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INSTITUT  
DE RADIOPROTECTION  
ET DE SÛRETÉ NUCLÉAIRE

**GEODERIS**

# Impact of underground cavities on soil-building radon transfer

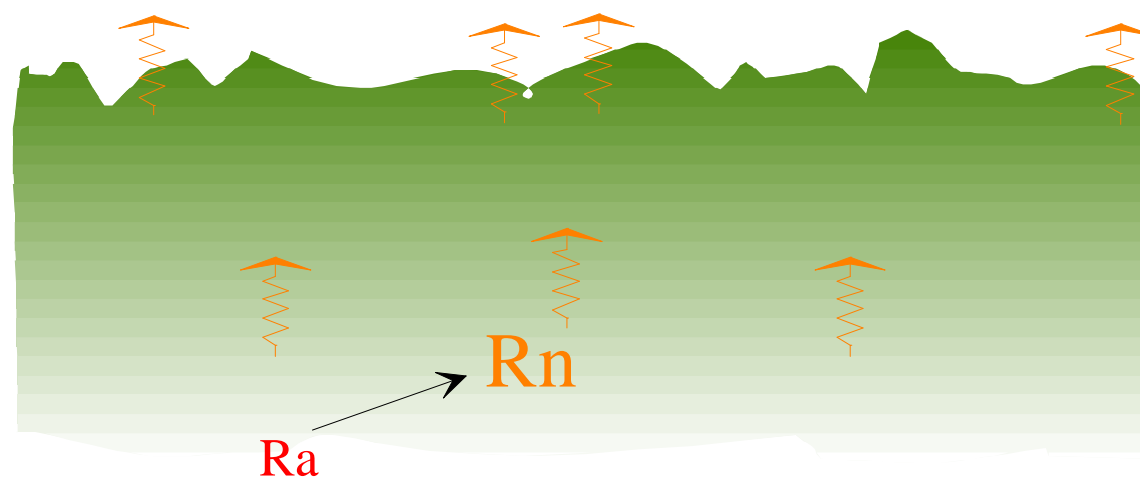
R. Améon, O. Diez, T. Doursout, M. Kimmel, R. Hadadou

