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Radiation Measurements in Soil in the middle of Gaza-Strip Using Different Type of Detectors

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Abstract: Radon *Alpha* particles and its daughter products dangers effect to human health is the main motivation behind several studies of measuring radiation in environment including the soil and building material.

We measured the activity of Alpha, Beta particles and Gamma Radiation in soil in the middle of Gaza Strip in general form by using five types of detectors. In our survey the middle region of Gaza Strip was divided into four areas, , included Dier El Balah (D), Mughazi (M), Buriej (B) and Nusairat (N), 40 samples where considered in the present work .

The samples then were tested and the results presented in this paper. The comparison between the four regions was obtained and showed low radiation level compared with the standard level known by the IAEA and UNCEAR report (U3, U6)[3,7].

This study was conducted to provide us with measurements and extrapolations about radiation concentration in general form in soil. This would enable us to expect the health effects of radiation might cause in the future, especially from the environmental point of view.

قياس الإشعاع في التربة في المنطقة الوسطي من قطاع غزة باستخدام أجهزة كواشف مختلفة

ملخص: إن خطورة النشاط الإشعاعي لجسيمات ألفا الناتجة عن غاز الرادون ونواتجه علي صحة الإنسان هو الحافز الرئيسي وراء الدراسات العديدة لقياس التلوث الإشعاعي في البيئة وتشمل التربة ومواد البناء. تم فحص عينات التربة للبحث عن وجود نشاط إشعاعي لجسيمات ألفا، جسيمات بيتا وأشعة جاما في وسط قطاع غزة باستخدام خمسة أنواع مختلفة من الكواشف. 40 عينة من التربة جمعت من أربع مناطق في وسط قطاع غزة تشمل دير البلح والمغازي والنصيرات والبريج.

تم إيجاد ألنشاط الإشعاعي في عينات التربة المختلفة والنتائج سوف تعرض في هذا البحث، يوجد مقارنة بين المناطق الأربعة وهي تثبت انخفاض مستوي الإشعاع

بالمقارنة مع تقارير (IAEA, UNCEAR) هيئة الطاقة الذرية وهيئة الأمم المتحدة لقياس الإشعاع.

الدراسة أجريت للحصول علي فكرة عامة لطريقة قياس شدة تركيز الإشعاع في التربة ، وذلك لمعرفة درجة تأثير الإشعاع علي الصحة، و لأغراض بيئية.

Radiation Measurements in Soil in the middle

1.0 Introduction: Radiation Effect

Radiation is all around us, it is naturally present in our environment and has been since the birth of this planet. Consequently, life has evolved in an environment which has significant levels of ionizing radiation. Radiation comes from outer space (cosmic), the ground (terrestrial), and even from within our own bodies. It presents in the air we breathe, the food we eat, the water we drink, and in the construction materials used to build our homes.

Alpha particle radiation is the major source of natural radiation in our environment. It is derived from radioactive decay of colorless, inert gas, Radon (^{222}Rn) and leading cause to cancer in the most world. An average person receives a radiation dose of about 300 millirem per year from natural sources compared to a dose of about 50 millirem [1] from produced artificial sources of radioactive material such as medical x-ray. Natural radioactive material in Rock and soil account for about 28 millirem or 8% of the radiation dose a person receives in a year from all sources see figure 1.1. The most abundant sources of natural background radiation are ^{238}U of life time $T_{1/2}$ = 4.5 billion years, and Thorium ^{232}Th of half life time t =14 billion years in sediment rock. Both of these elements decay to radon gas but Thorium decays to ^{220}Rn called Thoron which has half life time of only 55 second, whereas Uranium decays to ^{222}Rn called Radon which has half life time of 3.8 days. Because of the difference in half life, radon can diffuse from soil, where it is produced , into living spaces, whereas Thoron decays before it can move very far from where it was created [2,3].

