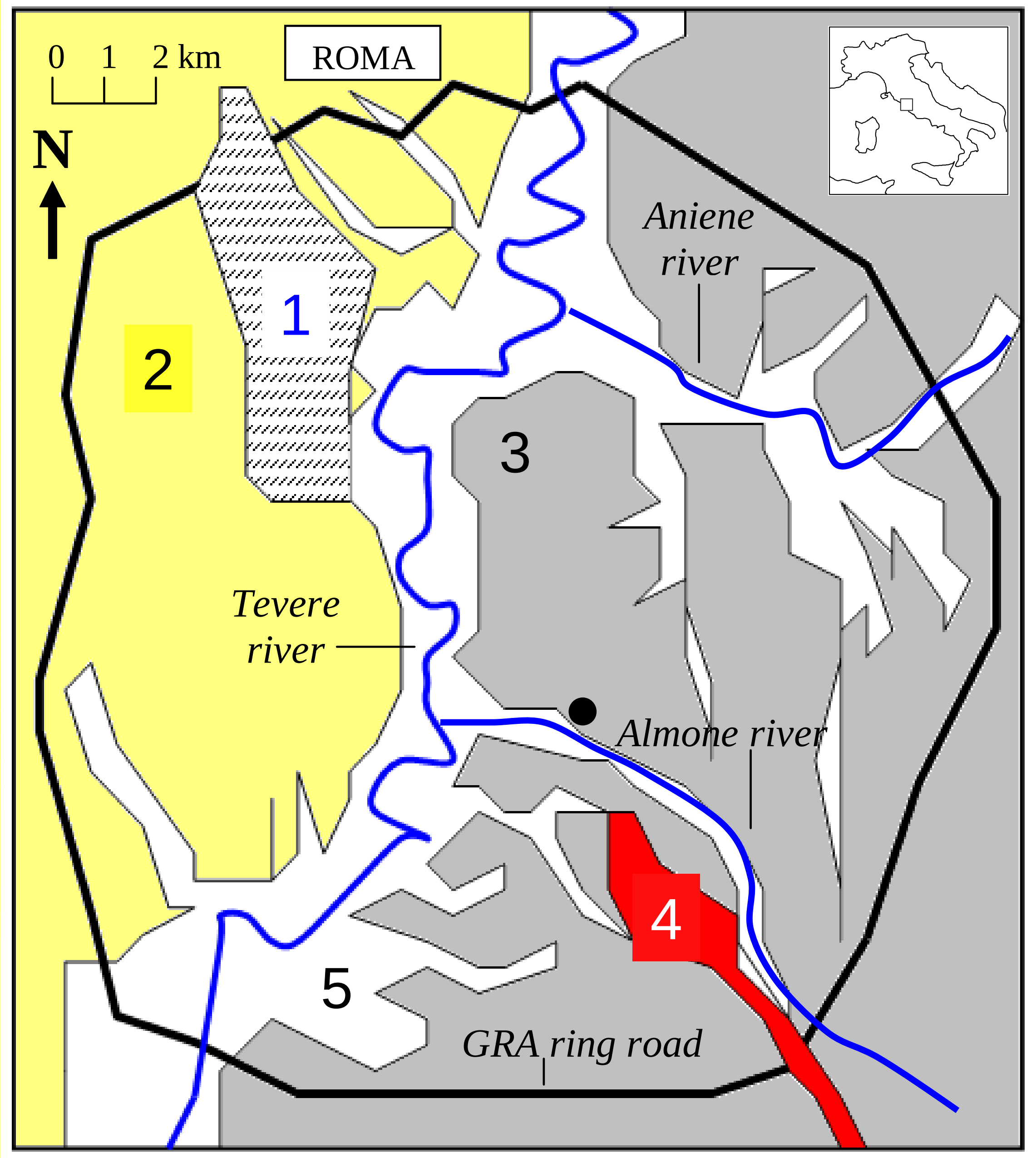
Soil Gas Radon Concentration and Permeability at “Valle della Caffarella” Test Site (Roma, Italy).

