PP SYSTEMS

Application Note

Studying Volcanic Activity Using Drones and Sensors- including the SBA-5 Portable CO_2 Gas Analyzer

To accurately and precisely predict volcanic explosive eruptions.

A team of research scientists from McGill University (Montreal, Quebec CANADA), Universidad de Costa Rica (San Jose, Costa Rica), and the Observatorio Vulcanológico y Sismológico de Costa Rica (Heredia, Costa Rica) are currently developing a series of drones and associated instrumentation to study Turrialba volcano in Costa Rica. This volcano has shown increasing activity during the last 20 years, and the volcano is currently in a state of heightened unrest as exemplified by recent explosive activity in May-August 2016. The eruptive activity has made the summit area inaccessible to normal gas monitoring activities, prompting development of new techniques to measure gas compositions. The team has been using two drones, a DJI Spreading Wings S1000 octocopter and a Turbo Ace Matrix-i quadcopter, to airlift a series of instruments to measure volcanic gases in the plume of the volcano.

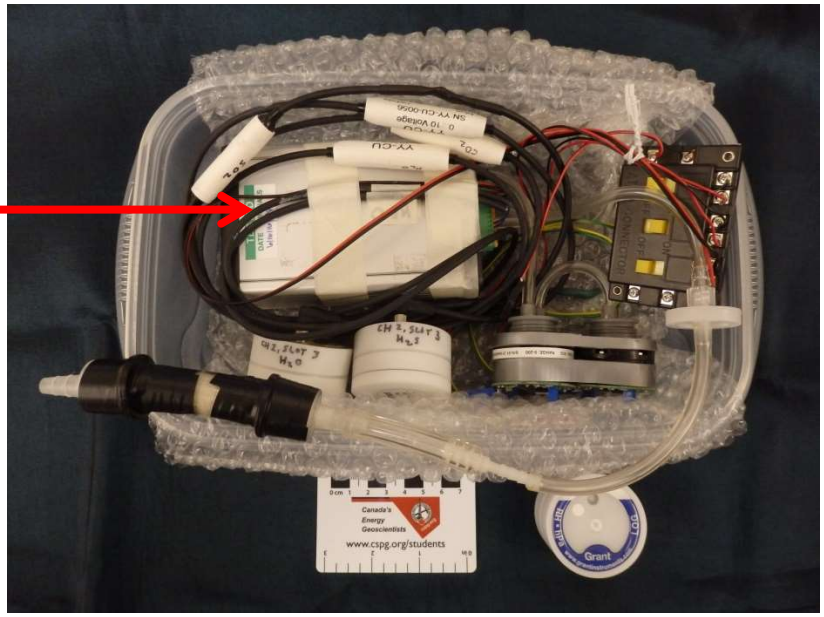
These instruments comprise optical and electrochemical sensors to measure CO_2 (**SBA-5 CO_2 Gas Analyzer – PP Systems**), SO_2, and H_2S concentrations which are considered the most significant species to help forecast explosive eruptions and determine the relative proportions of magmatic and hydrothermal components in the volcanic gas. The integrated payloads weigh 1-2 kg, which can typically be flown by the drones in 10-20 minutes at altitudes of 2000-4000 meters. Our broader goals are to map gases in detail with the drones in order to make flux measurements.

MINIGAS - Developed at the Universidad de Costa Rica, this compact instrument measures CO_2, SO_2, and H_2S , as well as GPS location, pressure, temperature, and humidity. Data are stored on data loggers and can also be transmitted by telemetry. Total weight is 1.2 kg.

MICROGAS – Developed at McGill University, this instrument measures CO_2, H_2O, SO_2, and H_2S. The CO_2-H_2O infrared sensor is made by PP Systems, while the SO_2 and H_2S electrochemical sensors are made by City Technology. Data are recorded on Grant Yoyo dataloggers. The entire package including battery weighs 1.14 kilograms.

