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Gas blowout from shallow boreholes near Fiumicino International Airport (Rome): Gas origin and hazard assessment

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ABSTRACT

In summer 2013 a toxic and polluting gas blowout (19 tonnes day^{-1} CO_2, 95 kg day^{-1} CH_4) occurred from two shallow boreholes drilled at only 50 m from the International Airport of Rome (Italy), in the town of Fiumicino. Another gas blowout occurred in the same period from a borehole located offshore, 2 km away, also generating sea-water acidification; it lasted only a couple of days. Onshore, CO_2 was also diffusing from holes within the soil, particularly toward the airport, generating a soil flux up to 1.8 tonnes day^{-1}. In 3.5 months ~1500 tonnes of CO_2 and 5.4 tonnes of CH_4 were emitted in the atmosphere. Temporal monitoring of gas geochemistry indicates that in this area a mixing occurs between shallow and pressurized gas pockets, CO_2-dominated, but with different chemical (i.e., He/CH_4 ratio) and isotopic ($^3He/^4He$, $\delta^{13}C$-δD_{CH4}) characteristics. Numerical simulation of CO_2 dispersion in the atmosphere showed that dangerous air CO_2 concentrations, up to lethal values, were only found near the vents at a height of 0.2 m. Fiumicino is a high blowout risk area, as CO_2 rising through deep reaching faults pressurizes the shallow aquifer contained in gravels confined underneath shales of the Tiber delta deposits. The Fiumicino blowout is a typical example of dangerous phenomenon that may occur in urban context lying nearby active or recent volcanoes and requires quick response on hazard assessment by scientists to be addressed to civil protection and administrators.

1. Introduction

Rome city is located between two Quaternary volcanoes, Albani Hills and Mts. Sabatini, belonging to the alkali potassic Roman comagmatic Province (Fig. 1). This zone of Central Italy, up to the Tyrrhenian seaside, is characterized by an anomalous release of endogenous gas (e.g. Tor Caldara, Lavinio, Ardea, Pomezia, Fiumicino, Palidoro in Fig. 1) mostly consisting of CO_2 (Chiodini et al., 2004). Most of these emissions occur above structural highs (horsts) of buried Mesozoic carbonates that represent the main aquifer, often geothermal, of the area. Carbon dioxide, either generated by thermo-metamorphic reactions in the limestones and of deeper mantle or magmatic origin (Minissale et al., 1997; Chiodini et al., 2004 and references therein) accumulates at the top of the carbonatic horsts. From there it escapes to the surface along deep-reaching faults, generating moffettes and strong emissive areas where lethal accidents frequently befall people and animals (Carapezza et al., 2003; Carapezza and Tarchini, 2007). Rising CO_2 dissolves in shallow aquifers, up to their saturation and excess free gas pressurizes them when they are confined underneath impervious layers (Carapezza et al., 2012). Dangerous blowouts have occurred, even in urbanized areas, when these pressurized aquifers have been reached by wells, at depths ranging from 350 m to only 10–15 m (Carapezza et al., 2011 and references therein).

On 24 August and 6 September 2013, new gas blowouts occurred at Fiumicino (Rome) from two shallow boreholes drilled to a depth of 35 m and 40 m respectively, at an important traffic roundabout of the town (Coccia di Morto, hereafter CdM) (Fig. 2). In this town several similar accidents have occurred in recent years, as in 2005 (Barberi et al., 2007 and Fig. 2) and the authorities were very concerned, both because of the emission of a dangerous cloud in the urban area (nearest houses at only 100 m) and because a runway of fundamental importance for Fiumicino International Airport was only 50 m away (Fig. 2). We were therefore entrusted by regional Civil Protection to monitor the emission and assess the hazard. We periodically analyzed CdM gas and estimated the total gas output, until the emission was tentatively closed by borehole cementation on 18 December 2013; the water emitted by CdM vents was also sampled and diffuse CO_2 flux was repeatedly measured

