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# Natural sources and interaction of gamma rays with degradable materials in the soil contaminated with crude oil

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**Abstract :** In the present study the soil samples in polluted and unpolluted area was examined by using high-purity germanium detector (HPGe).The result indicated the present of some nuclide such as (CS,H,SR) that accumulated in the beginning and then stable and the polluted area show higher levels of pollution than unpolluted area

**Keywords:** Soil pollution , High-purity germanium detector, Crude oil

## 1- Introduction:

Isotope stable radiation means electromagnetic radiation of a particularly more frequency above 1019 Hz and high photons energy, they are classically produced by the decay of nuclei atomic as they are transmitted from a high to a lower energy state known ( Radioactive Gamma Decadence RGD) according to Annunziata and Michael ( 2007). Also according to Eisenbud and Gesell (1997). Natural radio nuclides are found in planet earth in rocks and ocean, soil, air, water and food even found in products of our environment are often called Isotopic Stable Radioactive element (ISRe). There are over 1500 of different radioactive nuclides are symbolized based on the element and on the atomic weight, as in case of hydrogen radioactive or tritium with an atomic weight of 3 is shown as (3H). Or Uranium with an atomic weight of would be shortened to (235U). Human caused Radioactive for one hundred years around to the natural inventories because the shorter half-lives have seen testing of nuclear in weapons. Table (1-1 ), shows some of human produced radionuclides (Eisenbud and Gesell, 1997).

Table (1-1): Some of Human Produced Radionuclides (Eisenbud and Gesell, 1997)

| Nuclide | Half-life | Source |
|---|---|---|
| $^{3}H$ | 12.3 y | Produced from weapons testing and fission reactors, reprocessing facilities, nuclear manufacturing. |

| | | |
|---|---|---|
| $^{90}Sr$ | 28.78 y | Fission product produced from weapons testing and fission reactors. |
| $^{129}I$ | 1.57 x 10^7 y | Fission product produced from weapons testing and fission reactors. |
| $^{131}I$ | 8.04 d | Fission product produced from weapons testing and fission reactor, used in medical treatment. |
| $^{137}Cs$ | 30.17 y | Fission product produced from weapons testing and fission reactors. |

Natural Sources of Gamma Rays on earth such as 40K Gamma decay from naturally occurring radioisotopes, secondary radiation from various atmospheric interactions with Cosmic Ray Particles and some rare sources, but from lightning strikes and terrestrial gamma-ray flashes such as neutral pion decay and nuclear fusion (NASA, 2005).

Interact Gamma Ray with a bound Atomic Electron that it loses all of its energy and ceases to exist and used to overcome the electron binding energy, and most of the remainder is transferred to the freed electron as kinetic energy (Nelson and Reilly, 1991). In this interaction the photon is completely absorbed and all its energy is transferred to the atomic electron, the atom then emits characteristic x-rays and Auger electrons as it returns to normal (Nelson and Reilly, 1991). Radioactive deposition or presence of substances on surfaces or within solids, gases and liquids including human body where their presence is undesirable or unintended (IAEA, 2007).Radioactive Contamination may be affected by a place,

person after following an atmospheric nuclear weapon discharge or a nuclear reactor contaminated breach, the air, soil, people, plants, and animals in the vicinity will become by nuclear fuel and fission products(FAO and IAEA, 1996) enter the body through ingestion, inhalation, injection and absorption and may also be ingested as the result of eating contaminated animals and plants or drinking contaminated water from exposed animals (Annals of ICRP, 2007). The surface is contaminated by radioactive materials as a result, it deposited from the atmosphere depending on the agricultural practices contamination in area and the stage growing or harvest season at the time of the accident may become contaminated at later stage (The Government of Hong Kong, 2013). Plants can be affected by the atmospheric release of radionuclides, resulting in radioactive contamination. Radionuclides tend to be detected from leaf of plants especially that ones have a large of leaf, after a nuclear accident happened. Radionuclides are transferred through soil into corps or animals, or into rivers, lakes and the sea where fish and other seafood could take up the radionuclides.

Foods collected from the wild, such as mushrooms, berries and game meat, may continue to be a radiological problem for a long time (WHO and FAO, 2011). When radioactive substances in the plume are deposited on plants, water or soil, they entered the food web. In the first instance, animals and plants become tissue contamination and a surface contaminated could cause intake of ingestion of radiological contaminated nutrients (animals eating a large amount of contaminated items may be concentrated radioactivity in their organisms or tissues (The Government of Hong Kong, 2013).