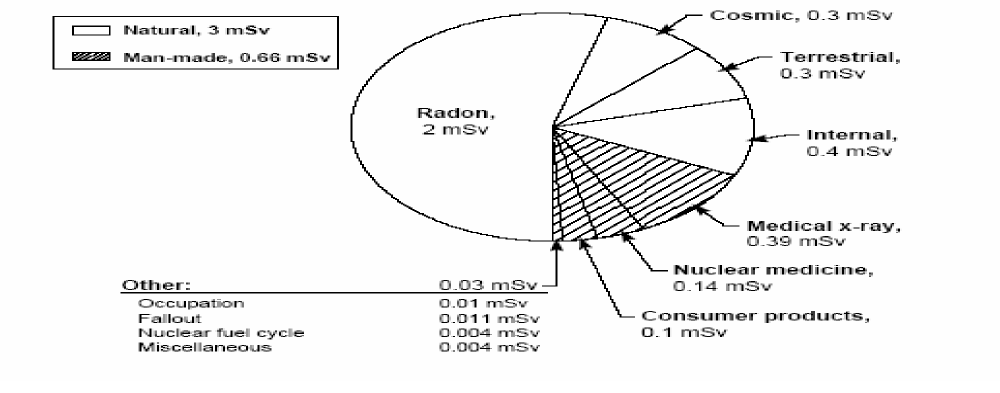


Figure (1.1) Typical annual radiation doses from natural and man-made sources (National Council on Radiation Protection and Measurement 1987)

Exposure to natural sources of radiation has become an important issue in terms of radiological protection. Much of this comes from ^{222}Rn and its solids, short lived daughter products, ^{218}Po, ^{214}Pb, and ^{214}Bi. The National Radiological Protection Board, NRPB, (1992), estimates that Radon accounts for approximately 50 % of person's annual dose of radiation from all sources in most of the world [4].

Radon is a naturally occurring radioactive gas that may be emitted from any rock that contains Uranium and Thorium. The radio nuclides and radon concentration for a given region is likely to be the result of combination of properties of the rocks and the soil, such as distribution of Uranium and Radium, porosity, permeability, and moisture content, as well as meteorological and seasonal variation.

2.0 Objectives of study:

We believe the several environmental problems currently affect the Gaza Strip. These problems have not received serious investigation. Practically, exposure to radiation materials may be represented one of these environmental problems. This research program aims to study a preliminary survey of radiation in soil at the middle of Gaza Strip. This study will enable us to identify the environmental problems concerning radiation hazards and improve the technique of measurements.

2.1 Area of Study (Gaza Strip):

As shown in figure (2.1) Gaza Strip is a narrow piece of land lying on the coast of the Mediterranean sea at roughly 31^0 N Latitude and 34^0 E longitude, about 32 km north of the Egyptian border [4].

The coast has sand dunes of about 20 to 40 m in height above sea level. Gaza Strip is very crowded place with area, 360 km^2 as shown in the map, it's whether is mild in winters dry and warm to hot in summers. The population size is estimated at 1,196,591 which is about 36.3 % of the total population in Palestine in 2001; the population is mainly distributed in the cities, small villages, and eight refugee's camps that contain 50% of the population [4].

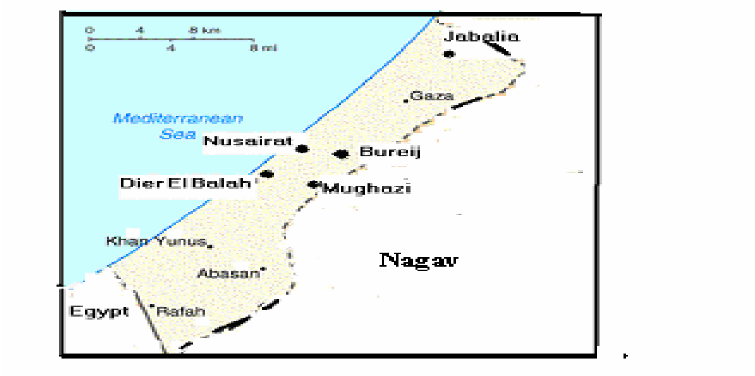


Figure (2.1) Map of Gaza Strip

Sand dunes along the coast of the Gaza Strip may well contain elevated concentrations of some of the radioactive minerals, like uranium and thorium, which are derived from the granite sources rocks present in the area [9]. These sands and other surface materials may contain some radioactive substances, which produce elevated levels of radon progeny [9].

The possibility of cancer induction due to radiation has been attracting increasing attention in the scientific community during the past decade. It is now widely recognized that indoor radon is one of the largest sources of exposure of ionizing radiation in the environment.

