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MEASUREMENTS OF DECAY PRODUCTSFROM RN-222 AND RN-220 NEAR GROUND LEVEL AND LOW ATMOSPHERE IN SÃO JOSÉ DOS CAMPOS, SP, BRAZIL

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ABSTRACT

The spectrum of low energy gamma rays (0.2 to 3.0 MeV)was measured in four points on the region of São José dos Campos, SP, Brazil. The distance of the four points measured it was less than 2 km one from another and in one location point 2 and 3, localized inone tour, it was measured in ground level and at 25 meter high. The monitoring of spectrum flux shows the strong presence of decay products of Rn-222, Rn-220 and potassium (^{40}**K**) on the four places. The integrated counts rates in the same interval of energy and each place shows influence of geological parameters and the removal of ^{210}**Pb**and ^{210}**Po**by fallout were taken also into account.

KEYWORDS: Decay Products, Atmosphere

INTRODUCTION

The source of gamma radiation from 200 keV to 3.0 MeV close to the ground in any region of the earth is due to the presence of cosmic radiation, the electrical discharge power in the lower atmosphere and the exhalation of radon gas in the same location [1],[2],[3] and [4].In tropical and even equatorial regions radiation are vented by radon gas that is very efficient due largest local heat stroke.The low energy radiation (α,β, X and gamma rays) in local environment depends of the presence of radionuclides and radon gas in the region. The local geological formation, the secondary cosmic radiation and human activities improve these radiations in same environment. These radiation with enough energy (E> 12 eV) can ionize an atom. The ionizing radiation called “background” or background radiation in a particular region is the sum of these components. The geological origin radiation is largely the result of the decay of radioactive isotopes potassium (^{40}K), uranium (^{238}U) and thorium (^{232}Th). The radioactive decay, the cores can emit alpha radiation, beta, gamma or X-rays. Moreover, they are formed natural radioactive isotopes belonging to each decay series mentioned above. The ^{235}U has a half-life of 713 million years while the ^{238}U has a half-life of 4.5 billion years. With this, there is in nature a much smaller amount of ^{235}U comparing to ^{238}U [5].

The other major source of ionizing radiation in the soil-air interface is radon gas (^{222}Rn) which is also formed by the decay of uranium and thorium. In turn, the radioactive decay of radon produces ^{218}Po, ^{214}Pb and ^{214}Bi, and these isotopes can be observed in the air near the ground by the presence of alpha particles, X and gamma rays. An important fact related to radon is that during rain, the concentration close to the ground may increase due to transportation of this gas by rain droplets [6], [7], [8].

The radiation from the cosmic component (primary and secondary) produced in the lower atmosphere varies little over time. However, it varies greatly with latitude and height above the Earth’s surface [7]. This cosmic radiation produces

"extensive air showers"composed of particles and photons that reach the Earth's surface. Artificial ionizing radiations are those produced by humans in a variety of activities such as medicine, dentistry and research in the industry. However, the sources of radiation are, in principle, confined and under control at a specific location [9],[10] e [11].

MATERIAL AND METHODS

The gamma radiation measurements was made using a 3" x 3" NaI(Tl) crystal scintillator manufactured by Ludlum Measurements, INC, USA, model 733 [10]. In these measurements it was used high tension of +650 VDC to polarize the photomultiplier. The data acquisition system developed by Ludlum gives the countrate versus (channel or energy) that coming on the scintillator each second and in these measurements was seethed in 3600 seconds for each spectrum. A general view of associated electronics with photomultiplier and crystal imbibed in thin aluminum foil is show in Figure 1.

Figure 1: View of Crystal Scintillator and Electronics of Multichannel Analyser Model 733.

(Radiation Dectetion for a Safer Word – Health Physics)

The points 2 and 3 it was made respectively on ground and on 25 meters high inside one room in the tour that can be seen in Figure 2.

Figure 2: The Point 2 and Point 3 is Localized in Same Tour on Ground and 25 Meter High.

In the Figure 3 it is shown the point 2 near the ground on the tour wherethe spectrum measurements was made with one hour of duration.This area belonging to a meteorological station where (precipitation, atmospheric pressure and

air humidity) is also monitored.

Figure 3: View of Nai(Tl) Scintillator And PC Duringspectrum Measurement on Ground Down to the Tour on December 8, 2015

In the Figure 4 also it is showed the exactly place inside the room were the spectrum measured was made in point 3 localized25 meters high in the tour. In the same room a set of instrument it is running to measure temperature, Geiger counts, infrared radiometer and low and fast electric field monitoring. During all interval of time (one hour) the spectrum measurement was made with temperature near 25^0 C.The local masonry seems quite the same in terms of materials so it is hope no big differences in counts/energy in the four points.