10<sup>th</sup> International Workshop on the Geological Aspects of Radon Risk

Prague - 22<sup>nd</sup>-25<sup>th</sup> September 2010

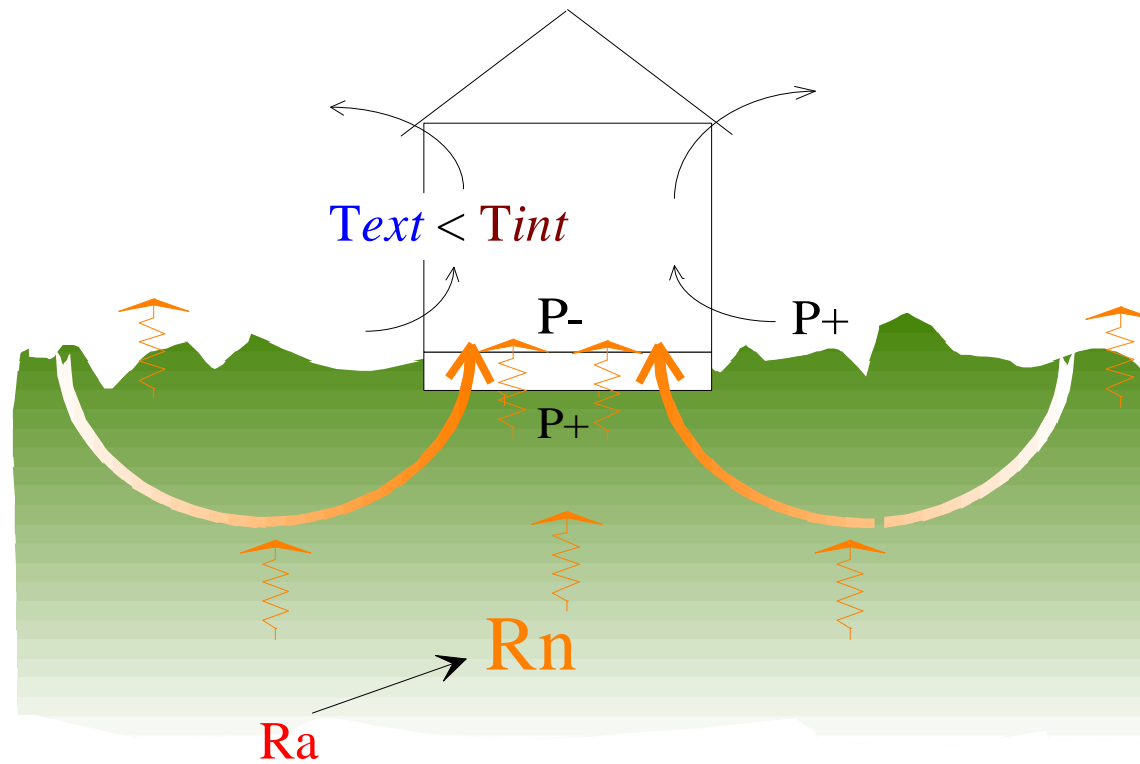
# Context

Radon transfer in bare soil is vertical and diffusive



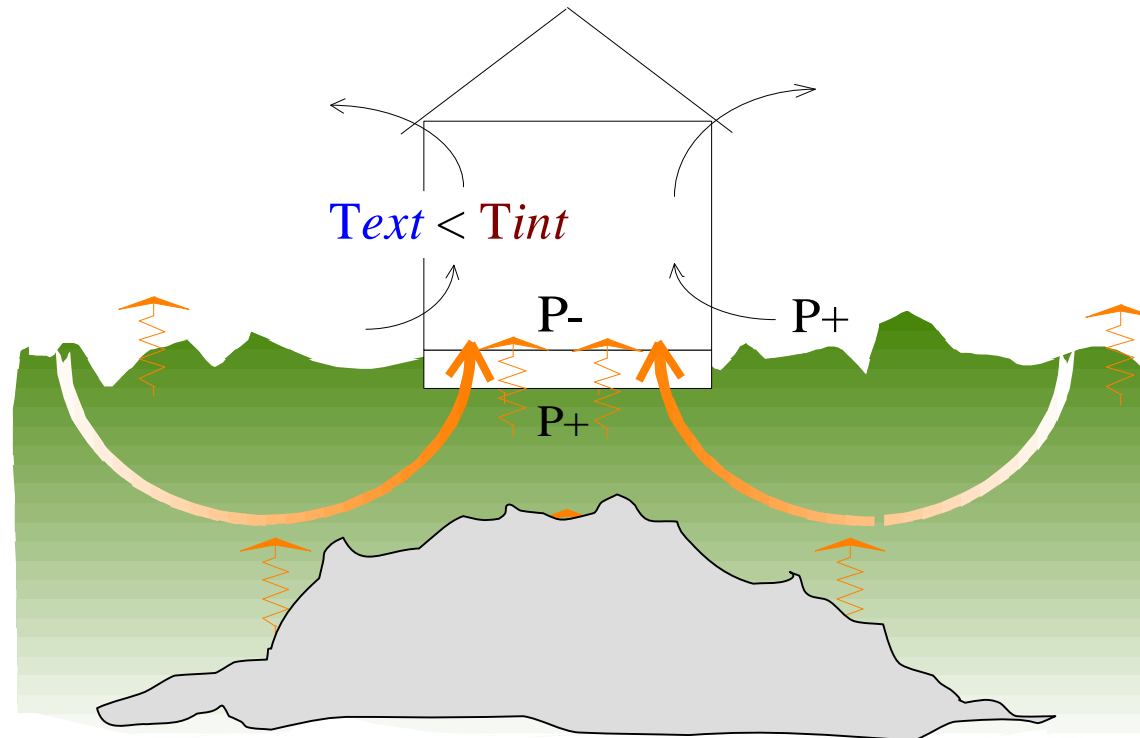
# Context

Radon transfer in soil with a building is non vertical and advective



# Context

Radon transfer in soil with a building and cavities is



Cavities act as

a reservoir in which Rn accumulates

a dilution reservoir compared to the soil

# Context

- ✓ The influence of the cavities is a topic of special interest in :
  - managing risks related to post-mining
