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RESEARCH ARTICLE

THE POTENTIAL TO INCREASE THE RATE OF RADON EMISSIONS FROM DECORATIVE STONE

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ABSTRACT

Today, natural rocks are popular in modern houses. Visage (surface) and decorative stones are suitable for internal and external use in the buildings; due to having high hardness and resistance in all climates.But some of the consumer groups and sanitary cliques are concerned about scattering and diffusion of radon gas by these valueable rocks. So, the investigation of this problem is necessary. For this purpose the real and accurate test must be designed for radon diffusion poten- tial of these rocks. This research indicated the researchers' concering is true and exact

INTRODUCTION

The decorative and variety stones have been seen stylish and impres- sive which are used as cover in kitchens and other places for a long time. In fact, the natural beauty of rocks is the reason that rocks are more prevalent than another covers such as dye, tile and ceramic. The other advantage is the rocks have resisted against spotting, heat and cold [1]. Researchs are presented in the house market of Iran that demand of using rocks increases 5 percent every year at the period of 1380 to 1386. In ad- dition, with the increasing of construct and house modernization in this country, it is estimated that the consumption of decorative stone volume will increase to 30 % untill 1400 [2, 3]. So natural stones will be impor- tant parts of the buildings such as: tile, cement, wall, floor, etc. In the mines, these rocks are exctrated from the earth's crust. After processing, these are available to decorate [2]. The crust of earth was created with the Big Bang at billion years ago. In the crust, some of the elements are radioactive material. In order that, every material is extracted and used in buildings, can contain radioactive material. Interpretation of the radio- active elements potential hazards includes two sides; radioactivity and radon gas. Radioactive elements decay to light elements for stabling with the releasing of ray due to their nature. This act emittes the light energetic particle, what includes: γ ray, β ray and α particles. These rays easily enter the body cells and damage DNA which is the main cause of cancer. Also, uranium nucleus of some rocks naturally decay to radium, that it produces the unstable radon gas. Inspiration of the air what contains the radon gas, can cause lung cancer [4, 5].

Characteristics of rock samples

In this study, 4 samples were selected for test which contained 45% of rocks in the stone market. The classification of sales was illustrated at the prantesis [6]. Characteristics of rock samples include

- 15 × 15 cm (the top surface was only polished).
- Every sample contained 4 parts
- The thickness of tropical brown sample was 3 cm and oth- ers were 2 cm
- Improper packaging, damaged and scratched up surface and rock angles.

(20) Absolute Black-1 (19) China Black-2 (18) gray Santa-3 (6) Tropic Brown-4

Geology of radon

Radon is the gas what is naturally created via radioactive diffu- sion of radium element. It is a spontaneous radioactive process that is the part of decay which its half life is years.

$$^{238}U \rightarrow ^{234}Th + \alpha \rightarrow \ldots ^{230}Th \rightarrow ^{226}Ra + \alpha \rightarrow ^{222}Rn + \alpha \rightarrow$$
$$\rightarrow ^{218}Po + \alpha \rightarrow ^{214}Pb + \alpha \rightarrow ^{214}Bi + \beta \rightarrow \ldots \rightarrow ^{206}Pb$$

The half lifeof is 1620 years, its is 3.823, its is 3.05 min, its is 26.8 min and its is 19.7 min [7].

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Most of Earth's rocks, soils and material that eroded from the earth's crust contain uranium. While the 99.3% of this uranium is the kind of isotope that it is converted to stable isotope of via 14 decays. If the dish is full of radon gas, after 3.8 days the half of radon leaves the dish but Pb, Bi and Po remain in it. Plutonium is the radioactive element what is made by decomposition of ra- don gas in air and breathing of man in lungs [8].

The minerals are receptacle of uranium such as monazite in granitic rocks, are the main source of radon in rocks, soil and groundwater

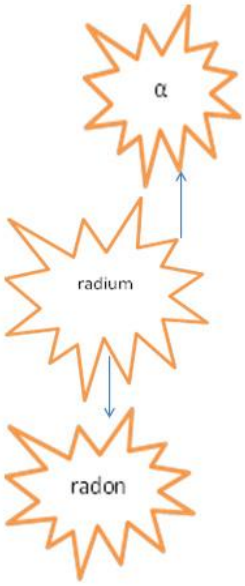

Figure 1radon atom and α particles' position after radium decay

So the direction of radon producing determines the position of radon gas atoms in the pores. If a radium atom is located at the depth of large mineral grain, regardless of its orientation, can not release the radon atom along the surface of mineral, thus the radon atom is confined at the inside of mineral. Even the radium atoms are located near the surface of mineral grains, if the orientation of α particles diffusion this way, push the radaon atoms to the depth of grains and they are confined at the min- eral structure (Fig. 2).

