

RADON, ITS PROGENY AND HUMAN HEALTH

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Abstract: *There is no doubt that radon, radioactive noble gas, is an important factor influencing environment. Sources of radon, their geological distribution and occurrence of radon and its daughter products (harmful for human health) are discussed in the article. The conclusion of our considerations and our research work (measurement of radon concentration) is very simple: the daughter products of radon are responsible only for cancer of human lungs.*

Key words: *radon, environments, influencing human health, responsibility for cancer of human lungs*

Introduction

Although radon was discovered at the beginning of 20th century, its effects have been known since 16th century. At Schneeberg in the Erz Mountains Agricola noted in 1597 a high frequency of fatal lung diseases occurred among local miners. Similar effects were seen in miners at Jáchymov as early as the 17th century. In these mines were copper, iron and silver ores accompanied by pitchblende – source of uranium and radium.

In 1879 two German physicians, Hartung and Hesle, pointed out that most of the Schneeberg mine deaths were lung cancers. The Schneeberg miners who had worked in the mines for more than ten years developed the Erz Mountain disease, called *bergkrankheit*, or *black death*. Here is the short historical chronology of radon:

1597 Agricola noted high level of what turned out to be lung cancer among Erz Mountain miners.

1896 Becquerel discovers radioactivity of uranium

1898 The Curies and Schmidt discover radioactivity of thorium and also elements radium and polonium

1898 Rutherford discovers alpha and beta particles

1899 Thomson and Rutherford demonstrate that radioactivity causes ionization

1900 Dorn discovers the emanation in the ^{238}U series, which is now called radon

1901 Rutherford and Brooks demonstrate that radon is a radioactive gas

1901 Discovery of active deposit of thorium by Rutherford and of radium by the Curies

1902 Rutherford and Soddy discover transmutation
 1902 Thomson discovers radon in tap water
 1903 Rutherford and Soddy develop equation describing radioactive decay
 1904 Geisel and Debierne discover actinon
 1913 Arnstein identifies squamous-cell carcinoma in autopsy of miner
 1913 Fajans discovers group displacement laws
 1914 First medical use of radon
 1925 First mention of the name radon in the literature
 1940 Causal link shown between radon and lung cancer
 1941 National Bureau of Standards advisory committee adopts an air radon standard
 (370 Bq.m⁻³)
 1955 Concept of a working level (WL) first suggested
 1957 Development of the Lucas cell for detection of radon

Physical properties and sources of radon

Radon is a naturally occurring, colorless, odorless, almost chemically inert and radioactive gas. It is the heaviest and has the highest melting point, boiling point, critical temperature and critical pressure from the other noble gasses. Radon is part of the naturally occurring radioactive decay chain from uranium or thorium to stable lead (Fig. 1). Radon decays with emission of α -particle to ²¹⁸Po which has a half-life approximately 3 minutes and because it is not electrically neutral, adheres to dust. The dust is then inhaled into lungs, where cell-damaging α radiation can occur when ²¹⁸Po decays. Similar situation repeats by decay of ²¹⁸Po to radioactive ²¹⁴Pb and then to radioactive ²¹⁴Bi.

Because radon is a radioactive, noble gas with no chemical reactivity, its concentration at any point of measurement is a function of three primary factors:

- concentration and distribution of its parent in the source material,
- efficiency of transport processes which bring it into the biosphere,
- its half – life.

Radon is a short – lived member of the ²³⁸U decay series and a progeny ²²⁶Ra, its concentration is a function of the levels of these elements in the source material. Because one of the most basic properties of uranium and thorium is the tendency to be enriched in rock which have a low melting point, their content is higher in granite than diorites, basalt or limestone. In the Fig. 2 there is radon situation in Czech Republic shown.

Radon gas enters homes in three main ways (Fig. 3):

1. It migrates up from soil and rocks into basements (cellars) and lower floors of houses.
2. Dissolved in groundwater, it is pumped into wells and then into homes.
3. Radon – contaminated material, such as building blocks, are used in the construction of houses.

The simplest way how radon can be reduced in our houses and other buildings is to locate the entry points of radon and seal them. This action however, is often not sufficient, so additional ventilation to the home, using fans and other device may be necessary. Increased ventilation is the primary remedy for radon problems. If these methods are not successful, a venting system may be constructed.

