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Continuous monitoring of hydrogen and carbon dioxide at Stromboli volcano

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Geochemical monitoring of fumarole and soil gases is a powerful tool for volcano surveillance, for investigating the subsurface magma dynamics, and for hazard assessment in volcanic areas. The monitoring of both carbon dioxide (CO_2) flux, and hydrogen (H_2) concentration in active volcanic areas helps to improve the understanding of the processes linking the surface gas emissions, the chemistry of the magmatic gases, and the volcanic activity.

The CO_2 flux measurement is a routine technique for volcano monitoring purposes, because of CO_2 is the second-abundant component of the gas phase in silicate magmas, attaining saturation at the mantle to deep crustal level. The H_2 concentration has provided indications concerning the oxygen fugacity of magmatic gases, a parameter that changes over a wide range of low values (10^{-16} – 10^{-8} bar), and affects the redox state of multivalent elements.

This study reports on the use a tailor-made automatic system developed for continuous monitoring purposes of H_2 concentration and CO_2 flux in the summit area of Stromboli volcano (Aeolian islands). The automatic device consists of an H_2-selective electrochemical sensor, and two IR-spectrophotometers for measuring the CO_2 flux in agreement with the dynamic concentration method.

The data collected by the automatic system deployed at Stromboli from 19 May 2009 to 15 December 2010 are presented herein. The data processing provides a better understanding of the relationships between the evolution of the low temperature fumarolic emissions, and the volcanic activity. The results of the data analysis indicates that the high frequency variations exhibited by CO_2 flux and H_2 concentration are positively correlated with the eruptive activity of Stromboli, typically changing on time scale of hours or days. Furthermore, the investigation of the relationships between CO_2 flux and H_2 concentration provides an evaluation of the depth of the degassing source, by which the gas mixture containing H_2 and CO_2 starts to move through the rock fractures. Our data indicates that the depth of the degassing source ranges between 2 and 4 km in the volcano plumbing system, in agreement with the magma storage zone that has been proposed by other geochemical, volcanological, petrological and geophysical investigations.