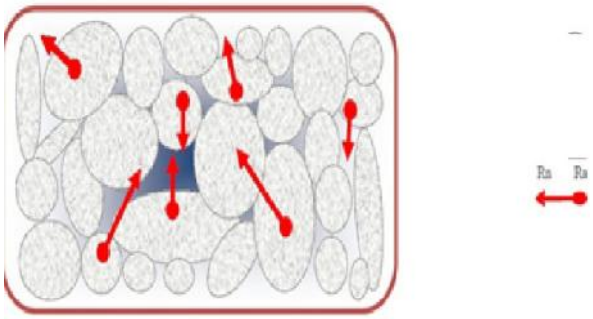

Figure 2 The direction of radon diffusion in the mineral and spaces which contain air and water

If the radium is near the surface mineral, some radon gas atoms move to the surface and in this case new radon atoms exit it and re- place at pores or fractures (Fig. 2). In most soils, only 10% to 50% of the radon production leave the grain and are located in the space between grains. Due to gas phase of radon therefore, it has greater mobility than uranium and radium. In order that, radium and ura- nium atoms remain in the solid phase of rocks and soils.

Radon atoms easily leave the rocks and soils by pores, fractures and cracks. This easy motion will cause the radon gas enter to the house and moves long distances before decaying, so has a high mobility in confined space of houses [10].

Felsic volcanic rocks, granites, dark shale and sedimentary rocks that contain phosphate and ultramaphic metamorphic rocks have uranium more than normal state. But it is related to mineral features and physical condition emanation.

Meanwhile the granite is usually used after cutting and polish- ing because it is dense, resistant and has the natural beautifull patterns. In spite of these characterizes, radium atoms have a chance for producing of radon in the air. But the pore and frac- ture is the minimum concern of granite stone. The main concern of human health is the polished surface, less polished surfaces, edge of stone and using it in building accessories.

Mineralogy and lithology

Base on lithology, the minerals are receptacle of uranium such as monazite in granitic rocks, are the main source of radon in it. The images of rock samples polished surface were magnified 30 times. In the images, small crystals of zircon what contain uranium and titanite were detected. But in the biotite, some crystals of apatite had the uranium.

Thus the locations that the uranium concentrated in it, were discovered via mineral tracing in biotite. These locations were the main source of radon.

Figure 3 Absolute Black: Igneous rock contains piroxen, ol- livin and plazhioclase (ophitic texture). [11]

Figure 4 China black basaltic rock containing very plazhio- clase beans, black augite Yellow and green olivine crystals contain is smaller than 1 mm

Figure 5 gray Santa Igneous rock containing quartz and feldspar minerals crystals of orthoclase Biotite also darker and where there are a bunch

Figure6 Size between 5 to 10 mm Tropic Brown rained igne- ous rock with similar tissue containing a variety of crystal

Investigation of Radon gas diffusion

Radon measurement unit is empirically (Picocuries / Liter) pCi / L. Of course, America's Environmental Protection Agency uses
Bq⁄m^3 andBq⁄m^2

= pCi/L
Ci =3.7×〖10〗^10 (s)
pCi=0/307
1pCi/L=37 Bq⁄m^3
Bq⁄m^3 /m=Bq⁄m^2

The granite rocks of each sample were connected by shaft which had 3 cm diameter and each of them was situated in the poly- ethylene barrel that had the tight lid. The amount of radon was calculated by PRASSI 5s that it is the system with high sensitiv- ity, high memory capacity, short response time and a big digital display (Tab. 1). The radon activity in the barrel was measured base on the following equation:

In this equation, λ is the decay constant of or 0.1813/day, and is the initial and final value of radon activity and t is the elapsed time. This test was started without delay at 15:30 of 27/04/89. Obviously, due to surface roudhness, the amount of radon flux in the vertical section, nonpolished surface and around of shaft was more than the polished surface. Therefore, all of samples were located at the barrel in the same situation. The system was read after several days, too. The actual results of this study are iluastrted for 4 week at table 1