3.0 Techniques and Methods of Measurements:

In sampling Technique**,** subsurface soil samples were collected from 40 places, believed to be undisturbed, in middle region of Gaza Strip. The samples collected from ten places of each of the four regions . Each sample was collected by employing a template method from a depth of one meter from the earth surface and the sample weight equal one kilogram. The stones and roots was removed from the samples, after that, each sample was put in plastic bag to take it for a laboratory to determine the radionuclide specific activities.

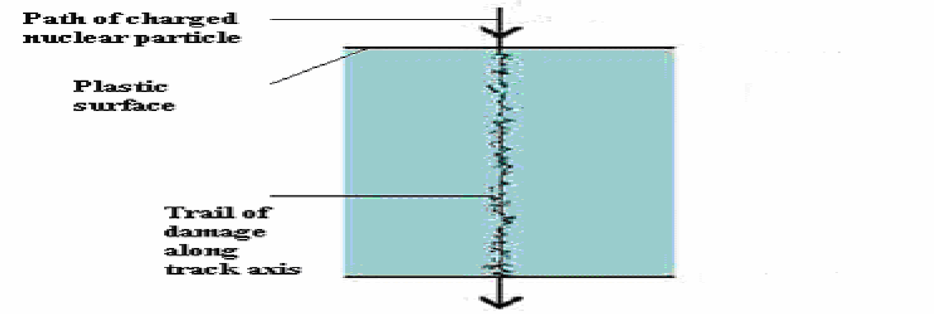
3.1 Measurements using Solid State Nuclear Track Detectors (SSNTDs) CR-39:

SSNTDs are sensitive to alpha particles in the energy range of the particle emitted by Radon. SSNTDs also have the advantage to be mostly unaffected by humidity, low temperatures, moderate heating and light[5].

The detectors were placed inside the dosimeters, and exposed for 2 to 12 months. When alpha particles from the decay of radon and its progeny strike the detector, they cause damage tracks. Also Measurements of Alpha and Beta activity in soil were carried out by different techniques that presented nuclear physics laboratory such as Electra Plus, Geiger-Muller counter and scintillation detectors.

A) Track Formation:

When a charged nuclear particle enters the plastic it creates a trail of radiation damage along its path, known as a latent track, shown schematically in figure (3.1). The soil samples are placed in a plastic cup with plastic cover, the diameter of the cover equal 6 cm and the height of the cup is 11cm as shown in figure (3.2), the CR-39 detector is fixed inside the cover facing the soil sample.



Figure(3.1): Creating an Alpha Particle Track

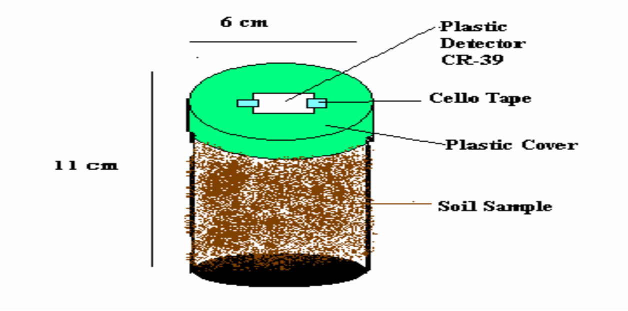


Figure (3.2): Measurement Technique for CR-39

Each sample was divided to two parts, each part was put inside the cup as shown in figure (3.2). Eighty (80) detectors were exposed to forty (40) samples which concern the middle region of Gaza Strip, this distribution of the detectors is based on the nature of the soil type and geological location. The detectors are left for about 60 days during the months October, November and December of 2004, the eighty detectors were collected and chemically etched using a 6 M (Mole) solution of NaOH, at a temperature of 70^0 C, for 5 hours, (Standard etching condition). The CR-39 detectors were mounted vertically in a stainless steel spring and then immersed in the etching solution inside a water bath. At the end of the etching process, the detectors were washed thoroughly with distilled water and then left to dry. Each detector was counted visually using an optical microscope with a power of (40×10). We counted the average number of tracks in 1 cm^2.