Evaluation of Gas Sampling Techniques and Radon Measurements Using Different Approaches

Italian team
Mauro Castelluccio, Massimo Moroni, Paola Tuccimei

Czech team
Matej Neznal, Martin Neznal

10th INTERNATIONAL WORKSHOP on the GEOLOGICAL ASPECTS OF RADON RISK MAPPING
September 22nd – 25th, 2010 - Prague, Czech Republic



Roma (Italy)

Simplified geological map

1 Plio-Pleistocene marine to transitional deposits

2 Sabatini district volcanites

3 Colli Albani district ignimbrites

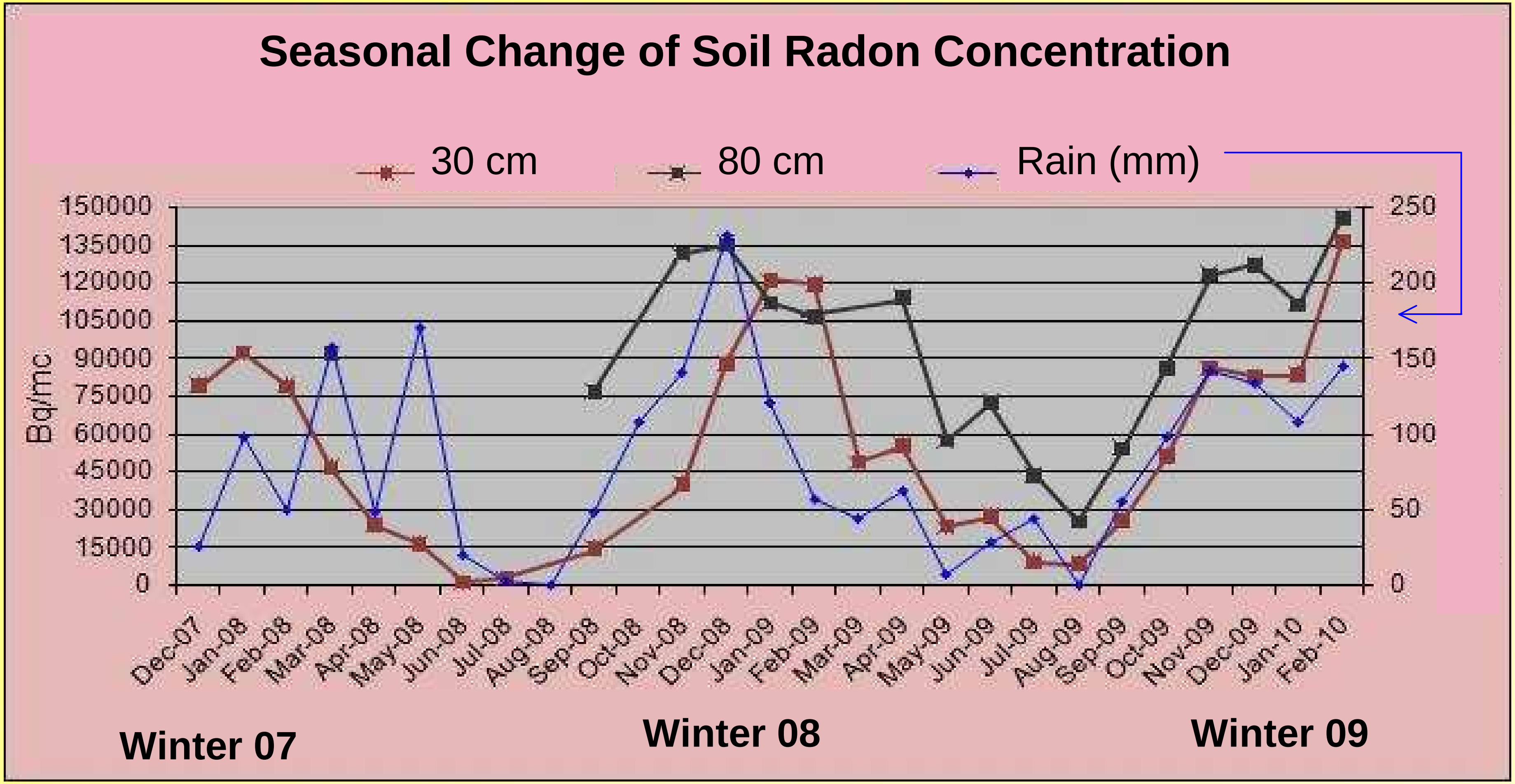
4 Colli Albani district lavas

5 Alluvial sediments of Tevere River and its tributaries

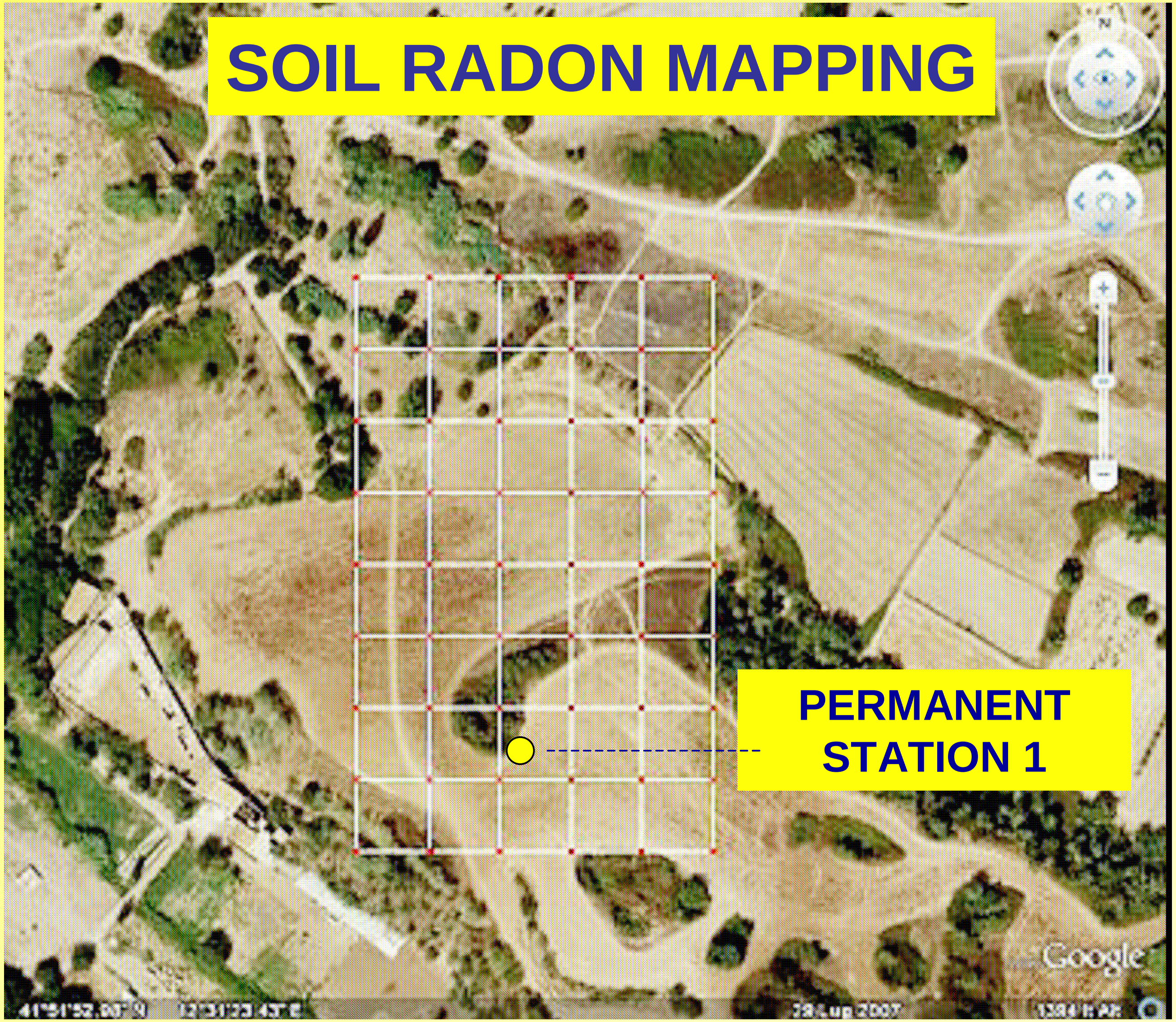
● Valle della Caffarella Test Site

PREVIOUS WORK AT VALLE DELLA CAFFARELLA TEST SITE (1)

