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Gas blowout from shallow boreholes at Fiumicino (Rome): Induced hazard and evidence of deep CO_2 degassing on the Tyrrhenian margin of Central Italy

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Abstract

A borehole drilled at Fiumicino (Rome) down to only 27 m depth in a zone where no gas emission at the surface was known, caused a gas blowout from a pressurized gas pocket confined beneath a clay cover. Gas slowly diffused from the borehole within superficial permeable sand. Seven persons living in three ground floor flats of a near building had to be hospitalized due to CO_2 exposure. All the houses in the proximity were evacuated. At the request of the Fire Brigade two additional boreholes were drilled nearby, hoping that this could rapidly exhaust the gas stored underground. To the contrary the soil gas flux near houses increased and indoor CO_2 air concentration rapidly rose to lethal values (15 to 30 vol.%). As a remediation we suggested to restore the continuity of the impervious gas cover by squeezing quick-setting cement into the formation through new boreholes to be drilled near the existing ones. Although the first cement squeeze reduced drastically the CO_2 soil flux and indoor concentration, six additional squeezes had to be carried out in order to lower the gas emission below the gas hazard threshold. The gas was mostly made of CO_2 (98 vol.%) with minor N_2 and CH_4. Its chemical and isotopic composition ($\delta^{13}C_{CO2}=-1.55$; $^3He/^4He=0.314$ Ra) is similar to that of the gas manifestations of Mts. Sabatini and Alban Hills volcanic areas. Though being somewhat contaminated by crustal and shallow organic volatiles, these gases likely have a component originated in the mantle, that beneath the volcanic Roman Comagmatic Province is probably deeply contaminated with crustal material. The Fiumicino gas blowout indicates that the area of Central Italy characterized by strong CO_2 degassing extends westerly to include the Tyrrhenian coast.

Keywords: gas blowout; CO_2 hazard; gas monitoring; remediation interventions; Earth CO_2 degassing in Central Italy

1. Introduction

Central Italy, North and South of Rome, is characterized by the presence of two Quaternary volcanoes (e.g. Mts. Sabatini and Alban Hills, Fig. 1). This area, as the entire Tyrrhenian hinterland, has a thinned continental crust (20–25 km) and high heat fluxes (> 80 mW m^{-2}) (Gambardella et al., 2004). It is also characterized by a very strong degassing of CO_2 of deep provenance, as estimated from the balance and the $\delta^{13}C$ of carbon dissolved in regional aquifers (Chiodini et al., 2000; 2004; Gambardella et al., 2004 and references therein). It has also been suggested that the Apennine seismicity could be driven by high pressure CO_2 sources at depth, i.e. crustal traps with overpressurized CO_2 reservoirs (Miller et al., 2004; Chiodini et al., 2004).

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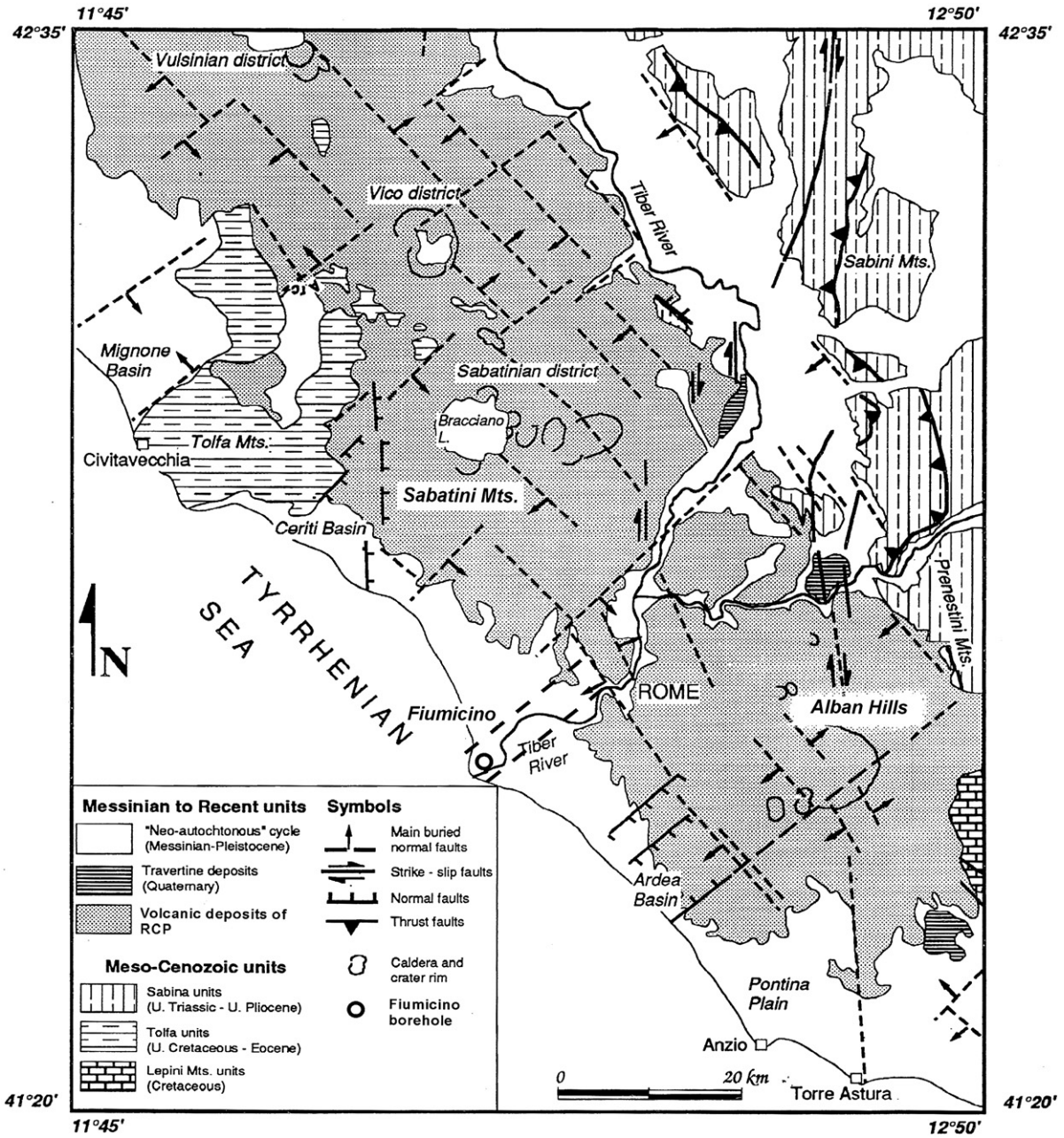

Fig. 1. Geological sketch-map of the Tyrrhenian margin of Central Italy (modified after De Rita et al., 1995). The extension of the volcanic rocks of the Roman Comagmatic Province (RCP) and the location of the Fiumicino borehole are indicated.

The carbon dioxide rising from depth, whose origin is controversial, dissolves into aquifers, geothermal or not, hosted in buried Mesozoic limestones and in shallower cold aquifers hosted either in Neogene clastic sediments and in the Quaternary volcanic rocks. All these aquifers release CO_2-rich gases toward the surface mostly along extensional fractures and faults, originating many discrete gas manifestations or zones of high CO_2 diffuse emission from the soil. The quantity of CO_2 released into the atmosphere is locally so high to represent a serious hazard to people and animals (Rogie et al., 2000; Chiodini and Frondini, 2001; Carapezza et al., 2003; Carapezza et al., 2005). In zones where there is no significant CO_2 release at the surface because of the presence of an efficient cover of impervious rocks, the existence at various depth of pressurized CO_2 pockets has