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On-field measurements of CO_2 isotope composition of diffuse degassing from soils in volcanic areas: Delta-ray setup for direct measurements in the 0-100% vol. range

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Volcanoes release carbon dioxide in the atmosphere and have been targeted as potential contributors to the global warming. Despite the evidences lay against these conjectures, the accurate estimation of the release of CO_2 of volcanic origin in the atmosphere is currently unavailable because both not all the volcanoes of the world are satisfactorily monitored, and the estimations available for monitored volcanoes are often discordant. At the same time, the available estimate for the monitored volcanoes can be different according to the state of activity of the volcano.Multiple sources can be effective in the release of CO_2 in volcanic zones as demonstrated by the isotopic fingerprinting of CO_2. Better estimates of the amount of carbon dioxide released by different sources represent one means of improving the accuracy of the estimation of the CO_2 budget in environmental systems and reducing the knowledge gaps related to the effects of the carbon cycle in the Earth-climate system. The coupled approach of carbon isotope and CO_2 flux measurements allows the precise identification of different sources, and enables the evaluation of the mass contribution of each source to the carbon dioxide emissions.
From a volcanological perspective, it is well known that the amount of CO_2 released by soils before and during periods of unrest increases appreciably, similar to the amount of carbon dioxide released from the craters of the volcanoes.
This study focuses on the application of a DeltaRayTM from Thermo Scientific, and reports the development of an innovative method for directly determining in the field the isotope composition of carbon dioxide discharged by soils at concentrations from atmospheric to 100 vol %. To settle the DeltaRayTM to the determination of the isotope composition of soil gases, a sampling method has been designed to analyse the isotope composition of the CO_2 in a gas sample of unknown CO_2 concentration, reduce the measurement operation time without loss of accuracy, and measure the isotope composition of the CO_2 without changing the instrument configuration.
The results of the first application on Vulcano (Aeolian Islands) are reported in order to evaluate the amount of hydrothermal CO_2 discharged by soils. The amount of hydrothermal CO_2 released by soils is not negligible because of the specific extent of the degassing surface. For the first time, the budget of the CO_2 of hydrothermal origin discharged by soils on Vulcano was computed separately from the contribution of the biogenic source, and the data indicate a degassing area that is wider than that previously reported in the literature.
Furthermore, the synchronous and extensive investigation of both the spatial distribution of the carbon isotope composition of CO_2 and the CO_2 flux provides a better assessment of the amount of CO_2 of deep origin. Monitoring of this type of CO_2 represents a step forward in the evaluation of the volcanic hazard.