Monitoring at Permanent Station 1, on Colli Albani ignimbrites



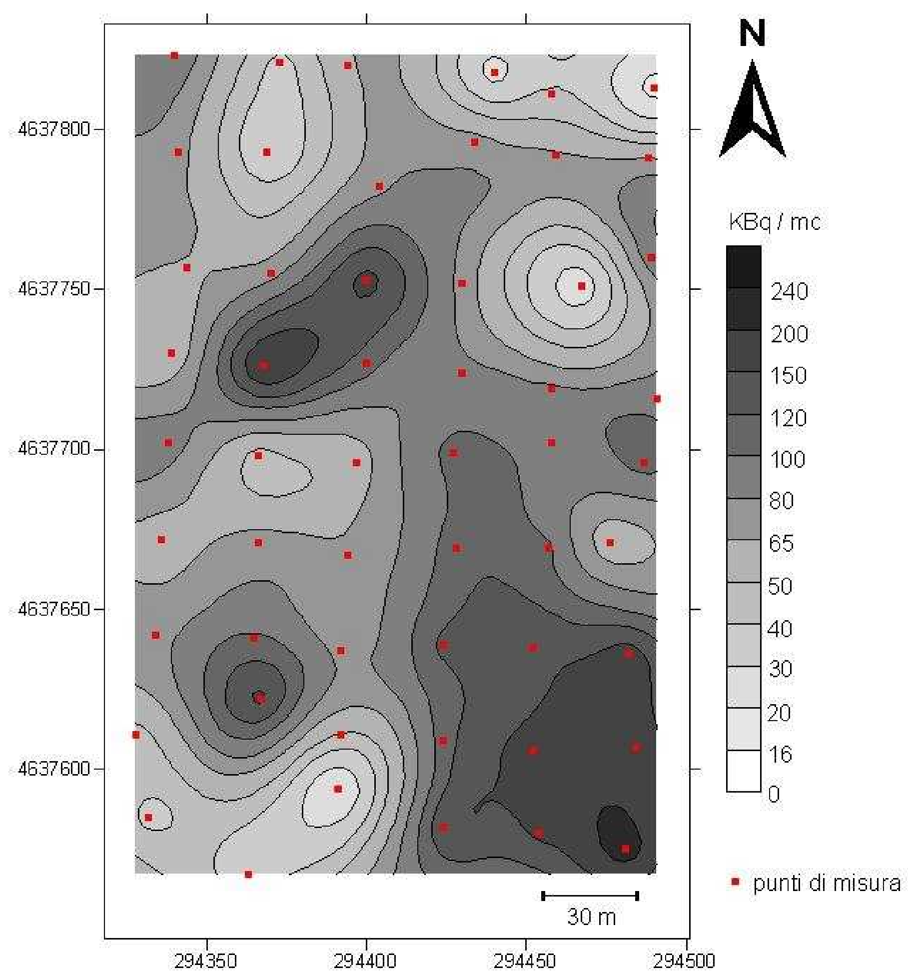
PREVIOUS WORK AT VALLE DELLA CAFFARELLA TEST SITE (2)



