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VOLCANIC MONITORING USING FIELD-PORTABLE MASS SPECTROMETERS: TOWARDS ON-SITE AND REAL-TIME GAS ANALYSIS AT FUMAROLES

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Volcanism is one of the most powerful driving forces on our Earth's surface. Contrary to tectonics and erosion where their effects can be seen over thousands of years, a volcano's spectacular and at times destructive displays of energy can change the landscape of an extensive area in a matter of days. Through decades of study and observation, it has been possible to gain a better understanding of the different processes involved in an eruption, but to have the possibility of predicting the time and place of eventual cataclysmic volcanic activity still requires a more appropriate determination of the key signs of the eruption process and a much more precise interpretation of the significance of these parameters. For this reason, it is important to improve the detection, monitoring and interpretation of possible essential indicators that precede volcanic eruptions by providing better instrumentation to the volcanologists. The purpose of volcanic monitoring techniques is to measure and detect changes in the condition of a volcano, caused by magma movement in its interior. If new magna coming from deep into the earth is injected into the volcano, there will be a change not only in the volcano's visible characteristics, but also in its associated measurable phenomena.

Traditionally seismology has been the most used parameter for volcanic monitoring but more recently, geochemistry is being used as a much better indicator to predict possible eruptions. The principle behind volcanic gas monitoring is that changes in the rate and composition of the emissions are associated with major subsurface movement of magma. To measure these concentrations, in-situ mass spectrometer measurements of volcanic gaseous emissions were conducted at fumarolic sites in volcanoes of Hawaii, Costa Rica and California. For validation purposes of this new technique, gas concentrations obtained by MS were in agreement with the values obtained using GC at the Hawaiian Volcano Observatory for both in-situ and traditional bottle sampling. Several other tests are been conducted in Poas, and Irazu volcanoes in Costa Rica and Mammoth Lakes in California to demonstrate the power of field-portable mass spectrometry for real-time continuous volcanic gas monitoring of species such as. He, CO_2, SO_2 and H_2S released by degassing of the magma either at the fumaroles or by diffusion. Two types of mass spectrometers have been used for these experiments: a commercial quadrupole mass spectrometer (QMS-300 form Stanford Research Systems) and a newly developed Field-Portable Compact Double-Focusing Mass Spectrometer that could drive the cost of mass spectrometers down by one order of magnitude.

The ultimate goal of the project is to establish a network of low cost miniature mass spectrometer located near the rim of each volcano to monitor on-site and in real time the key gases released by the volcano and connected to internet through wireless communication to each local observatory. The instrument would be accessible through the web from any point of the planet and data shared by four types of users: a) government to issue local alert of possible activity or the evacuate in case on increased volcanic activity, b) scientist for data analysis and research, c) education and d) general public.