  - determining Radon Hazard Maps at the « mining area » scale
  - mapping the geogenic Rn potential to determine Rn prone area
- ✓ In France, Ministry responsible for mines developed a **Mining Risk Prevention Plan** with the objective of drawing **Radon Hazard Maps**
- ✓ In Uranium mining region, Radon Hazard Maps coincide with Radon prone area without need of validation
- ✓ In Iron or Coal mining region, **Radon Hazard Maps must be validated**
- ✓ Validation was performed on the basis of Rn **measurements in soil**



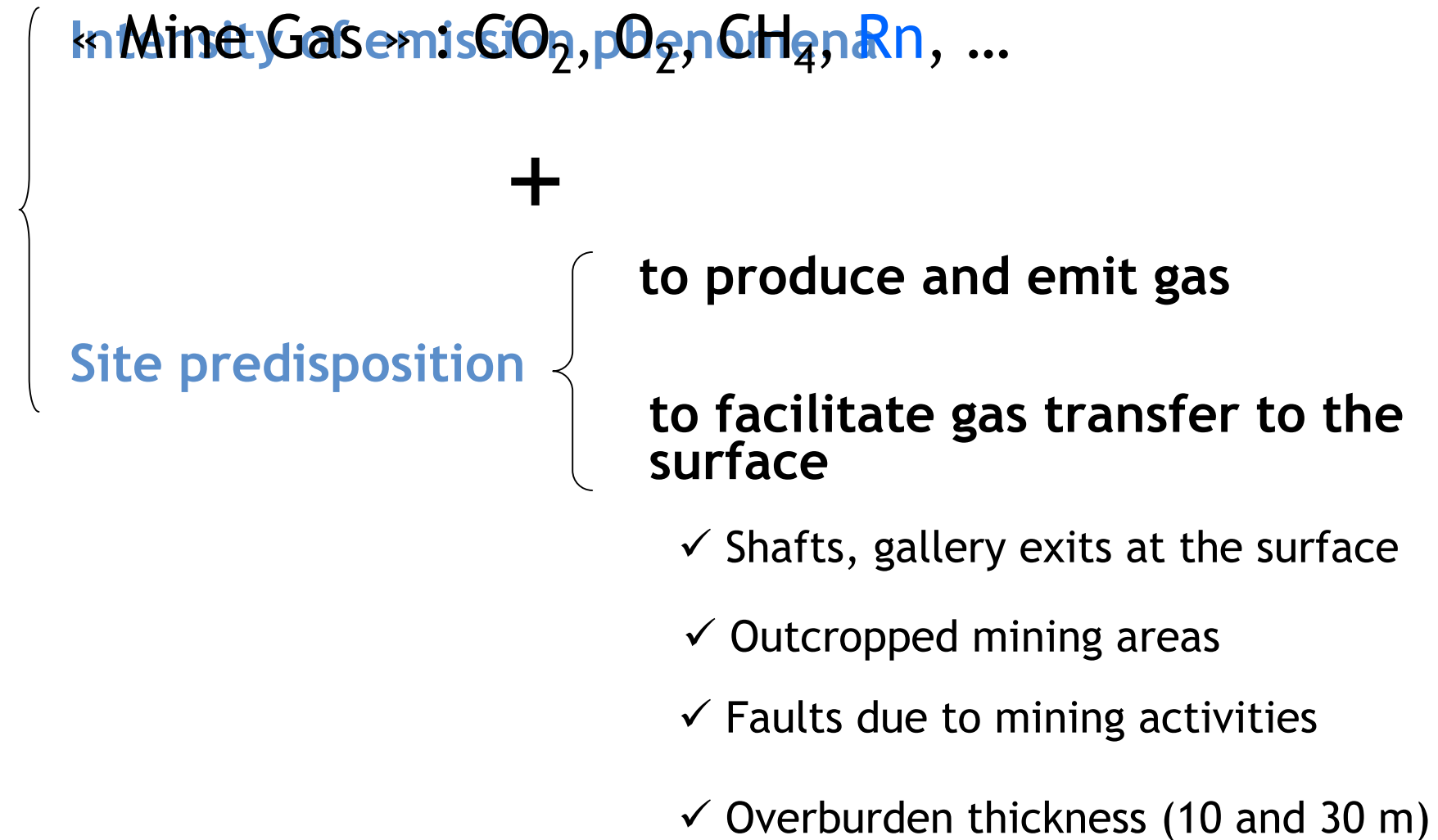
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# Methodology for determining Radon Hazard Maps according to the French Mining Risk Prevention Plan