B) Determination of gross alpha contamination and Calibration Technique:

Gross alpha contamination in surrounding air is measured in terms of Bq/m^3. Determination of gross alpha contamination and the standard deviation (S. D.) in soil air at middle of Gaza Strip is done by the following equation [11].

$$C_S\left(\frac{Bq}{m^3}\right) = \left(\frac{C_R T_R}{\rho_R}\right)\left(\frac{\rho_S}{T_S}\right)_{\text{det}} \qquad \text{……….} \ (3.1)$$

$$\sigma_n(S.\,D.) = \sqrt{\frac{\sum_{k}^{n}(X_k-\overline{X})^2}{n-1}} \qquad \text{……..… (3.2)}$$

where, C_R: The total exposure of ^{226}Ra (Radon Source) in term Bq/m^3.
ρ_R : Track density(number of track/cm^2) of detectors exposed to ^{226}Ra.
T_R: Exposure time (days) of detectors exposed to ^{226}Ra.
ρ_S: Track density (number of track/cm^2)of distributed detectors in soil.
T_s: Exposure time (days) of detectors in soil.
σ_n (S. D.): Standard Deviation.
Simply, a number of detectors were exposed to a known activity of ^{226}Ra (radon source) for a period of time of 60 days. Then theses detectors were collected and treated by chemically etching. The average numbers of tracks/cm^2 were observed. These detectors were considered as a calibration standard [8, 9]. Similar method is also used for detector technique to determine the calibration constant (factor). This is derived by dividing the track density by the total exposure of radon source. Then equation (3.1) for radon exposure becomes as follows.

$$C_S\left(\frac{Bq}{m^3}\right) = \left(\frac{C_R\,T_R}{\rho_R}\right)\left(\frac{\rho_S}{T_S}\right) = K\left(\frac{\rho_s}{T_s}\right)$$

$$\frac{Bq}{m^3} = \left(\frac{\left(\frac{Bq}{m^3}\times\frac{Day}{1}\right)\left(\frac{Track}{cm^2}\right)}{\left(\frac{Track}{cm^2}\right)\left(\frac{Day}{1}\right)}\right) \qquad \text{……… (3.3)}$$

$$C_S\left(\frac{Bq}{m^3}\right) = K\left(\frac{\rho_s}{T_s}\right) \qquad \text{……………….. (3.4)}$$

To determine the calibration factor (K) we have prepared five (5) detectors and exposed then for fourteen (14) days of ^{226}Ra (Radon Source) of activity concentration 800 Bq/m^3. The calibration process for detectors used in this survey was carried out at the nuclear laboratory at physics department in The Islamic University of Gaza (IUG). Since, average K was computed from the measurements then, $K = 23.36\left(\frac{Bq.Day.cm^2}{Track.m^3}\right)$ where K is called the calibration factor and standard deviation error was 10.5%. The overall uncertainty calibration was estimated to be ±10% [10]. Substituting the calibration constant in equation (3.4) then, it becomes

$$C_S\left(\frac{Bq}{m^3}\right) = 23.36\left(\frac{\rho_S}{T_S}\right) \qquad \text{.............(3.5)}$$

This equation was used to determine the gross of alpha contamination at the present work.

4.0 Results :

4.1 Results from CR-39 detectors :

Table (1) shows the gross gross alpha contamination in soil air. C is the average contamination and S. D. is the Standard Deviation (1 pCi /L =37 Bq/m^3).

Table (1) Results from CR-39

Location		No. of Detectors	Min. Con.(Bq/m^3)	Max. Con.(Bq/m^3)	C (Bq/m^3)	S. D. (Bq/m^3)
1	D	20	3.17	23.47	8.87	5.93
2	M	20	3.59	7.11	5.54	1.06
3	B	20	3.35	8.92	5.96	1.72
4	N	20	2.8	9.02	5.09	2.23
Average	80		3.22	12.13	6.36	2.735

and equation (3.2), respectively. Figure (1) shows the average gross alpha activity of B and D locations were found higher than M and N locations. There was a study done by [9] showed similar results about the radon concentration levels in air, D region and B are greater than the values in M and N. Also, the result indicates that the difference between the minimum and maximum gross alpha contamination in each location is very high. This large variation in gross alpha contamination inside the location is due mainly to the difference type of soil, porosity, permeability and moisture contents as well as meteorological and seasonal variation.

