

Project V5 - Diffuse degassing in Italy

Responsibles:

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A map of deep CO₂ degassing in some regions of Italy has been recently elaborated on the base of the isotopic and chemical composition of the carbon dissolved in the main aquifers of the studied areas. The map highlights two large anomalous degassing structures located in the Tyrrhenian sector of Italy. The first comprehends Tuscany, Latium and a part of Umbria regions. The second coincides with the Tyrrhenian side of Campania. The two anomalous areas overlap the two Quaternary magmatic provinces of Tuscany-Latium and Campania.

The total CO₂ flux emitted by the two structures has been estimated from 1 to 3×10^{11} mol/y, a very high amount which constitute about 10% of the estimation of the CO₂ globally released by volcanic activity in the world. Several CO₂ rich gas emissions, characterised by high gas flow rates, are localised in the two anomalous areas. The gas is emitted both from soil diffuse degassing and from focussed vents.

The gas emitted by some of these gas emissions caused in the past lethal accidents. At Mefite d'Ansanto (Avellino) two researchers died during the 1990's; at Tivoli (Roma) the gas emitted by a river saturated in CO₂ killed some children; at Colli Albani (Rome) numerous lethal accidents involved animals and persons; at Veiano (Viterbo) the gas killed some fishermen along a river affected by strong gas emissions; in the area of Mt Amiata (Siena) the last accident occurred in 2002 and caused the death of a hunter, lethal accidents involved some workers during the drilling of a geothermal well etc.

This list is incomplete because does not exist any specific research on the casualties caused by gas emissions in Italy. Few gas emissions have been investigated in non-volcanic areas, or in areas of extinct volcanism. At the contrary many gas emissions from volcanic areas have been already studied as for example at Vulcano, Stromboli, Etna, Campi Flegrei, Ischia, Vesuvio and Colli Albani. However, most of these studies were focussed on volcanic surveillance and only partially to the evaluation of the volcanic gas hazard. These studies have however confirmed the presence of numerous zones in volcanic areas where the flux of CO₂ (and sometime H₂S) are so high that they can constitute a serious danger for people and animals.

The main objective of this project is the mitigation of the hazard from gas emissions in Italy trough a multidisciplinary and coordinate study of earth degassing.

The project is organised in 3 main tasks:

- 1- Identification and characterization of the gas emissions, relations with the structural and hydrogeological setting and with seismic activity;
- 2- Definition of the scenarios and estimation of the hazard;
- 3- Evaluation of the vulnerability and mitigation of the risk.

Task 1. Identification and characterization of the gas emissions, relations with the structural and hydrogeological setting and with seismic activity

This is the main task of the project and it is aimed to produce the catalogue of the Italian gas emissions. The areas which will be investigated in the frame of the project are: Tuscany, Umbria, Latium, Campania and Sicily with its minor islands . Gas emissions eventually located outside from these regions are also of interest for the project.

We suggest to the RU's interested in this task: 1) to point out the study area and 2) to coordinate, possibly before the submission of the project, with other operators (UR) interested in the same areas. The coordination is necessary to avoid overlapping and to produce a complete set of data for each investigated area. The questions which should be addressed within this task in order to have a better knowledge of the degassing process in Italy and to acquire the necessary information for the definition and mitigation of the gas hazard, are:

- What are and where are exactly localised the gas emissions in Italy ?
- What are the gas flow rates?
- What are the chemical and isotopic compositions of the discharged gas and, in particular, what is the concentration of the gas species potentially dangerous?
- What is the origin of these gases, and what are the relations with the geological-structural-hydrogeological setting?
- What are the relations with other natural phenomena such as seismicity?

The task is divided in 4 workpackage:

WP1.1: Localization of the areas affected by gas emissions; sampling, chemical and isotopic analysis, measurements of the gas emissions

Deliverables:

1. Catalogue of the Italian gas emissions
2. Specific bibliography for each manifestation
3. Mapping of the degassing process, quantification of the gas flux trough soil gas flux measurements and statistical and geostatistical treatment of the data
4. Quantification of the gas flow rate of focussed vents
5. Gas sampling and chemical and isotopic analysis
6. Characterization of the geological, and hydrogeological setting of the areas
7. Collection of the data of deep drillings eventually located in the areas and comparison with the natural emissions
8. Photos and movies of the main gas emissions (for example images of dangerous accumulation of gas highlighted by smoke bombes)

WP1.2: Conceptual and physical-numerical models of the process (for the main gas emissions)

Deliverables:

1. Models of the origin of the main gas emissions

WP1.3: Specific investigations on the relations between gas emissions and sink-holes with particular attention to the areas near villages or infrastructures

Deliverables:

1. Individuation and localization of the areas affected by sink-holes
2. Geochemical models of the process

WP1.4: Estimation of the amount of deeply derived CO₂ dissolved by the main aquifers

Deliverables:

1. General map of Earth degassing in Italy

Task 2. Definition of the scenarios and estimation of the hazard

The gas hazard depends on the high concentration of dangerous gases (CO₂ and H₂S) in the air near the gas emissions. The accumulation and the dispersion of the gases in the air depend on many factors such as the flow rate of the gas emission, the morphology of the emission area, the meteorological conditions, etc. Each of these factors should be considered in order to evaluate the gas hazard. The main questions which should be addressed, are:

- What are in Italy the 'killer' gas emissions?
- Are the gas flow rates and the compositions constant in the time?
- If not, what factors control the gas flow rates and the gas compositions?
- What are the space-temporal variation on the gas concentration in air and in groundwaters, and what factors control such variations?
- What is the area of influence of the gas emissions?
- Does exist in the area the condition for the formation of sink-holes?

The task is divided in 2 workpackages.

WP2.1. Historical investigation on the occurrence of accidents caused by the gas in Italy

Deliverables:

1. report on the accidents caused by the gas emissions in Italy

WP2.2. Modelling of the gas dispersion in the atmosphere and development of monitoring techniques.

Deliverables:

1. individuation of suitable test sites (i.e. main gas emissions)
2. detailed survey of the morphology
3. physical-numerical models of gas dispersion in the atmosphere under different meteorological conditions
4. acquisition of the data necessary for the validations of the models (meteorological data, concentration of the gas species in air, soil gas fluxes, etc.)
5. statistical elaboration aimed to the individuations of dangerous gas concentration in air; methods for the monitoring of the dangerous gas emissions

Task 3. Evaluation of the vulnerability and mitigation of the risk

The evaluation of the vulnerability regards the effects of the gas emissions on the people and on the environment. The main questions to address are:

- What are the thresholds of the concentrations of the dangerous gas species in air for people and animals?
- What are the precautions, the restraints on the use of the territory and the structural and non structural interventions which should be recommended in order to diminish the vulnerability?

This task has 1 workpackage.

WP3.1. Evaluation of the vulnerability and mitigation of the risk

Deliverables:

1. Revision of the concentration thresholds of gas species dangerous for people, animals, cultivations
2. Evaluation of the exposed value in one (or more) area recognised at high gas risk and estimation of the hazard
3. Feasibility studies for the mitigation of the risk
4. Selection on the maps of the dangerous areas which should be enclosed and predisposition of the texts for the danger signals
5. Formulation of rules for the access to the dangerous zones and for living in areas near the dangerous gas emissions