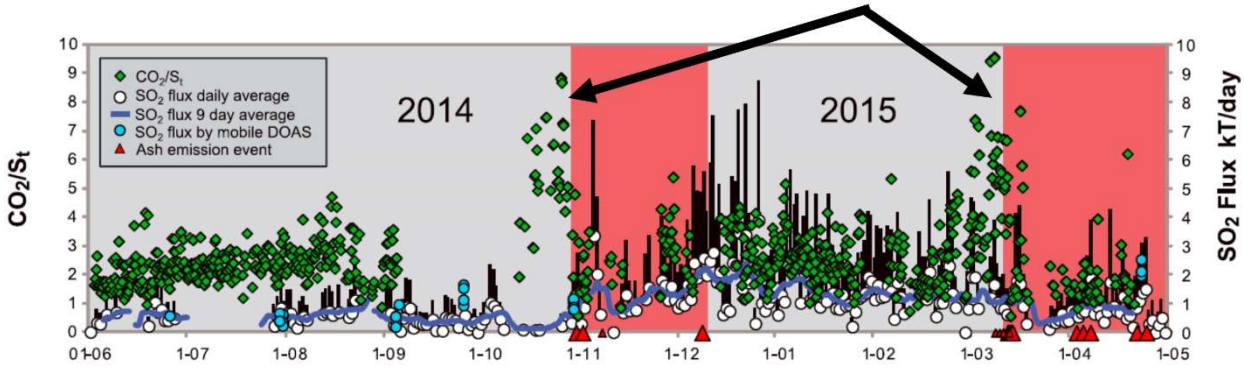
SBA-5
CO_2 Gas Analyzer

including H_2O sensor, pump and enclosure.



We now have the means to forecast explosive eruptions. The key information that is gathered includes gas, seismic, and geodetic data which indicate (a) overpressure and (b) open system behavior. Four examples follow:

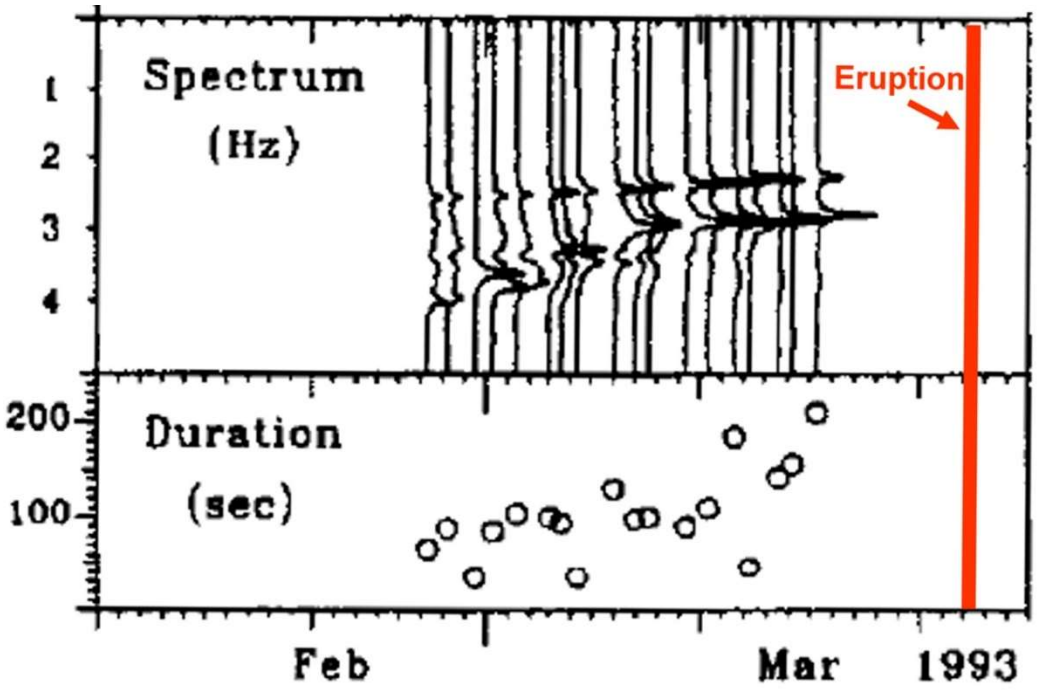
Example 1. Turrialba 2014-2015 (Costa Rica):
CO_2/sulfur ratio increases substantially prior to explosive eruptions and ash emissions



From: De Moor et al. 2016, J. Geophys. Res. 121, 5761-5775

Example 2. Galeras 1993 (Colombia):

