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Continuous measurement of fluid pressure gradients in soil gases at Stromboli volcano (Italy)

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Abstract

Measurement of gas pressure gradients in soil is based on the method developed by Natale et al. (*Geophys. Res. Lett.*, 27, 24, 3985-3987, 2000). This parameter can be very useful as a tool to be integrated with other geochemical techniques for the monitoring of volcanic unrest, as it can be a good indicator of bulk gas mass efflux from the soil. The devices developed for this purpose are relatively cheap, thus allowing to set up large networks of measurement stations. The prototype sensor consists of a high-sensitivity low range pressure transducer (model 5266, Gems Sensor, UK) equipped with a stainless steel diaphragm and a capacitive sensor, a volt data logger (model EL-USB1, Lascar Electronics, UK) to record the signal from the transducer, a Tygon tube and a special 50 cm - long stainless steel probe. Also a barometer (model HD9408T BARO, Delta Ohm Sensor, Italy) has been used in order to monitor barometric pressure. The Tygon tube connects the probe to the transducer, thus obtaining a positive volt signal due to the soil fluid pressure exerted on the transducer. The difference between the gas pressure in the soil and the atmospheric pressure, called “gradient”, is then calculated always at 50 cm depth in order to obtain the corresponding fluid pressure gradient. A sampling frequency of 1 minute or higher can be obtained with the above system. Recent field surveys on Mt. Etna showed a good correlation of this parameter with soil CO_2 effluxes starting from efflux values of about 23 g $m^{-2}d^{-1}$. Below this efflux value, soil gas transport is evidently driven exclusively by diffusion, and hence no pressure gradient is measurable. Conversely, above this value advection

becomes progressively more important as a transport mechanism, and hence the two parameters match well. The gas pressure gradient was also measured continuously in two test sites on Stromboli volcano during the period June 8^{th} to September 30^{th}, 2007. The results obtained showed again a very good correlation with soil CO_2 efflux data continuously recorded at the same sites, and also an evident influence from environmental parameters, mostly from air temperature. Once filtered from this influence, the gas pressure gradient data showed an interesting co-variation with the magnitude and focal depth of VLP events.