Health Effects

Once inhaled, radon gas quickly finds its way to the blood stream. It is a chemically inert gas and only a small fraction on that inhaled will be absorbed by the blood and not exhaled. Further, because the half – life of radon is relatively long compared to breathing time, only a small amount of it will decay while in the lung. Acute and subacute early effects, as well as late effects, can be expected following exposure of the respiratory tract to radon progeny. High concentrations of radon decay products in the lungs of animals can result in profound structural and functional changes that may produce lifespan – shortening, pulmonary emphysema, pulmonary fibrosis and lung cancer. Many of the more than 40 distinctive cell types of the respiratory tract could be affected. The nature and magnitude of biological effects that may occur following inhalation of radon decay products will depend on many factors, such as fractions deposited in the respiratory tract and their retention times, translocation to other tissues and rate of excretion to the body.

Inhaled short – lived radon decay product will, to a large extent, decay at their deposition site. Consequently, the tissues in the nasopharynx, the tracheobronchial tree and the pulmonary region receive the majority of the radiation dose. The dose to the bronchi generally predominates in humans. These sites contain precursor or stem cells that are particularly sensitive to the cytotoxic and carcinogenic properties of α - emitting radon progeny. They may be more sensitive to carcinogenesis because of exposure to other environmental agents (such as cigarette smoke) that may increase cell division.

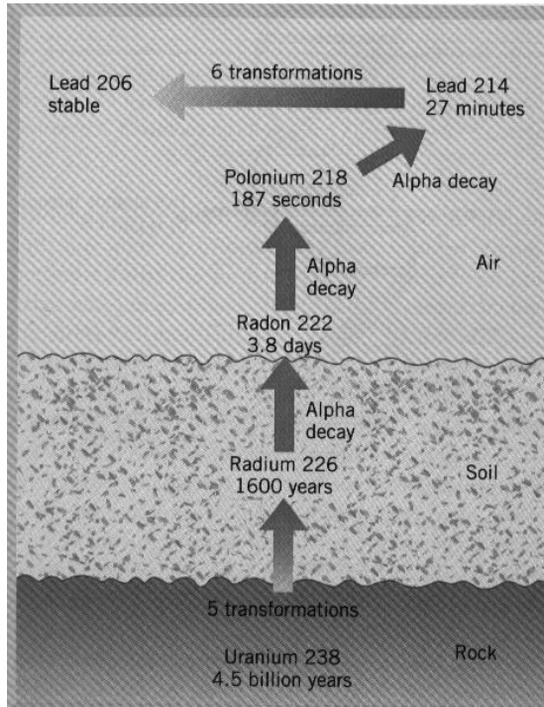


Fig 1.1. Simplified diagram of radioactive decay chain for radon

Experimental results and Conclusions

The concentration of radon and its daughter products in many parts of Moravia has been measured. For this purpose we used outstanding equipment Level Living Monitor LLM 500 (Münchener Apparatebau für elektronische Geräte GmbH, Germany). The monitor consists of a dealer large area proportional detector. The efficiency is enhanced by using a β -reflector. A mechanical code inside the filter mouth recognizes the correct insertion of the loaded side of the filter diskette. The reliable portable sampler consists of a powerful turbine with a precise readout. The sinter diskette with very low flow resistance supports the filter material and reduces the noise level.

All measurements has been made in all parts of Moravia from the year 1997 predominantly in nonventilated cellars. In the Fig4. There is shown as an example the result of a typical measurements (South – Western Moravia, the foot of Javořice Mountains, beginning of June

2010). The numbers means the highest and the lowest value of radon concentration in the measured place. Because the concentration of radon is time and place dependent, the error has not been counted.