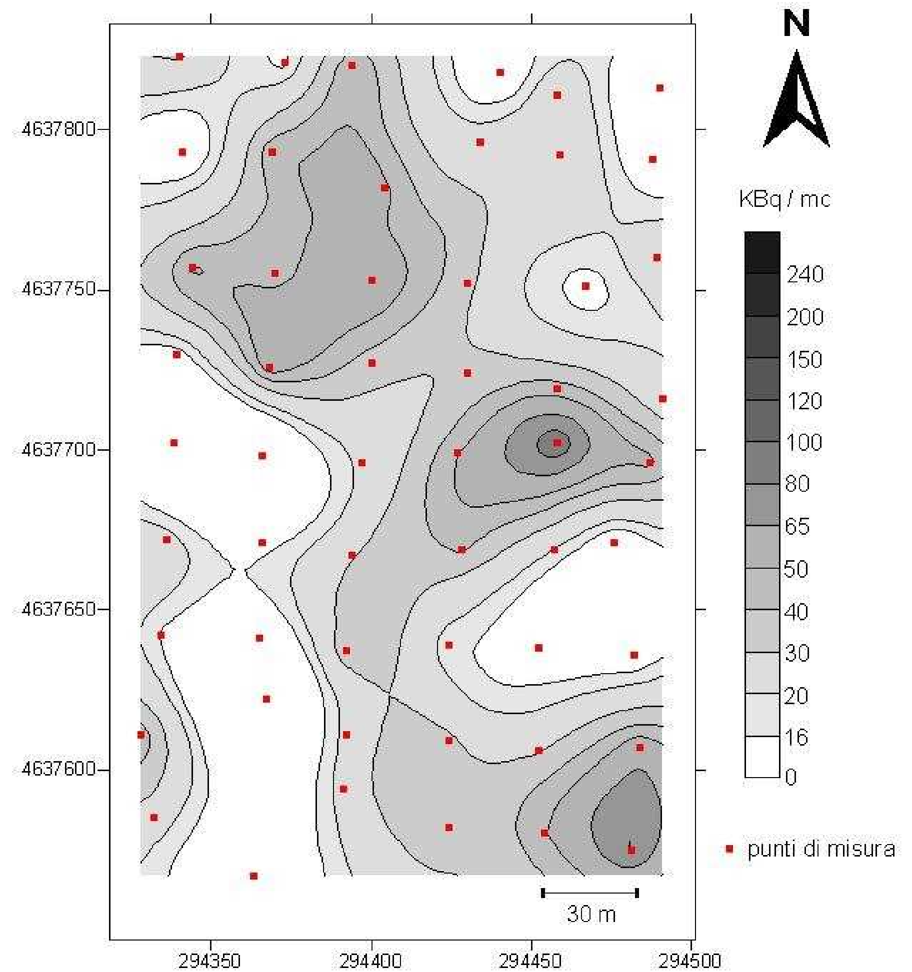
PREVIOUS WORK AT VALLE DELLA CAFFARELLA TEST SITE (3)