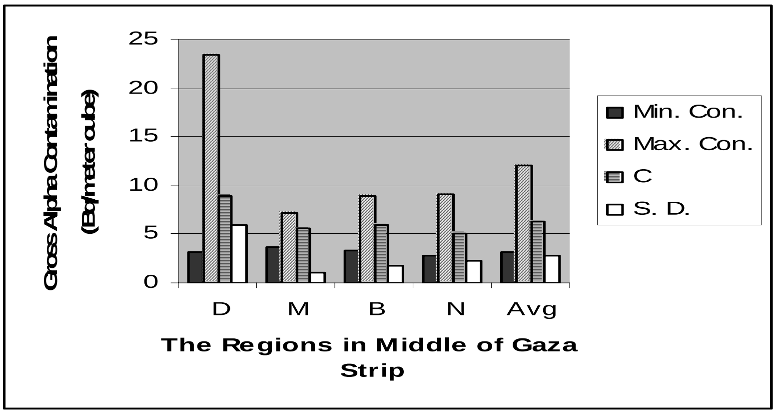
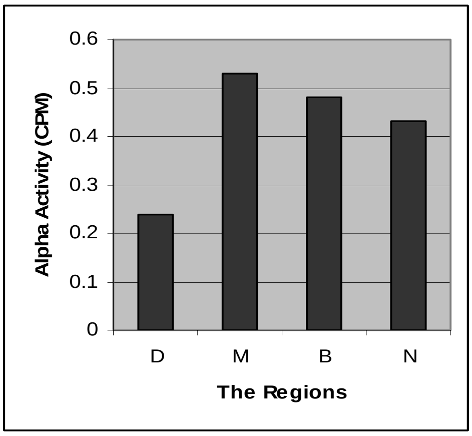


Figure (1): Gross Alpha Contamination in Each Location and S. D.

4.2 Results from Electra Plus :

The results obtained from Electra Plus showed the relation between the activity in soil sample in unit of (CPM) and each region. Figure (2) showed the relation between alpha activity and each region. We see that, alpha activity in M region is greater than other regions D region is less than other region. Figure (3) showed the relation between beta activity and each region. Also, beta activity in D is greater than other regions. M region is less than other regions but in general form the results obtained from Electra Plus showed the radiation level in these regions is very low.

Radiation Measurements in Soil in the middle



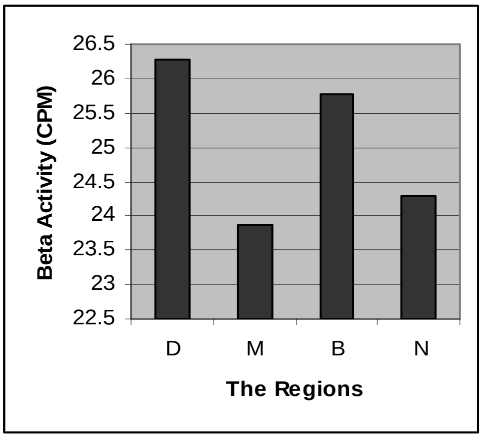


Figure (2): Alpha Activity **Figure (3): Beta Activity**

4.3 Results from Geiger counter :

Figure (4) indicates the low levels radiation in soil samples in the studied area.

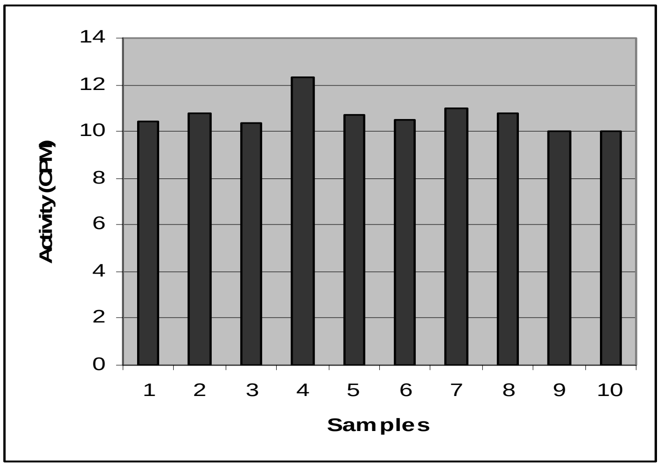


Figure (4): The Activity in D Region (Geiger Counter)

4.4 Results from Gamma Spectrometer:

Figure (5) showed the concentration in unit of (pCi/gm) to ^{125}I in each region. In M region, the concentration to ^{125}I (1.47pCi/gm) is greater than other regions, but in general form the activity is very low. In D region the concentrations (0.14 pCi/gm) less than other regions because there are difference in the distribution of rocks and radioactive material and soil properties. Figure (6) showed the concentration in unit of (pCi/gm) to ^{57}Co isotope in each region. In N region the concentration to ^{57}Co (0.26pCi/gm) is greater than other regions because the soil contains different distribution of radioactive materials results from rocks and from waste. In D region the concentration to ^{57}Co (0.08 pCi/gm) is less than other regions because the factories, which used ^{57}Co in its products in D region.