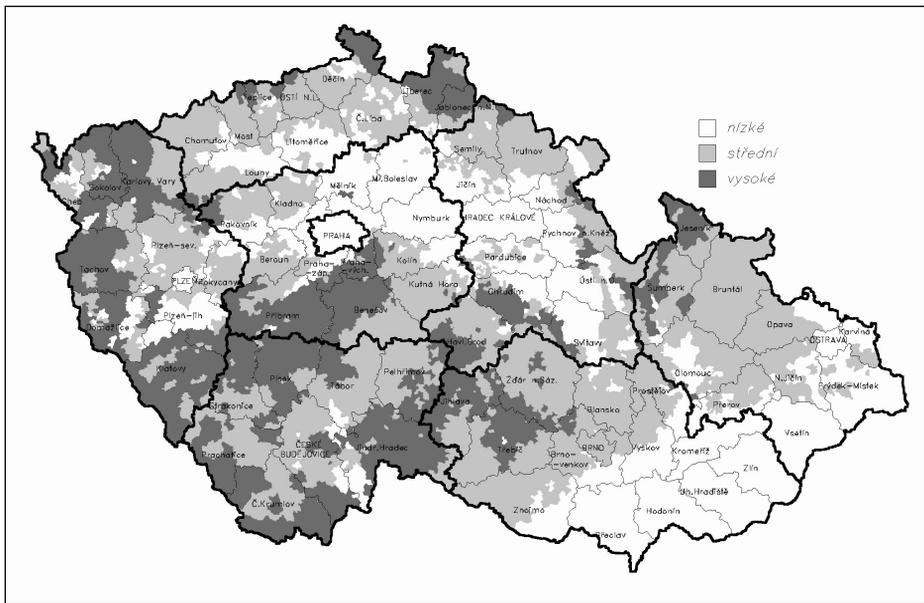


Fig. 2. Radon situation in Czech Republic

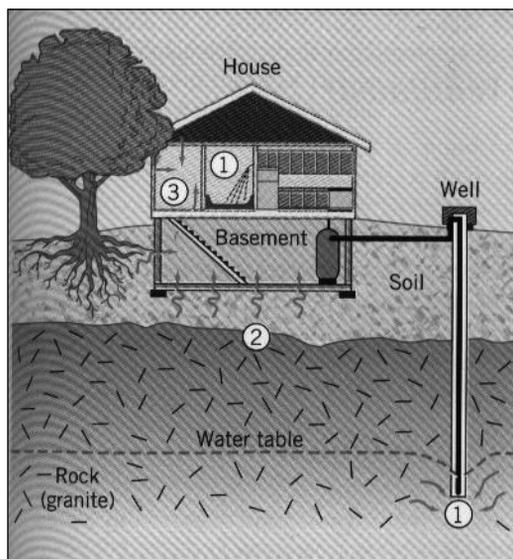


Fig 3. How radon may enter homes

From the figure we can see increasing of activity in left part of the map (granite bedrock) in comparison with right part of the map (gneiss bedrock). The highest concentration of radon was indicated on the boundary between granite and gneiss bedrocks –geological break . In the break deposits of uranium were found.

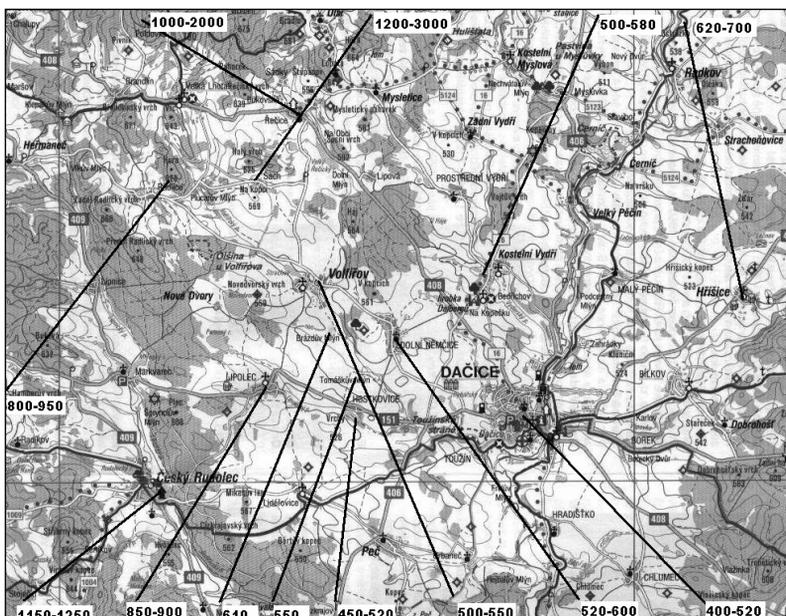


Fig. 4. Measurements of radon concentration (Southwestern Moravia, June 2010)

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RADON, JEHO PRODUKTY ROZPADU A LIDSKÉ ZDRAVÍ

Abstrakt: Radon, radioaktivní netečný plyn, je důležitým faktorem, který je třeba řadit k činitelům, ovlivňujícím životní prostředí. V našem článku je kromě historie zkoumání radonu a jeho účinků na lidské zdraví, diskutován mechanismus jeho působení na živé tkáně (radon a jeho dceřiné produkty způsobují rakovinu plic). Konkrétním přínosem našich měření a našeho výzkumu je mapa, udávající výskyt radonu v oblasti Jihozápadní Moravy.

Klíčová slova: radon, životní prostředí, vliv na lidské zdraví, rakovina plic