GEOMETRY OF SOIL GAS SAMPLING, SOIL PERMEABILITY AND RADON ACTIVITY CONCENTRATION

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Introduction

Measurement of radon activity concentration in soil gas, carried out in the Czech Republic in the period 1991 - 1999, indicates the relationship of determined radon (^{222}Rn) activity concentration in soil gas with the depth of sampling, soil permeability, dimensions of free space for soil gas sampling and the soil sampling technique. Low permeable soils, preventing often the soil gas sampling in standard probe geometry, require the enlargement of the sampling space in the soil. Relationship between radon activity concentration in the soil gas and non-standard sampling geometry was studied.

Field experiments

In the Czech Republic, standard soil gas sampling for radon risk mapping and for detailed radon risk classification of foundation soils is performed by means of hollow iron rods from the depth 0.8 m (Barnet 1994). If soils exhibit low permeability, the sampling space at the end of the probe rod can be enlarged by pulling the rod upwards. Investigation of this intervention on determined radon activity concentration was carried out at two selected areas in 1999.

Site Jirny, 15 km east from Prague, with the bedrock formed by claystones, siltstones and sandstones of Cretaceous age, covered with deluvium silt sandstone soils, clay sandy soils and clay loams, exhibits low to medium permeability, determined by grain size analyses and direct in-situ measurements.

Site Louňovice, 15 km southeast from Prague, is formed by medium grained biotite granodiorite of the Central Bohemian pluton, weathered into sandy and loam sandy eluvium. Soil grain size analyses and direct in-situ measurements showed medium to high permeability of soils.

Relationship of radon activity concentration in soil gas with sampling depth and sampling space was studied by measurement in nine points at each site, using two diameter different types of hollow iron rods and two different types of radon detecting instruments:

⇒ a field portable radon detector Scintrex RDA-200, with Lucas cell 170 cm^3, the sampling space is created by the extrusion of a free tip at the end of the rod, samples are collected by a hand pump of a volume cca 1000 cm^3, reported as sampling technique of small sampling space (= cylindrical surface of about 6,8 cm^2 with the diameter 0,8 cm and the height 2,5 cm)

⇒ radon detector LUK with Lucas cells 125 cm^3, the sampling space is created by the extrusion of a free sharp tip at the end of the rod, samples are collected by using a hypodermic syringe of a volume cca 150 cm^3, reported as sampling technique of larger sampling space (= cylindrical surface of about 20,0 cm^2 with the diameter 1,2 cm and the height 5,0 cm).

Soil gas samples were taken from the depths 0.4 m, 0.6 m, 0.8 m in standard sampling geometry, and by pulling the rod, from depth intervals 0.75-0.8 m, 0.7-0.8 m and 0.6-0.8 m. Tables 1 and 2 introduce resulting radon activity concentration.

Table 1 Mean radon activity concentration (N = 9) at the site Jirny determined at variable soil gas sampling depth and geometry.

Depth of sampling (cm)	40	60	80	75-80	70-80	60-80
	radon activity concentration (kBq/m^3)					
small sampling space	37.4	48.2	42.7	43.2	50.9	48.3
stand. deviation	7.9	13.0	13.9	19.0	12.4	17.5
larger sampling space	32.3	41.2	46.2	42.4	40.6	38.7
stand. deviation	4.9	6.8	10.7	8.5	8.9	6.3

Table 2 Mean radon activity concentration (N = 9) at the site Louňovice determined at variable soil gas sampling depth and geometry.

Depth of sampling (cm)	40	60	80	75-80	70-80	60-80
	radon activity concentration (kBq/m^3)					
small sampling space	87.8	109.9	137.4	139.2	121.1	99.2
stand. deviation	25.9	26.5	22.8	23.5	32.8	49.7
larger sampling space	72.6	104.7	121.1	122.9	115.7	100.4
stand. deviation	10.0	26.9	37.1	24.9	30.3	26.6

Conclusions

Radon activity concentration increases with depth of sampling: at Jirny site, of low to medium soil permeability, the increase is mild, at Louňovice site, of medium to high soil permeability, the increase is expressive. This is in agreement with the theory on the change of radon activity concentration with depth in rock environment of low and higher coefficient of diffusion and the respective escape of soil radon to the atmosphere.

Difficulty of soil gas sampling was more frequently observed at low permeable soils using the small sampling space technique.

Limited increase of soil sampling space, by pulling the rod upward (depth 75-80 cm), did not affect the observed radon activity concentration, while further extension of sampling space (70-80 cm, 60-80 cm) towards the earth surface may involve the measurement of radon diluted soil gas from low depths below the surface. This effect is more pronounced for both small and larger sampling space at high permeable soil (site Louňovice).

Realized study indicates the necessity to apply the soil gas sampling from free soil sampling space of sufficient dimensions, and a limited possibility to enlarge the sampling space by pulling the sampling rod towards the earth surface, in both low and particularly high permeable soils. Observed changes in radon activity concentration caused by studied effects may exceed the errors of radon measurements.

References

Barnet I. (1994) Radon Risk Classification for Building Purposes in the Czech Republic. In: Barnet I. and Neznal M., eds. Radon Investigations in CR. Vol. 5., Geological Survey Praha, p.18 - 24.