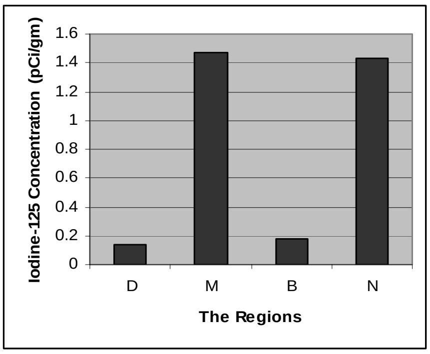


Figure (5): Average Concentration for ^{125}I Isotope

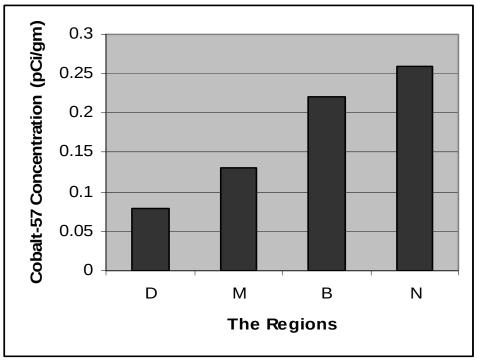


Figure (6): Average Concentration for ^{57}Co Isotope

Figure (7) and Figure (8) showed the average concentration in unit of (pCi/gm) to ^{51}Cr and ^{137}Cs in each region. In B region, the average concentration to ^{51}Cr and ^{137}Cs (0.78, 0.68) pCi/gm respectively, greater than other regions because B region is closed to different types of waste such as medicine waste, industrial waste and so on. However in D region, the concentration to ^{51}Cr and ^{137}Cs (0.01, 0.28) pCi/gm respectively, less than other regions because D region far away industrial waste. Figure (9) showed the concentration in unit of (pCi /g) to ^{129}I isotope in each region, in D region, the concentration to ^{129}I (0.59 pCi/g) is greater than other regions because ^{129}I used in medicine and in D region there are medicine waste contained 40 years ago. Some of samples taken from place closed to the waste place so that the activity in D which concern ^{129}I is very high. In N region the concentration to ^{129}I (0.14 pCi/gm) is less than other regions because N region far away from the waste places.