SOIL RADON MAPPING – 80 cm depth

Soil Radon – Winter

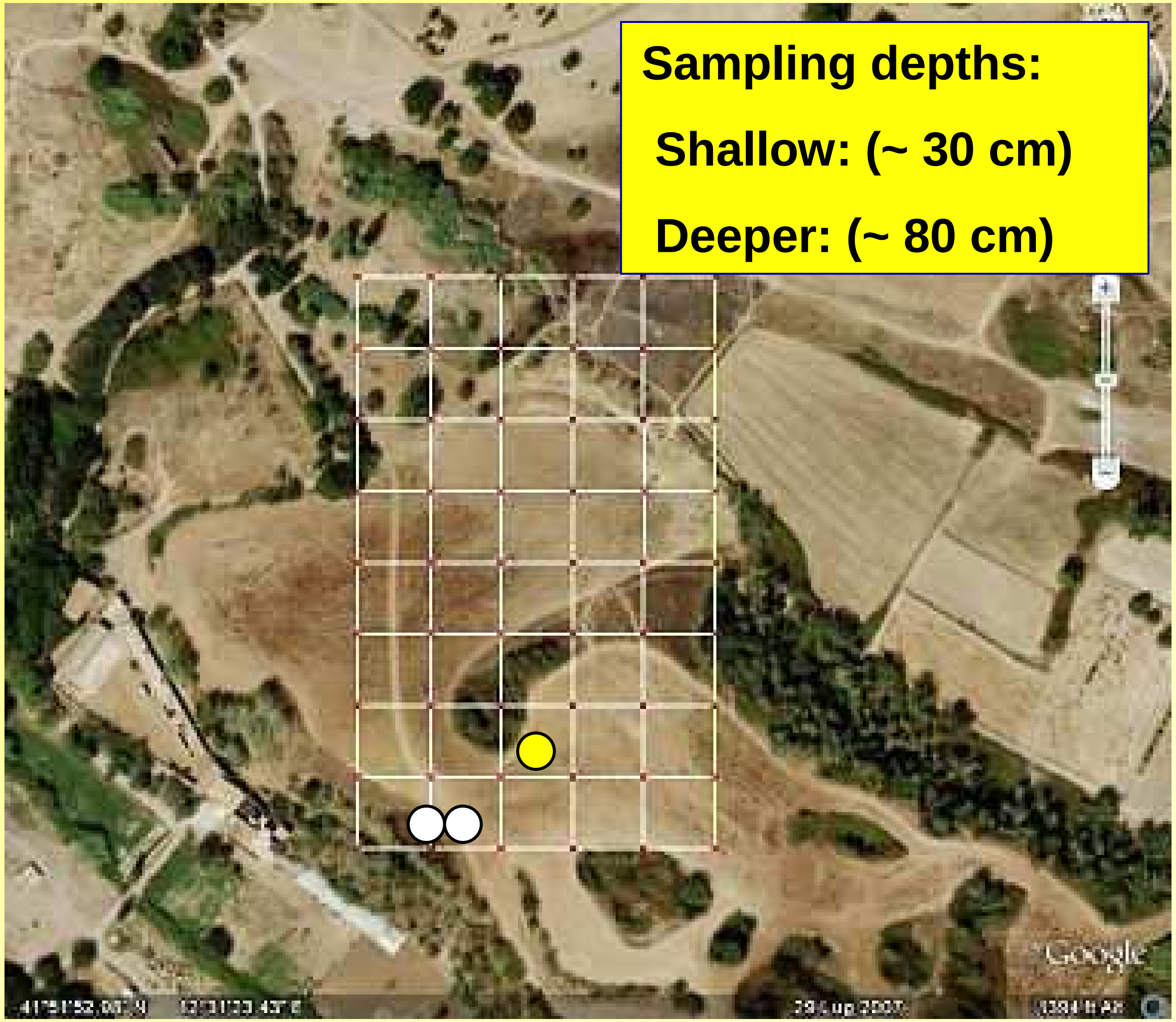


Soil Radon - Summer



THIS WORK

Sampling stations
December 2009 and June 2010



Italian Team → Durrridge approach
Durridge Probe and alpha counting (RAD 7)

Italian Team → Durrridge approach
Durridge Probe with fixed point

- ID 7 mm
- OD 11 mm
- Point maximum diameter 13 mm

Main concern: leakage of fresh air down to the sampling point

Special care to tamp down the soil around the probe

Check Team → Radon v.o.s. approach
Radon v.o.s. Probe and Lucas cell + Ionization Chamber

www.radon-vos.cz

- ID 8 mm
- OD 12 mm
- Point maximum diameter 12 mm

www.radon-vos.cz

SOIL GAS PERMEABILITY MEASUREMENTS

www.radon-vos.cz

SOIL GAS PERMEABILITY USING THE RADON-JOK PERMEAMETER

The principle consists of air withdrawal by means of negative pressure driven by a rubber sack, with one or two weights.

Air is pumped out from the soil under constant pressure through the probe with a constant surface of contact between the probe head and the soil.

The gas permeability (k in m^2) is calculated using the known air flow through the probe.

$$k = {(V * \mu)} \Big/ {(F * \Delta p * t)}$$

(Neznal & Neznal, 2005)

V: **air volume in the rubber suck**
µ: **air dynamic viscosity at 10°C**
F: **Shape factor of the probe**
Δp: **pressure difference between the surface and the sampling depth**
t: **opening time of the cell**

- Winter campaign

- Total of 60 soil radon measurements including replicates for Lucas Cells and Ionization Chambers

- Soil Radon and <u>Thoron</u> measurements using RAD7

- 21 soil gas permeability determinations

Results of the Winter campaign

Deeper depth (~ 80 cm): 100 – 200 kBq / m^3

→ The three methods (alpha counting, Lucas Cell and Ionization Chamber) gave comparable results → Durridge approach up to 15 % lower