# Qualification of « Mine Gas Emission » Hazard



# Qualification of « Mine Gas Emission » Hazard

Criteria Intensity of emission  
« very low to very high »

+

= Hazard « zero to high »

Criteria site predisposition  
« very low to very high »





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# Methodology for validating Radon Hazard Maps

## Methodology used

For a given soil texture → Level of permeability → Type of Rn transfer in the soil

Soils with the same texture, at and outside the mining area, shall present similar temporal variation of Rn the activity concentration

yes



No influence of mining works

no



Influence of mining works

## Methodology used

- ✓ Continuous measurement of the Rn activity concentration in the soil (1 m depth) at and outside the mining area (duration > 2 months)
- ✓ Characterization of the soil texture (granulometric analysis)
- ✓ Characterization of Radium content of soil samples
- ✓ Measurement of meteorological parameters

# Measurement of Rn activity concentration in soil

## French Standard NF M60-767 (ISO 11665-5)

BARASOL Sensor  
(Algade)

Sampling is  
purely diffusive  
(no disturbance  
of the soil)



The sensor is placed at 1m depth  
in a PVC tube inserted in the soil



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Application to a French iron mining basin



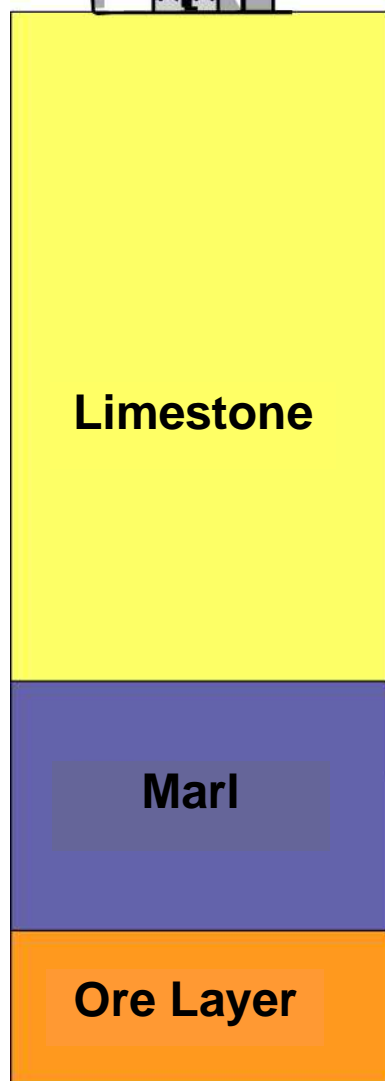
✓ 11 measuring points at and outside the mining area to cover the 3 levels of possible hazards defined in this basin (none, low, average)