Figure 4: View of the Nai(Tl) Scintillator And PC Runningthe Spectrum Inside the Room with 25 Meter High in Tour on December 08, 2015

RESULTS AND DISCUSSIONS

The spectrum for each sitehas been measured during total time of one hour per site During this day December 08, 2015 the temperature was ~25^0C, air humidity near 60% and pressure about 940 milibars. The four spectrums per placeis

shown in details in Figure 5

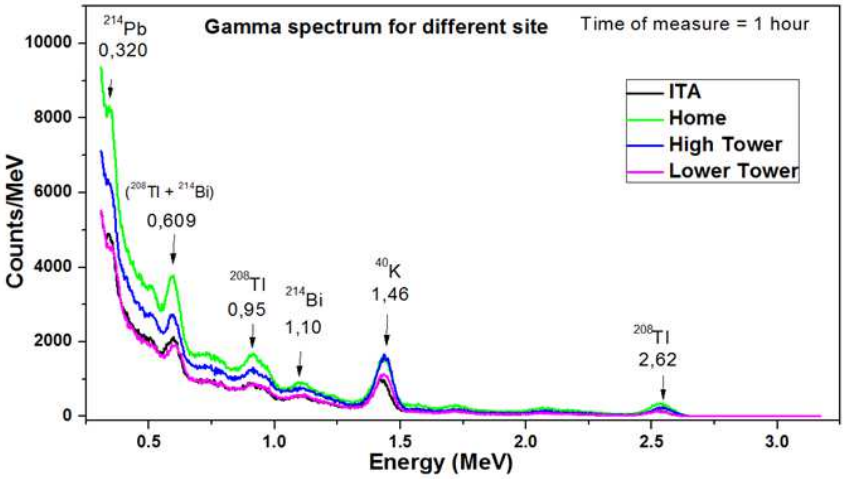

Figure 5: The Spectrum Measured in Each Point Showing the Picks from Radioactive Elements

The six picks observed with good efficiency during 3600 seconds in each place are described in the Figure 5. In **Home** the spectrum and all picks presented the bigger intensity (green curve) followed by the measure in **High Tower** (blue curve).In **ITA** and **Lower Tower**the intensity measurements seembequite similar(black and red). The different intensities observed in the four points are related with local geology produced by materials in masonry and also with the presence of radon gas Rn-222 and Rn-220.In this Figure 5 it is identified the elements and energy coming from Rn-222 that is:

^{214}Pb (0,320 MeV); ^{214}Bi (0,609MeV); ^{214}Bi (1,10MeV) and ^{214}Bi (1,76 MeV).

Coming from Rn-220 that is:

^{208}Tl (0,609 MeV and ^{214}Tl (2, 62 MeV)

The radionuclide ^{40}K (1, 46 MeV) that coming with very clear pick in all spectrums do not proceed from Rn-222 or Rn-220 but in geological elements (decay from ^{238}U).

Exactly in the day of spectrum measurements no rain are registered in the region and in the four site of monitoring of spectrum radiation (see Figure 6a and 6b). These rain measurements were taken from each minute near ground level and also in 30 meter high in up part of the tour.

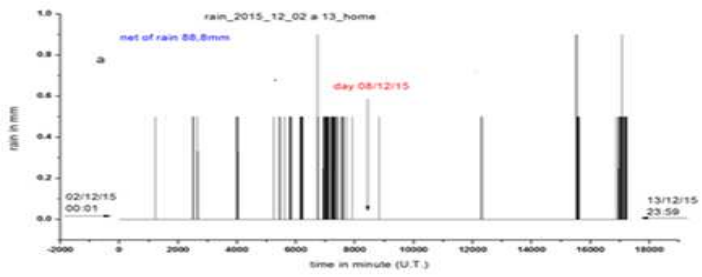

Figure 6a: Graph of Precipitation between December 02, 2015 to December 13, 2015 Each Minute

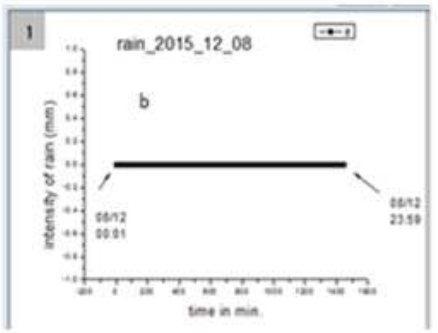

Figure 6b: Graph of Precipitation during the Day December 08, 2015 Each Minute, Indicating No Rain

CONCLUSIONS

The spectrum of radionuclides that coming from Rn-222 and Rn-220 in the energy interval of 0,2 to 3,0 MeV were measured in the region of São José dos Campos, SP, Brazil. It was observed in this region the strongly dependency of radionuclides picks (intensity) in four different points with masonry materials and high.The radon gas has great influence in the background of low energy gamma rays in the region. The decay products of ^{238}U; ^{235}U; ^{232}Th;^{222}Rn;^{220}Rn and ^{40}K with only gamma ray measurements could be identified in each place using this simple and portable spectrometer with 1 hour sampling time.

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