Table 1 The results of radon gas determining (pCi/L

Sample	Start of	(Pci/L)4	(Pci/L)3	(Pci/L)2
Absolute Black	22/5/2010	3	2	1
China Black	25/5/2010	2	1	4
gray Santa	26/5/2010	5/1	1	2
Tropic Brown	27/5/2010	17	10	8

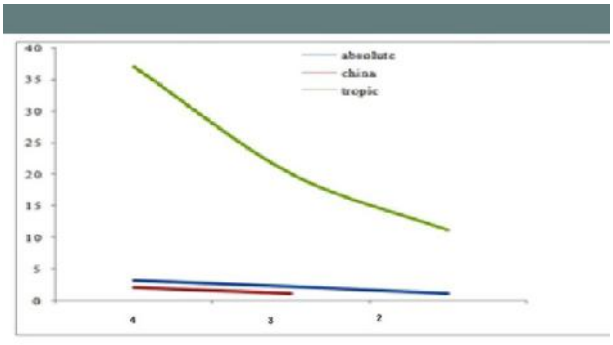

Figure 7 The curves about the result of test

The scattering condition of radon in the indoor Radon gas passes from voids and fractures near the earth's surface and is released into atmosphere. In the residential area, the air of soil moves to the foundation due to the following reasons:

- The pressure difference between the air that is in the soil and that is in the the indoor
- There are voids in the foundation of the buildings.

The increasing of permeability around the foundation

The building's components includes: foundation, dog void, base and coarse gravels that are usauly used under the concerete sheet.

The radon penetrates from the soil that is around the foundation to the disturbed area and gravels of the foundation. The materials of the disturbed area are generally rocks and soil that are made from the soil of around the buildings and make themselves the radon gas. In the disturbed area and the gravel of foundation, the amount of radon gas is related to the amount of uranium in the foundation, permeability of soil in this area and soil moisture.

In the ground around the buildings, the air pressure is higher than the air pressure inside the rooms. So the air penetrates from disturbed and gravel to rooms by the open space and fracture in the foundation. All of the houses have the fractures and cracks in the foundation that they are the reason for the entering of radon gas to the rooms. In the most houses, less than 1% of indoor air is from the air in the foundation and soil. The residual part of air comes from the outdoor that it usually has very little radon gas.

When the air pressure of the indoor is low, the foundation doesn't insulate completely and there are the voids for penetrating of air from foundation, 20 % of the indoor's air was intaked from soils. In this state, even if the amount of radon gas in the soil is according of EPA, but the level of radon gas will become high in house [10].

The volume of air is 454m3 in the house that the height is usually 2.5m.the barrels what used in test for holding of rocks, their volme is 0.01 m3, thus the diluation factor is marked 24000.

However, the average size of granite was assumed 10*10cm or two surface areas are 200cm2. The area of 4 pieces of granite stone (15*15 with the 2cm thickness) was 2323cm2. So the am- plification factor was 12. In the tropical brown stone that the thickness was 3 cm, the area was 2602cm2 and amplification factor was 19. The increasing amount of radon could be calcu- lated easily due to using of granite. In other hands, the amount of radon was added to indoor air due to granite, was equilibrium to amount of radon in barrels. Therefore the following equation is recogonized.

This study showed the concern is not very important in typical house, if it has suitable air conditioner and ventilation. But otherwise we should be more careful in the using of stones. The amount of air displacement per hour (ACH), which is related to

heat and cold, is 6ACH in a house and the quantity of air penetrating is 0.25. Hence

Hence rate of dilution of the radon concentration in a home for the holidays, the doors and windows are closed The calculated rate is much higher than can3/8235د.

Nonetheless, the radon gas penetrates from the floor and is increased, but we can decrease this value via making the space be- tween foundation and floor, insulating of foundation and piping, adding air conditioner under foundation rising of air pressure in house especially in winter**.**

CONCLUSIONS

In this research, radon gas diffusion was investigated which was only produced by decorative granite stone. Base on EPA recom- mendation, the guideline of radon is 4Pci/L in houses. Accord- ing to the results of this sudy, there are a few concerns for the using of tropical brown granite, so its use should be further re- stricted. But the radon gas product is at the standard level in the three other type of granite. The main resources of radon are black and brown biotite minerals which contains uranium. It is a mention that radon gas was released from quartz and ortho- clase is negligible.

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