Real-time measurements of concentration and isotope composition of atmospheric and volcanic CO_2 at Mt. Etna (Italy)

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We present unprecedented data of real-time measurements of concentration and isotope ($\delta^{13}C$) composition of CO_2 in air and in fumarolic-plume gases collected at Mt. Etna volcano. Two campaigns of measurements were performed on 11 July and on 5-6 September 2013, by using a Thermo Scientific Delta Ray™ Isotope Ratio Infrared Spectrometer (IRIS). With the assumption of a two components mixing, a simple linear regression was applied to the data in order to obtain the volcanogenic $\delta^{13}C$.

Data acquired along the route Catania–Etna, while the car was moving, showed an excess of ^{13}C-depleted CO_2 when passing through populated centers due to atmospheric pollution produced by car exhaust. Fumaroles of Torre del Filosofo (2,900 m a.s.l.) displayed a $\delta^{13}C$ between -3.2±0.03‰ and -3.7±0.05‰ comparable to IRMS measurements of discrete samples collected on the same date and in previous investigations. Diluted plume gases were collected at more than 1 km from the craters and showed $\delta^{13}C$=-2.2±0.2‰ in agreement with crater fumaroles gases collected and analyzed by IRMS.

Considering the large amount of data that may be acquired in a very short time by Delta Ray IRIS, we demonstrate that the addition of ~100 ppm of CO_2 from an unknown source to the atmospheric CO_2 background is enough to allow a mathematical calculation of the endmember with an uncertainty generally <0.15‰. This is achievable with the assumption of binary mixing. We thus postulate that the demonstration performed at Mt. Etna may represent a historical step forward for the scientific community in volcanic surveillance.