



NATURAL SPRINGS OF CO₂ AS DIDACTIC LABORATORY

Introduction:

The doline of Bossoleto is located in a part of Tuscany region rich in secondary volcanism phenomena. The peculiarity of the doline, excluded to free access, is given by conspicuous gas emissions from the soil and from a large cave mainly composed of CO₂ with traces of hydrogen sulphide and other gases.

CO₂ atmospheric concentrations as high as 75% have been measured at predawn, at soil level. Later and during the day the concentration drops to lower levels mostly due to air turbulence. In Bossoleto the combination of topography and CO₂ emissions makes the Greenhouse effect evident for this reason it represents a school laboratory for didactic and moreover, the field visits of local students implement the awareness of the territory's worth against its depopulation process of the countryside.

Lots of simple experiments show the greenhouse effect due to CO₂ and its effects on plant and animals.

Preparation time: 5 minutes

Duration of activity: 30 minutes

Application: science of atmosphere, greenhouse effect, CO₂ properties and effects

Time for data analysis and discussion: 15 minutes

Previous knowledge required: none

Cost: travel cost, eventually guided tour visit.

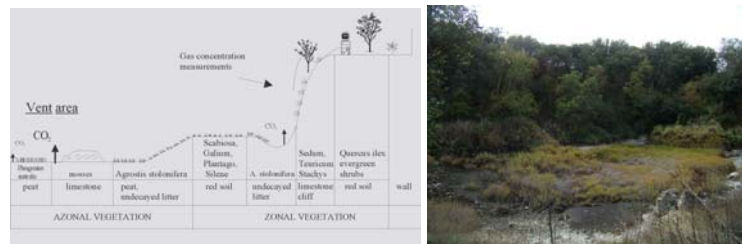
Materials:

- 1 candle and lighter
- Pen & blocknotes, camera
- 1 Gas Analyzer
- 1 or more balloons
- Plastic bags, seeds

Procedure:

- Observation of the area, effect of high concentration of CO₂ on plants spatial arrangement:

Phragmites australis is the only one species with some mosses and algae and fungi growing at the bottom of the doline. A ring of *Agrostis stolonifera* characterizes the middle part of the hedge while the highest part is covered by Mediterranean species.



- Effects of CO₂ on plant physiology and leaf characteristics: several studies have been conducted there and results shown that high rates of CO₂ stimulate the plant growing only in the first period (days) of growing. Furthermore, adapted trees show a reduction on water fluxes due to the low stomatal conductance and density and then they are characterized by smaller leaves than those growing without CO₂ enrichment.
- Effects on plant growing: comparison between barley seeds grown in CO₂ enriched air and at school, far from the CO₂ springs.



- Effects of CO₂ on animals: dead animals demonstrate the effect of high concentration of CO₂. The high concentration of the gas in atmosphere (1%) is toxic and it will make some people feel drowsy. Higher concentrations of 7% to 10% cause dizziness, headache, visual and hearing dysfunction, and unconsciousness within a few minutes to an hour.



1) Experiments on CO₂ and greenhouse effect:

- 1) Light a candle and bring it near the spring of CO₂: the candle will switch off due to the high concentration (>0.3% ppm) that inhibits the combustion.
- 2) The Gas analyzer and a digital thermometer give instantaneous values of CO₂ in ppm and of the air temperature. A vertical transect from the bottom of the crater to the top can be done to test the gradient of concentration and the relative temperatures.

- 3) A big cave is the main source of CO₂. The concentration is very high so it's forbidden to enter in and to stay long time in its proximity. But, simple experiments are didactically nice and efficient:
inflate the balloon and approach carefully to the cave. Push the balloon inside and it will start floating at a certain height from the ground. The balloon is pushed by an upward force (the air density –composed prevalently by CO₂ that is also an heavy gas- is higher than the air inside the balloon) and it floats on the air.

Diagram or Picture of Experimental Set-up (if available):



Presentation of Results:

The concentration of the gas varies around 500-600 ppm at the top of the crater while, going down to the bottom it raises at 800-1000 ppm. The springs of CO₂ in correspondence of rising water from the underground.

What about the temperature? the site's topography and the presence of CO₂ produce a difference of about 2 °C (measured in a windy day) between the lowest and the highest part of the doline.

Discussion of results:

Why was the balloon floating on the air, at which height from the soil?

Which should be the effects of an increasing of atmospheric CO₂ on non adapted plants?

Which are the characteristics of the flora and fauna living at the bottom of the doline?

A second part of the experiments description may be added as a guide or an aid to other teachers who would want to do the experiments in their schools. This can include the following:

1. Suggested further experiments:

- 1) Observation and identification of the micro-biomass of the soil by microscope.
- 2) Leaves observation: taking a sample of branches, leaves and fruits from adult trees adapted to the site and comparing their size and visible characteristics with trees of the same species grown far from the CO₂ springs.

2. Suggested readings (literature or links):

Guerra M., Raschi A. (2004) Field sight near Rapolano Terme (Siena, Tuscany) relationship between tectonics and fluid circulation. Vol.3 Post 32nd International Geological Congress.

Etiopie G., Guerra M., Raschi A. (2005). Carbon dioxide and radon geohazards over a gas-bearing fault in the Siena Graben (Central Italy). *Terrestrial Atmospheric and Oceanic Sciences* 16: 885-896.

Raschi A., Vaccari F.P., Miglietta F. (Eds) (1999). Ecosystem response to CO₂: the MAPLE project results. Office for Official Publications of the European Communities, Luxembourg, pp. 205.

Larcher W. (1993). *Ökologie der Pflanzen*. ©E. Ulmer Verlag – Stuttgart.

<http://en.wikipedia.org/wiki/>

3. Some tips or notes on things what one should pay attention to when preparing the experiment:

Visits are forbidden in the early morning.

Windy or rainy days should be avoided because of the minor visibility of the greenhouse effect due to the air turbulence and water dissolution.

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