## 2 -MATERIALS AND METHODS:

### 2-1: Description and samples collection of the study area:

The samples were collected from the study site during January 2021. Two sites were chosen in Baghdad city,

- one site is central oil company as a contamination site with petroluem hydrocarbons
- And other site is AL- Rashdia as a control sites

### 2-2: Sampling:

Soil samples were collected from each contamination and natural sites with 3 replicate of each sample by using cleaned polyethylene bags from 30 cm in depth. The total samples were 6 soil samples .

### 2-3. Experimental Procedure:

### 2-3-1:Experimental setup of HPGe detector

When gamma-ray drops on the germanium crystal in the detector, the energy of the photon was moved to atoms in electrons and crystals were ejected. Forms an electron-hole pair which forms a pulse. So the detector passed the signal in form of current. The signal was not so strong; it was connected to a preamplifier. The basic function of preamplifier was to increase weak signals from the detector and to drive it through the cable that connects the preamplifier to the rest of the equipment. It changes the current into current signal and at the same time, it must add the least amount of noise possible. Since the input signal at the preamplifier was weak, preamplifiers were attached as close to the detector as possible. When the Signal went from preamplifier to the amplifier, Amplifier had two main purposes. The first purpose of the amplifier was to amplify the signal came from preamplifier. The second purpose of amplifier was to shape the signal to a convenient form for further processing. In both cases the amplifier must preserve information of interest. Analog to Digital Converter (ADC) capture continuous signal and assigns a digital number that represents the amplitude of the signal. A multichannel analyzer sorts out incoming pulse and keeps count of the number at each. The

experimental set-up and equipment of the gamma ray spectrometry system used in this study were summarized in Table (3-5). About energy resolution of gamma ray spectroscopy system distinguish between two energy peaks to get value of resolution FWHM full width at half the maximum.

**2-3-2: Examination of Samples**

The measurements are carried out by using gamma spectrometry systems from Canberra, equipped with high purity type coaxial germanium detector (HPGe) with high resolution (2.0 keV at 1332 keV) and relative efficiency of ~30% for 137Cs (661.7 keV). The detector was surrounded by 11.5 cm thick lead shield in order to reduce the background and by a 0.3 cm layer to attenuate x-rays emitted by the lead shield. The detector was connected to standard electronics and the spectra were accumulated in 8K MCA (integrated data processor 1510 with S100 MCA band a desktop inspector from Canberra) and calibrated by using multi gamma standard sources prepared in the same geometry (marnilly beaker) as the analyzed samples. The efficiency calibration was implanted and the curves were obtained by right the experimental efficiencies for each sample density. Efficiency curves are corrected for absorption and attenuation. The linearity of the detectors was checked by using mixed source from Canberra for Quality Assurance (QA), Certified Reference Materials (CRM) was used in the same counting geometry as the samples. The background spectra is frequently measured under the same conditions as the sample measurements and used to correct the calculated sample activities. The average counting time is 10800 second for each sample, to ensure a good statistical significance. The spectra are analyzed offline using Genie 2000 software from Canberra including peak search, nuclide identification, activity and uncertainty calculation modules. Specific activity is expressed in (Bq/kg or Bq/L) dry or wet weight depending on the sample type. The required sample taken weighs 1kg and put them in Beaker where the container is placed in the machine and then starts counting from the word except the pressure on Start at the top of the left for a period of half an hour to samples of the water for a period of hour to sample of soil. The form of information is incorporated as follows: 1- The registered name incorporated on the form (Soil and Water) Sample Title. 2- A place in the collection of samples entered in Sample Description. 3- The quantity 1 kg for samples of soil and 1 liter of water samples entered in the Quantity Field. 4- The unit (kg, liters) entered in field of Units. 5- The engineering sample form Marnilly get into field of Sample. Geometry, then choose instruct Load Cal--- choose Marnilly Cal folder GC 3020-OC10 (1)510 ---Load ---Ok.(The booklet that came with device HOGE DSA-1000 in The Ministry of Commerce).Experimental HPGe Detector and the System of Data acquisition in Ministry of Trade Laboratory.

**3- RESULTS AND DISCUSSION:**

**3-1: Measurement the specific activity of isotopic stable radioactive in soil samples.**

Isotopic stable radioactive have been determined the soil samples in polluted and unpolluted areas within the criteria for determining the published values limited factor of global proportions (USEPA,2011).The final concentration standard deviation and significantly was recorded in soil P-value ($P<0.05$).According to (Hudson et al.,2005; Briffa et al.,2020., Reyam ,2018) who reported that the tiny isotopic stable radioactive were the primary pollution conditions would be higher than of the rough, in our results has been identified on the basis of natural environmental and source pollution factors affected from accumulation to stability in the soil .