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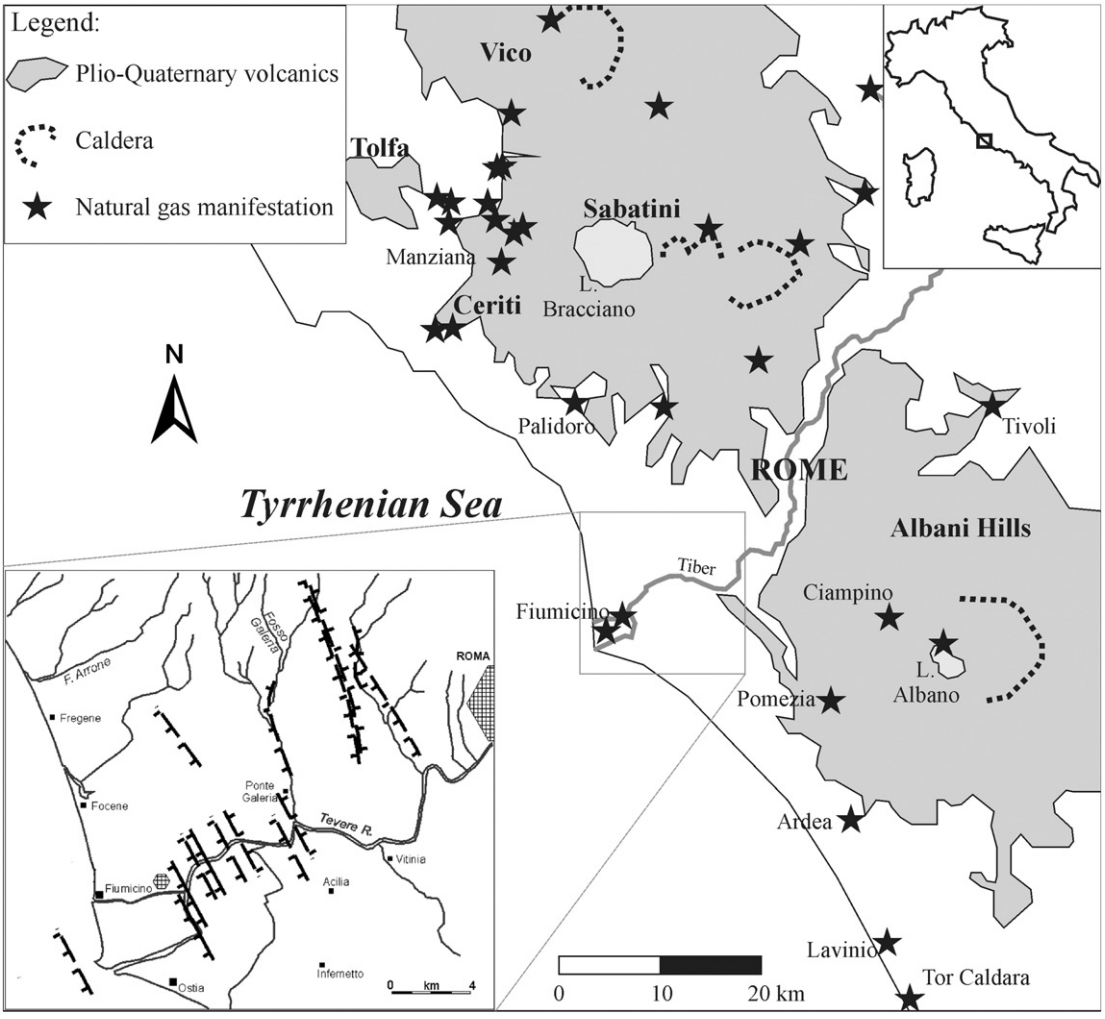

Fig. 1. Main volcanic features and location of the natural gas emissions in the Thyrrenian side of Central Italy. The main faults of the zone between Fiumicino and Rome, buried and inferred from seismic profiles, are shown in the insert (after Milli et al., 2013).

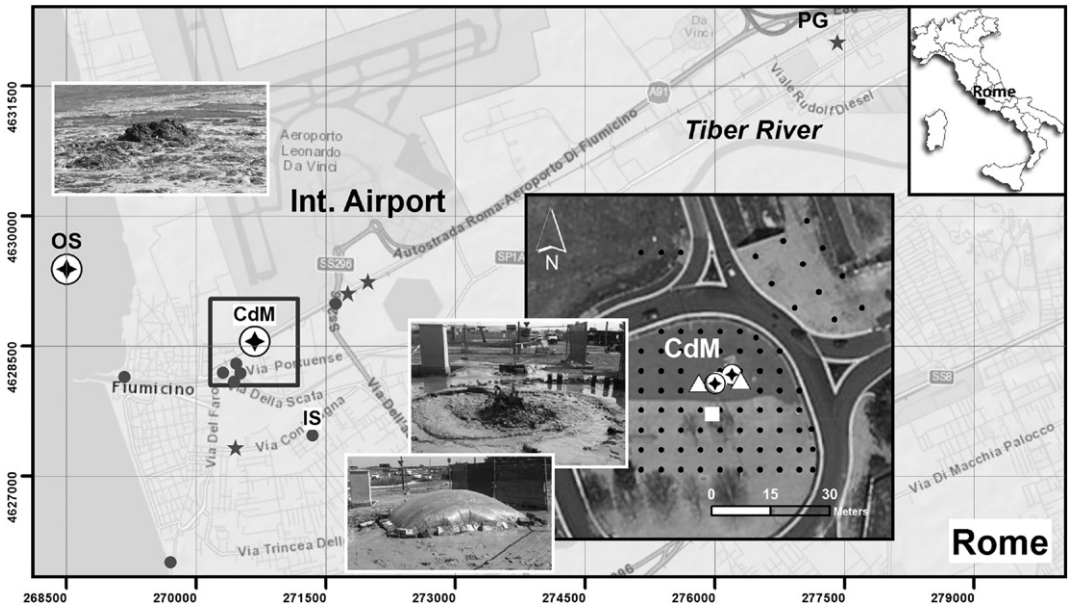

Fig. 2. Fiumicino area with location of the 2013 onshore (CdM) and offshore (OS) gas blowouts, of natural gas emission (stars) and of other gas blowouts occurred in the same area (dots). Black square shows the area of numerical simulation of CO_2 dispersion in the atmosphere. The insert shows the road roundabout where the two onshore boreholes were located (vent 1 to SW), the CO_2 soil flux measurement points (small dots), the location of the gas air concentrations stations (triangles) and the meteorological station (square). Pictures (from left) show the offshore gas emission, the CdM vent 1 degassing into atmosphere and during viscous gas flux measurement. IS: Isola Sacra, CV: Canale Vignole, and PG: Ponte Galeria.