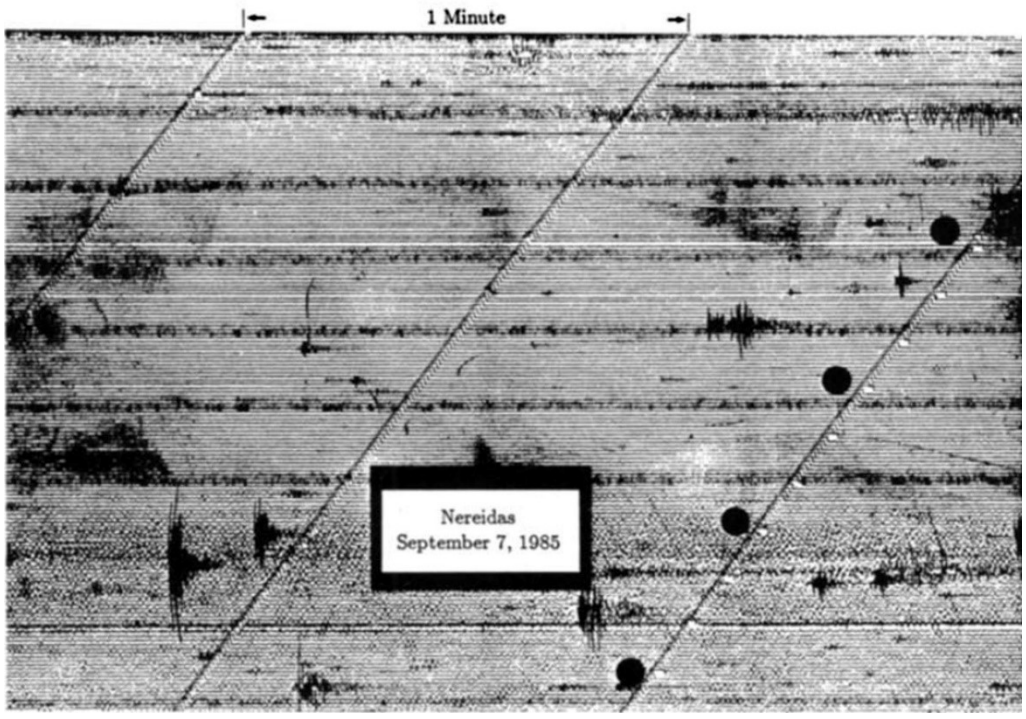
Monochromatic seismic signals ("tornillos") systematically increase in number and duration, and decrease in dominant frequency, prior to explosive eruptions.



From: Narváez M. et al. 1997, J. Volcanol. Geotherm. Res. 77, 159-171;
Gómez M. and Torres C., 1997, J. Volcanol. Geotherm. Res. 77, 173-193

Example 3. Nevado del Ruiz 1985 (Colombia):

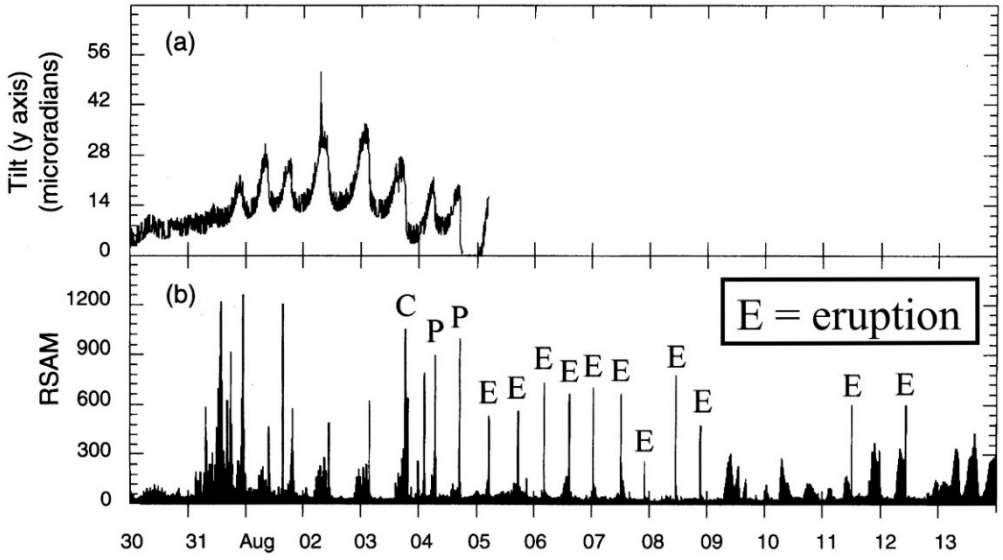
Banded tremor on 7 September, 4 days prior to ash emission on 11 September. Each tremor cycle is 15-20 minutes' duration.



From: Martinelli 1990, J. Volcanol. Geotherm. Res. 41, 297-314

Example 4. Soufrière Hills volcano, 1997 (Montserrat):

Inflation cycles shown in (a), RSAM in (b). Peaks in tilt and RSAM correspond to vulcanian eruptions. Note the ~12-hour cyclicity from 4 to 9 July.



From: Druitt et al. 2002, Geol. Soc. London Mem. 21, 281-306

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If you would like to learn more about this application or would like to speak with one of our experienced technical staff, please feel free to get in direct contact with us at:

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