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Indoor – soil gas radon relationship in the Central Bohemian Plutonic Complex

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Abstract. The relationship of indoor radon measurements and radon in bedrock was studied in the geologically complicated granitoid Central Bohemian Plutonic Complex (CBPC). The indoor data were linked to vectorised geological and radon risk maps using the coordinates of particular dwellings. For each geological unit and rock type it was possible to calculate the statistical characteristics of indoor radon measurements. A clear relationship between indoor radon values and radon in bedrock was confirmed in all 7 districts situated on CBPC, where the study was performed.

1 Introduction

In the Czech Republic the indoor radon measurements are performed by the National Radiation Protection Institute (NRPI) since 1990. Up to now more than 130 000 track – etch detectors (Kodak LR 115) were distributed within the whole country. The indoor measurements (together 16 145) were selected from 7 former districts Praha – east (444), Benešov (2985), Príbram (6341), Písek (2164), Strakonice (1779), Plzen – south (1596) and Klatovy (836) covering the areal extent of CBPC.

The soil gas Rn database of the Czech Geological Survey comprises the soil gas radon data from more than 8900 test sites (15 measurement each). Since 1998 the Czech Geological Survey has vectorised all 214 map sheets of geological maps on a scale 1:50 000 (Mikšová and Barnet, 2002).

In 2002 the Czech Statistical Office has finished the digitalization of centroids of all buildings in the Czech Republic.

2 Geological setting

The CBPC forms the elongated body of 3200 km^2 spreading between Klatovy (SW) and Rícany near Prague (NE). According to the subdivision of Variscan orogenetic belt in the Bohemian Massif (Matte et al., 1990) the CBPC is emplaced between two terranes – the weakly metamorphosed Barrandian on the NW (or Teplá – Barrandian unit in the sense of other authors – e.g. Vrána and Stedra (1997), Scheuvens (1999), Scheuvens and Zulauf (2000), Dörr et al. (2002), Zulauf et al. (2002) and medium to high grade metamorphosed Moldanubian assemblage of Precambrian and Proterozoic rocks on the SE. The tectonothermal history of both mentioned major units was different since the Proterozoic. The CBPC was emplaced along the Central Bohemian Shear Zone during late Devonian – early Carboniferous.

The indoor data from 7 former districts extent by its position the range of CBPCs granitoids. On the SE, S and SW of CBPC the bedrock is formed by medium to high grade metamorphosed Moldanubian paragneisses, migmatites and orthogneisses. The border with NW Tepla – Barrandian unit comprises the unmetamorphosed folded Palaeozoic sediments (Cambrian to Devonian shales, limestones and quartzites) and Lower Proterozoic slightly metamorphosed shales locally with silicites.

3 Method of GIS analysis

The database of centroids of dwellings was linked to database of indoor radon measurements in FoxPro 3.0 programme. The resulting database from the area covering the territory of former 7 districts comprised 16 145 dwellings with defined indoor radon mean and maximum value (EEC) and x, y coordinates (Barnet et al., 2002). In the second phase this database was put into GIS based on MGE 7.1, Oracle and Microstation 95 programmes and transformed into ArcView 3.2. programme. The areal analysis performed using MGE Analyst and Mapfinisher programmes enbled to link the geological unit and rock type from the uniform legend for each dwelling. Consequently each dwelling was characterised by indoor radon data (EEC) and corresponding mean soil gas radon concentration in the underlying rock type and category of radon risk from bedrock. The database of NRPI doesn't contain data on the technical characteristics of the dwellings

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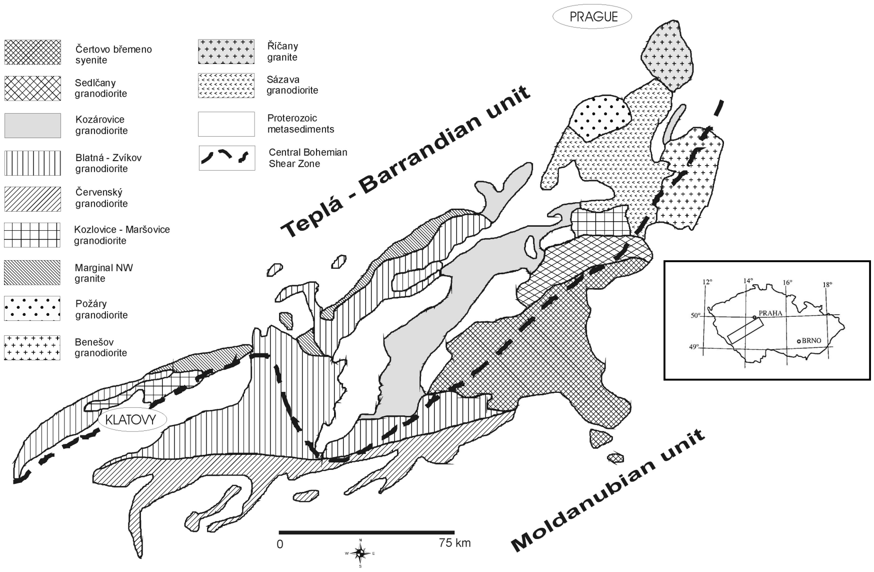

Fig. 1. The major granitoid types in CBPC and the probable position of the Central Bohemian Shear Zone (modified after Chlupác et al., 2002, Zulauf et al., 2002).