✓ All measuring points :

are away from building influence

have the same Radium content

are under the same meteorological conditions



**Limestone**

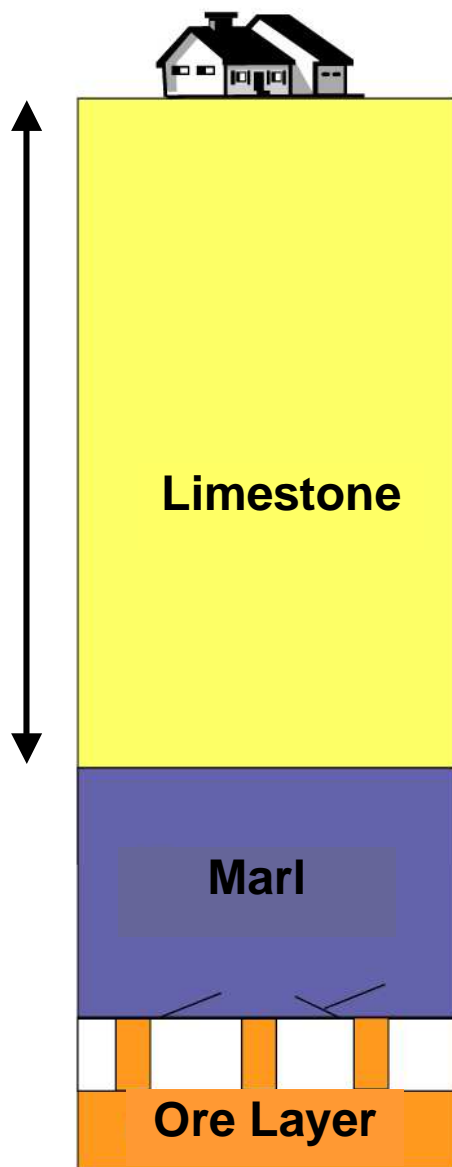
**Marl**

**Ore Layer**

**Unmined area**

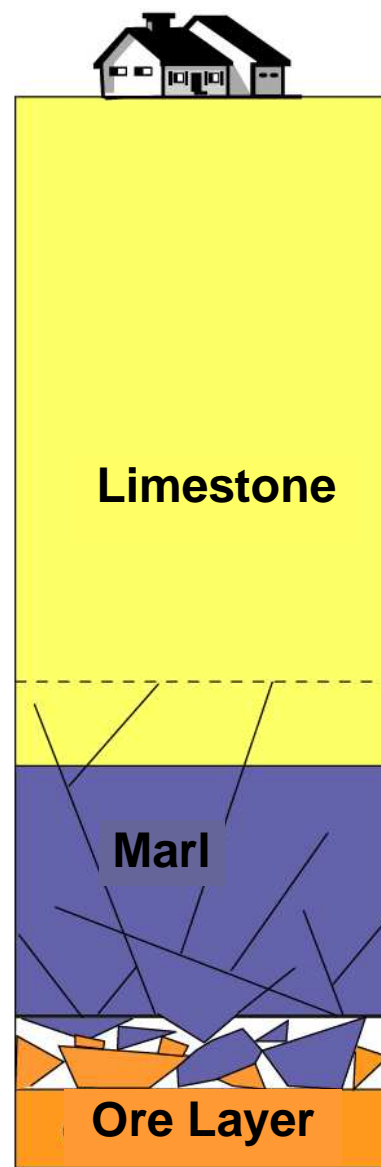
**Local Background Level**

Hazard Level  
depending on  
overburden  
thickness



Mined area with rooms  
and pillars

Hazard Level  
depending on  
overburden  
thickness



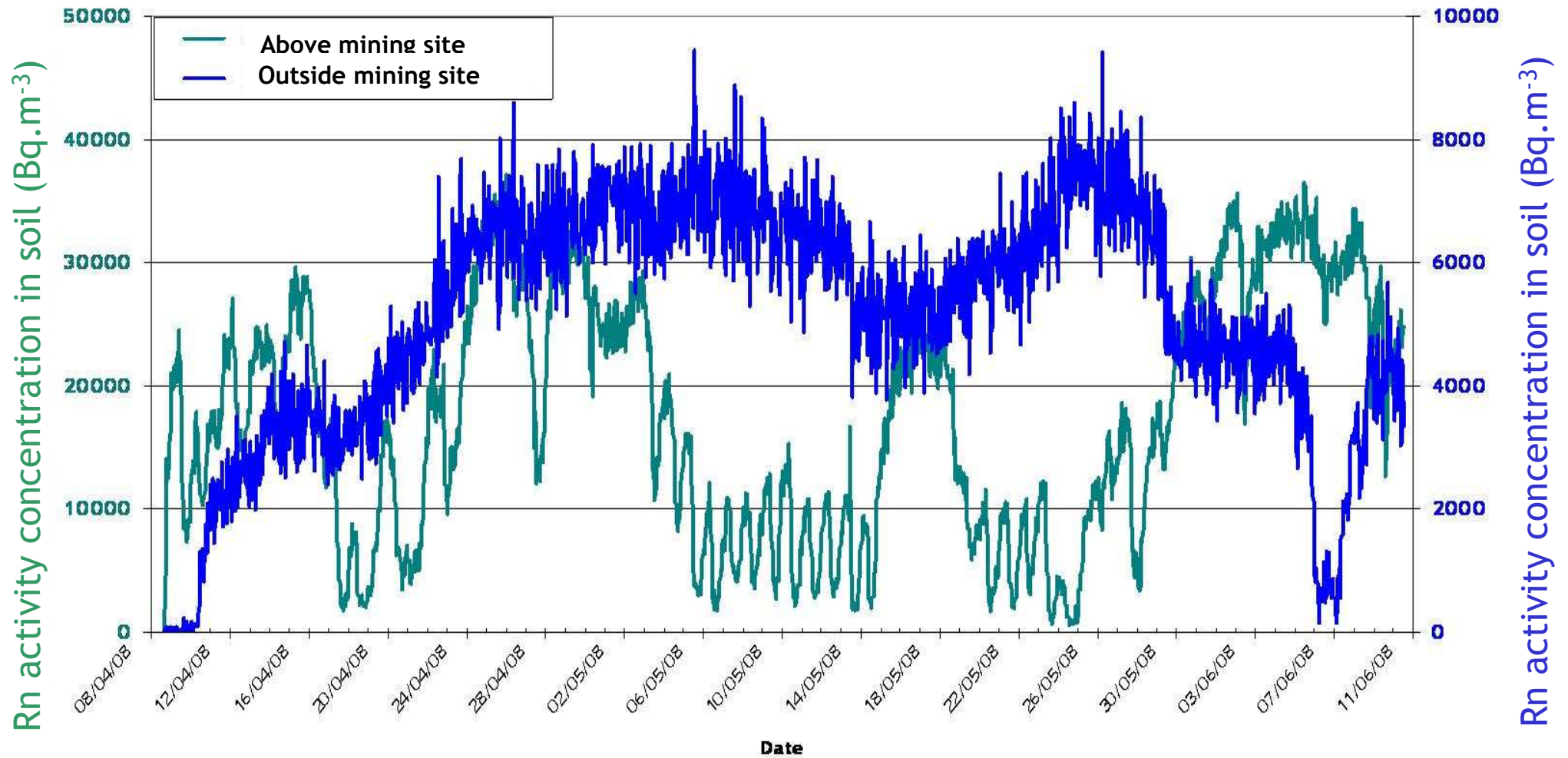
Mined area with  
removed pillars



# Example of results

Same Soil texture

Same Radium content



## Conclusions and perspectives

- ✓ Disparities in types of transfer of radon in the soil above Iron mining areas compared with that outside the mining area
- ✓ Disparities may be attributed to changes in sub-soil permeability caused by disturbances in burden due to mining works
- ✓ Influence of these mining cavities on the Rn transfer in the soil is demonstrated even for cavities located at depths greater than 30 metres
- ✓ In order to get data on the ultimate impact of mining cavities on radon levels in buildings built above mines, a theoretical study based on Rn transfer modelisation is conducted