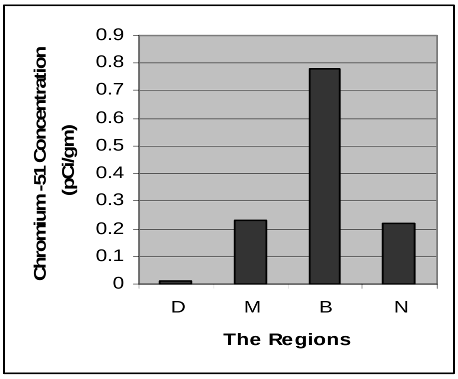


Figure (7): Average Concentration for ^{51}Cr Isotope

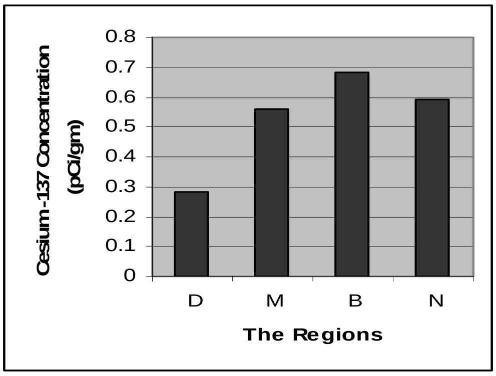


Figure (8): Average Concentration for ^{137}Cs Isotope

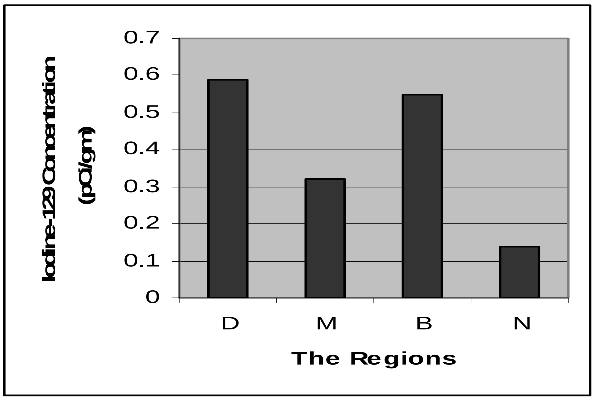


Figure (9): Average Concentration for ^{129}I Isotope

4.5 Results from Scintillation Counter :

Figure (10) sows the spectrum of soil sample for one region and indicates low level of radiation. For calibration we used 60Co and 22Na sources , comparison between these spectra and the soil spectra showed no peaks appear in the soil spectra which indicates that the soil does not contain radiation or very low content.

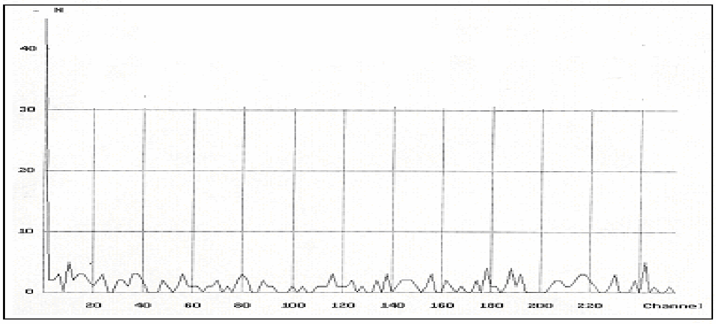


Figure (10): Spectrum to Soil Number-39 in Nusairat region

4.6 Results from Chemical Analysis :

One sample of D region was treated with chemical way to determine the weight of the total potassium in the soil sample and other nuclides using photo absorption method, the selected sample was analyzed at Rural and Environmental Center Islamic University-Gaza to obtain the weight of isotopes.

Name of isotope	mass of Sample (gm)	mass of isotope(gm)
Total K	200	6.9×10^{-3}
^{40}K	200	6.9×10^{-5}
Total Na	200	0.75
Total Li	200	3×10^{-4}
^{6}Li	200	2.16×10^{-5}
^{7}Li	200	2.75×10^{-4}
Total Co	200	-
Total Pb	200	-

Potassium is the primary source of internal radiation exposure, and an essential mineral for life, the Potassium 40K is a natural radioactive isotope exist as 0.01 percent of all Potassium in nature, it enters the human body through the food chain. The Lithium-6 isotope is 7.5 percent of all Lithium, but the Lithium-7 isotope 92.5 percent of all Lithium [12, 13].

5.0 Conclusions :

In this study we measured radiation in soil in middle of Gaza using different technique and different devices. The regions of study were divided into four regions. Results obtained have shown a variation in the values of contamination of alpha particles by using CR-39 techniques, this variation of radiation is due to the type of soil, porosity and radium concentration. The present study indicates that the nature soil of Gaza Strip has a very low level radiation, this subject due to the small contents of radioactive materials in the soil. The concentration of 129I, 125I, 57Co, 51Cr and 137Cs in the middle of Gaza Strip soils were 0.14-0.59, 0.14-1.43, 0.08-0.26, 0.01-0.78 and 0.28-0.68 pCi/gm dry, respectively.

The low concentration of ^{129}I (0.14 pCi/gm) was observed in N and the highest value (0.59 pCi/gm) in D. Similarly, the low concentration of ^{125}I (0.14 pCi/gm) was observed in D and highest value (1.43 pCi/gm) was seen in N. Significantly higher level of ^{129}I (2.45 pCi/gm) activity was found in the sample number-6 in D region. One sample of D region, the results showed, there is ^{40}K and ^{7}Li but Cobalt not found in this sample. It is hard to compare different detectors results since it is different methods , different device characteristics and different radiation type measured.

6.0 Recommendations:

The present work suggest that more investigation about the radioisotopes in different places in middle region of Gaza Strip are required, and to map the gross alpha contamination in soil in Gaza Strip. It is important to starting with making epidemiological studies of the general population to determine lung cancer incidence due to high level of radiation, although there is hope for future. This would give a good motivation to remedial the area of radiation contamination and to protect people of radiation risks. We recommend upgrading the existing equipments to get better quality and higher resolution with new equipments.

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