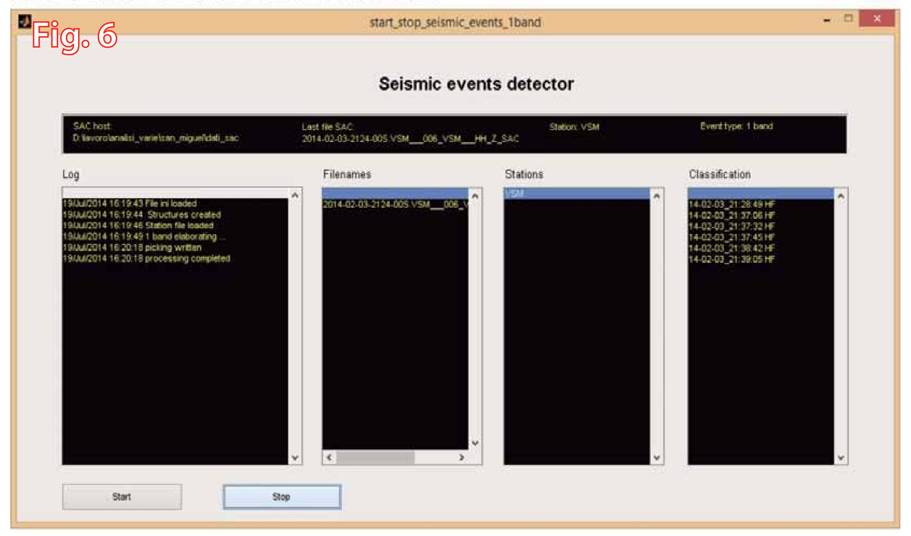


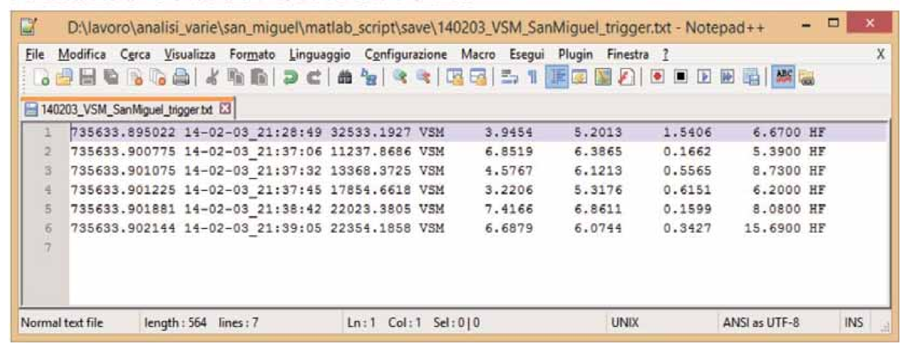
Fig. 5 depicts how the seismic signals acquired by the stations showed amplitude transients with emergent onsets and spectral content mainly in the range 3-8 Hz. in Fig. 5 (a) seismic signals recorded at the vertical component of RANC, VSM and TAN stations, and (b) corresponding Short Time Fourier Transform. In order to automatically detect these seismic events, a software was specifically developed in Matlab ® (Fig. 6), allowing to characterize the events by obtaining amplitude, spectral features, as well as a first rough classification.

GRAPHICAL USER INTERFACE

Fig. 6



RESULTS STORED IN ASCII FILES



GROUND DEFORMATION

Fig. 7