Graphic images that were obtained considered the entrance of the variables as an indicate a distributed the data by site and rate of pollution , from the start point time of pollution, a curve in one level and its stability is observed at the last point on a rate that may be considered the normal limit factors in polluted area , graphic images in figure (3-1),b spatial analysis activity of isotopic stable radioactive in soil samples in unpolluted area oscillatory in more levels its stability last point with elevated quantities on in the graphic images in figure (3-1) a in the polluted area it have a spatial analysis activity of isotopic stable radioactive samples that recorded higher levels of pollution were ultimately stabilized by a high extent of accumulation , that may be considered higher than the normal limit factors . It was clear the little level of polluted area , less than the polluted area , as the indicator starts to increase significantly at the first , then the accumulation stops for one level only , the graphic images Figure (3-1 a,b ),the all graphic images of spatial analysis activity of isotopic stable radioactive in soil samples in all sites below in following images.

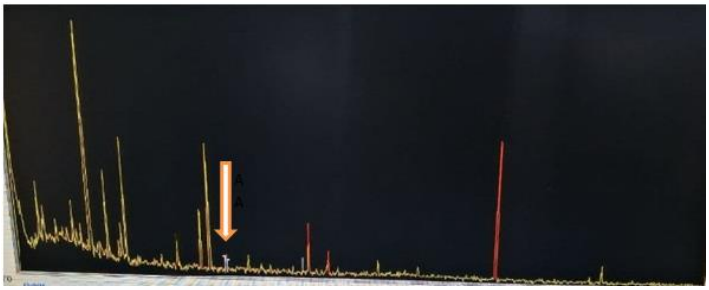

Figure (3-1) a, Graphic images of spatial analysis activity of isotopic stable radioactive in soil samples in polluted area.

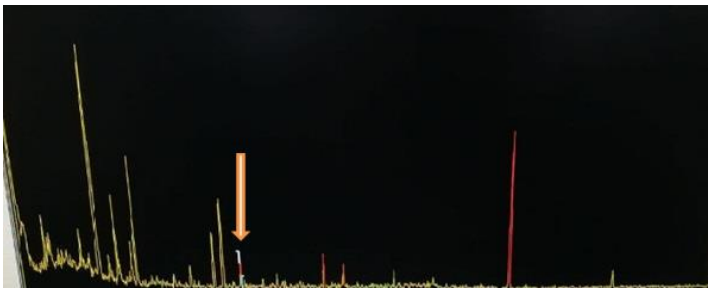

Figure (3-1) b, Graphic images of spatial analysis activity of isotopic stable radioactive in soil samples in unpolluted area .

So it can be seen the environmental indicators for a first level of pollution including a variety of influence factor, such as topography area , human activities and all the harmful releases to the surrounding environment, especially crude oil pollutants. Through the process of spatial analysis and interpretation based on the ecological characteristics of radiation exposure accumulation according methods (ESRI,2012; Ruimin iu, etal., 2016, Reyam , etal 2021). Depending on the longitude and latitude that have been taken by GPS/ Geko 201,the geographic location of study area created by ArcGIS 10.5, https://www.arcgis.com/index.html, a graphical map of the spatial analysis to all half-life the elements variables of the study areas and after checking authenticity and conformity with all input data it has been applied to obtain the highest level of

prediction in environmental factors quantitatively and qualitatively in study areas, the resulting according to energy and spatial analysis activity of isotopic stable radioactive in table (1) and figure ( 3-2).

Table ( 1):Specific Energy Isotopic Stable Radioactive in polluted area

| Polluted area | Energy | Activity | Half life | Yield |
|---|---|---|---|---|
| B1214 | 71.0Kev | 2.1082Bq/kg | 10.5Y | 30% |
| Cs134 | 1460Kev | 30.118Bq/kg | 15.8M | 7% |
| Pb 214 | 1215.2Kev | 620.05Bq/kg | 2.10Y | 30% |
| Pb212 | 1210.3Kev | 214.82Bq/kg | 12.8M | 5.8% |
| Hg228 | 1113.9Kev | 29.001Bq/kg | 2.1H | 51% |
| Unpolluted area | Energy | Activity | Half life | Yield |
| B1214 | 93.0Kev | 4.5082Bq/kg | 11.5Y | 33% |
| Cs134 | 2490Kev | 34.148Bq/kg | 16.8M | 7.09% |
| Pb 214 | 1315.2Kev | 740.55Bq/kg | 2.60Y | 40% |
| Pb212 | 1305.3Kev | 314.85Bq/kg | 18.8M | 7.8% |
| Hg228 | 1103.9Kev | 31.007Bq/kg | 2.9H | 55% |