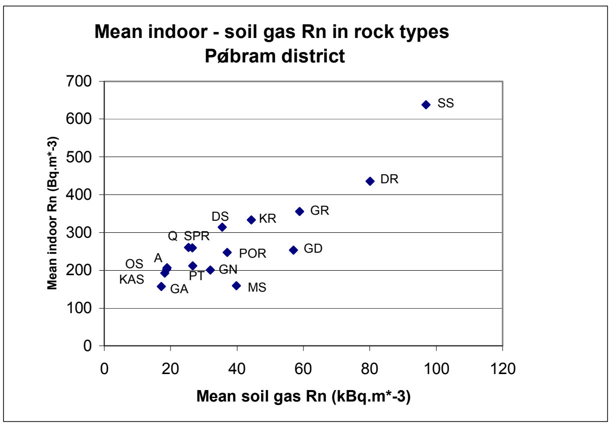

Fig. 2. explanation of rock types: SS – Silurian sediments, DR – durbachites (syenites), GR – granites, GD – granodiorites, KR – Moldanubian paragneisses, POR – Palaeozoic volcanites, MS – quartzites, erlanes, GN – Moldanubian orthogneisses, DS – Devonian sediments, PT – Proterozoic metasediments, SPR – loess, A – amphibolites, Q – Quaternary, GA – gabbros, OS – Ordovician sediments, KAS – Cambrian sediments. (6341 indoor Rn data).

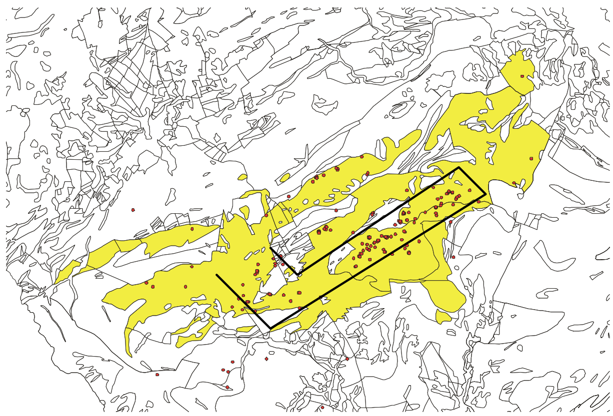

Fig. 3. The position of dwellings exceeding 1000 Bq.m^{-3} within the CBPC. The reader should compare the framed segment with the course of Central Bohemian Shear Zone in Fig. 1.

(namely the quality of sealing) but sufficient number of indoor radon measurements enables to neglect this load.

4 Results

Within each district the mean indoor radon concentration in dwellings situated on the particular rock type was plotted against mean soil gas radon concentration. Following Fig. 2 illustrates the indoor – soil gas radon relationship in one of 7 districts. Mean indoor values are given in EEC.

Figure 3 illustrates the position of dwellings from 7 districts with indoor radon levels exceeding 1000 Bq.m^{-3} equilibrium equivalent concentration. Most of the houses is situated on the NW border of durbachites of Čertovo břemeno and Sedlčany granodiorite but doesn't follow the contact of both rock bodies with other types of granitoids of CBPC. The position of high indoor radon dwellings resembles the orientation of the Central Bohemian Shear Zone, especially in the southeastern region of Čertovo břemeno syenite and Sedlčany granodiorite areas. This feature is not influenced by the density of indoor radon measurements and technical state of dwellings – in all 7 districts both factors are comparable. Therefore we suggest, that the quasilinear course of the high indoor radon dwellings' position corresponds to the paleocontact of two major terranes – Teplá – Barrandian and Moldanubian.

5 Conclusions

1. In all seven former districts the distinct trend of increasing indoor radon with increasing soil gas radon was proven in all rock types from Precambrian to Quaternary. This fact supports the prognostic ability of radon risk maps based on the geology and soil gas radon measurements.

2. The linear position of extremely high indoor Rn dwellings within the CBPC doesn't follow the local contacts of granitoid rocks or present tectonic network, but corresponds to the supposed course of the Central Bohemian Shear Zone. The evidence of the early development of the Bohemian part of the Variscan orogen can thus be related to the radon distribution in the regional scale.

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