→Low permeability → averagely in the range of 10^{-13} - 10^{-14} m^2

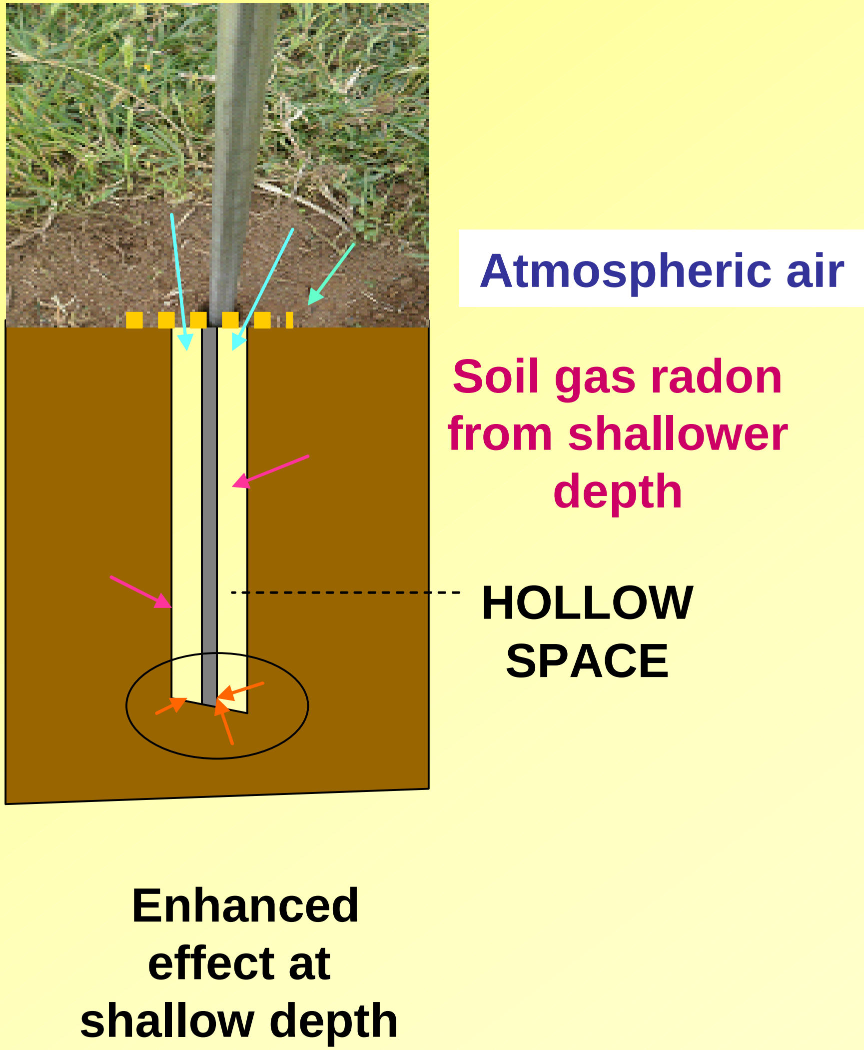
Shallow depth (~ 30 cm): 30 – 180 kBq / m^3

→ Durridge approach gave results 60 % sistematically lower than Radon v.o.s.

→ Higher permeability → $2.5 \cdot 10^{-12}$ m^2

Discussion

Durridge approach gave lower soil radon concentrations because of leakage of fresh air down to the sampling point



Summer campaign

- Replication of winter measurements
- Increased care to seal the probe hole
- Testing a mixed approach at station C:

Radon v.o.s. probe + RAD7 continuous monitor

Results of the Summer campaign

❖ Lower values of soil radon and higher permeability compared to winter

Deeper depth (80 cm): 40 – 160 kBq / m^3

→ The three methods (alpha counting, Lucas Cell and Ionization Chamber) gave comparable results → Durridge approach just 5 % lower

Shallow depth (30 cm): 20 – 50 kBq / m^3

→ Reduced differences between the two approaches

→ The mixed approach gave comparable results with Radon v.o.s. approach

Conclusions

•Gas sampling techniques affect soil radon concentration results more than analytical methods

• Fresh air leakage down the sampling hole is is due to the combined effect of the probe tip relative size and the poor sealing of the sampling hole.

• Summer soil radon concentration are lower because of enhanced radon release to the atmosphere when soil is drier, warmer and more permeable.

•Soil gas permeability is a crucial parameter to interpret spatial soil radon variability and seasonal changes