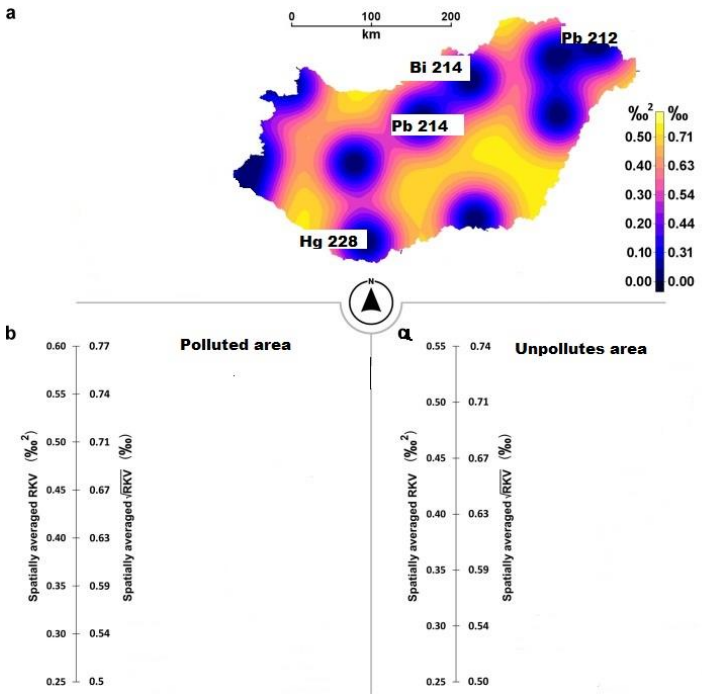


Figure (3 ): Specific Energy Isotopic Stable Radioactive in polluted and unpolluted area

**4- Conclusion :**

Based on observed spatial analysis for each elements of isotopic stable radioactive samples of all sites, examinations indicate that there is considered definite risk in future. That is evident was the spatial analysis have been showed a behavior elements and refers to the different distributions of concentrations, in general the distribution elements it was the most of the five sites for the elements (B1214, Cs134, Pb 214, Pb212, Hg228) and oscillatory the elements of conduct in the soil samples ,the results of (Pb 214, Hg228 ) in study site there were indicate significantly within high levels in polluted area , its value ( 620.05 , 29.001) Bq/kg and (740.55, 31.007Bq/kg) Bq/kg respectively in polluted and unpolluted area , more than acceptable limit which is estimate (100Bq/kg) according to (IAEA,2005)which can be used as a tracer to infer soil dynamics due not only to its long radioactive half-life as a most polluted with industrial waste and crude oil risk high values of the radioactive isotopes.

So the second step of the analysis was for determine the affected soil through the forces of magnification to compare its shapes under microscopic examination.

**REFERENCES:**


- **Eisenbud, M. and Gesell, T. (**1997).”Environmental Radioactivity from Natural, Industrial and Military Sources", 4th Edition, Academic Press, Inc.
- **NASA.(**2005)." Flashes in the Sky: Earth's Gamma-Rays Bursts Triggered by Lighting".
- **Nelson, R., & Reilly, D.** (1991)."Gamma-Ray Interactions with Matter",chapter2.
- **Annals of the ICRP**, The 2007 Recommendations of the International Commission on Radiological Protection "ICRP (37) 2-4pp.
- **Reyam Naji Ajmi** , 2018 Detection of Isotope Stable Radioactive in Soil and Water marshes of southern Iraq Journal of Global Pharma Technology. JGPT V(10) No. (9-10) ISSN 0975-8542.
- **IAEA.** (2007). "Safety Glossary: Terminology Used in Nuclear Safety and Radiation Protection", Vienna.
- **FAO, I A E A**. International Lab our Organization, Oecbd Nuclear Energy Agency, Pan American Health Organization, World Health Organization, International Basic Safety.(1996).Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources, Safety Series No. 115, IAEA, Vienna.
- **WHO and FAO**. (2011)."Nuclear accidents and radioactive contamination of foods”.
- **USEPA**.(2011).Exposure Factors Handbook. Washington, DC. /http://epacupf .ncea /risk/recordisplay.cfm?deid¼23625.
- **Hudson, F. N., Kaeberleine, M., Linfprd, N., Prichard, D., Beyer, R. P., & Rabinovich, P.S.,** eds.(2005).Microarray Analysis of Gene Expression Changes Aging,6th ed.(Academic Press).
- **Reyam Naji Ajmi, Ahmed Ghalib Ibraheem . 2021**. Spatial Analyses Distribution of Isotopic Tracers in Different Polluted Areas of Iraq. Research Journal of Microbiology and Biotechnology |ISSN: 2520-3975 |Volume 1 |Number 2 |Page No. 27-34 .