



## The Relationship between Natural Radioactivity of Al-Rohban Soil in Al-Najaf Governorate and Its Microbial Content

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### Abstract

The present study was designed to explore the relationship between radioactivity at Al-Rohban soil in Al-Najaf Governorate, located 30 km away from Najaf city center, and its microbial content. The radiological survey was conducted by  $\gamma$ -ray spectrometry, using purity Germanium (HPGe) detector. A selected surface soil layer (10 cm depth, 50 and 100 m expansion) was tested. The physical analyses were conducted in the Ministry of Environment, Center for Prevention of Radiation. The results showed that the estimated concentrations of Bi-214, Ra-226, Ac-228, Th-232, K-40 and Cs-137 were 47.93, 81.87, 5.03, 1.63, 126.3 and 3.5 Bq/Kg, respectively. Isotopes average concentrations were equivalent to the lowest specified International Atomic Energy standards. As related to the analysis of bacterial content in the soil sample, the total cell count (in cells per gram of soil) in the different areas studied (R1, R2, R3 and R4) had values of 70000, 200, 60000 and 300 cell/gm., respectively. The statistical analysis of these results revealed no relationship between radioactivity and microorganisms existence.

**Key words:** Soil microbes, Active isotopes, Radioactivity Radiation pollution.

### دراسة العلاقة بين النشاط الإشعاعي الطبيعي لترب منطقة الرهبان في محافظة النجف الاشرف ومحتواها الميكروبي

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### الخلاصة

اجريت الدراسة الحالية لاستكشاف العلاقة بين النشاط الإشعاعي في تربة منطقة الرهبان بمحافظة النجف الاشرف ومحتواها الميكروبي. أجريت التحاليل الفيزيائية في وزارة البيئة مركز الوقاية من الإشعاع- الهيئة العراقية للسيطرة على المصادر المشعة قسم البحوث الإشعاعية. أظهرت النتائج أن القيم التقديرية لتركيز النظائر (Bi-214 و Ra-226 و Ac-228 و Th-232 و K-40 و Cs-137) كانت ( 47.93 و 81.87 و 5.03 و 63.1 و 126.3 و 3.5 بيكريل / كغم) على التوالي. وكان متوسط تركيز النظائر يعادل أدنى المعايير الدولية المسجلة للطاقة الذرية. هدفت الدراسة إلى إجراء مسح إشعاعي للتربة في منطقة

الرهبان على بعد 30 كم من وسط مدينة النجف. تم استخدام طبقة التربة السطحية المختارة وعمقها (10 سم) ومساحتها (50 وكذلك 100) م من مكان محدد، وعلاقتها بمحتواها الميكروبي. كان العدد الكلي في المناطق المدروسة (R1 و R2 و R3 و R4) التي أظهرت العدد الإجمالي هو (70000 و 200 و 60000 وكذلك 300) خلية / غم من التربة على التوالي، من خلال مسح هذه المناطق المختارة. كشف التحليل الإحصائي ( اختبار مربع كاي) لهذه النتائج عن عدم وجود علاقة بين هذه النظائر المشعة والمحتوى الميكروبي الكلي.

## Introduction

Al-Rohban area is located at the west of Najaf governorate (200 km west of Baghdad) and 15 km north-west of Rahema village, which surrounds the populated area. Fire events of unknown origin began to appear in this area that some people attributed to volcanic activity while others attributed long time-burned wood and tree branches that may have been introduced into the interior of soil[1]. Environmental pollution of Najaf governorate has been studied by many researchers; Tueij (2011) evaluated many groundwater chemical elements at the region between Al-Rahema and Al-Aziyah of Al-Najaf province. The outcomes indicated that the greatest portion of groundwater is not suitable for use due to salinity [2]. Al-Rammahi (2012 and 2019) detected the radiological activity of Al-Ansar soils neighborhood in Al-Najaf province. The results of concentrations measuring of ordinary radionuclides of the uranium successions (B-314 and R-226) and the thorium series (Ac-228 and Th-232 ), K-40, and C-137 for various selected samples showed values that are consistent with IAEA minimum values. The authors concluded that radiation was not the core reason leading to cancerous diseases that appeared in this area after the Gulf War [3&4]. Houmadi (2013) assessed the nuclear radioactive pollution influenced by uranium excavating[5]. He measured the ordinary radioactivity of the radionuclides K-40, Th-232, and U-238 in the surface area nearby the uranium mine of Al- Najaf province. The results were compared with global average values, and the comparison showed that the examined area was not safe according to the criteria of radiological risk [6]. Al-Hamidawi and others (2013) measured levels of radon (Rn-222) in 40 homes in Al-Najaf city. They detected particles of alpha source produced from radon by cumulative inert radon doses that were previously calibrated. The results indicated that radon levels were within the overall global permissible level in the air inside residential areas. As the volcanic level is limited in Red Sea and Dead Sea and bordering regions, e.g. Jordan, Saudi Arabia and Yemen, mainly regions closest to the eastern side of the Red Sea either in the Iraqi desert and Iraqi sedimentary regions, which is far from the areas of volcanoes due to the forces field of influencing Iraqi areas which are the polarization forces, but volcanoes ground power is product of forces from chastity led to opening of the crust and lush exiting [7]. A minor crack occurred alongside the fault of Abu-Jir – Euphrates, which is an active crack that outspreads at long distances. Hydrocarbons were released from bottomless oil reservoirs, while gases were exploding very easily. Also cause organic and hydrocarbon substances burning of adjacent the fault, which have already been ripped off from fault in preceding times and coincided with the soil [1, 2, 3, and 8]. Uranium also creates an important concern against human health [9]. Its solubility in soil is influenced by pH, redox potential, temperature, soil consistency, organic and inorganic composites, humidity and microbial activities [10]. Soluble forms move with soil water and are absorbed by plants or aquatic organisms or volatilized [11]. In view of this, the contamination by uranium has severe negative biological effects on important groups of the soil food web [12&13]. Its contamination in soil and water has been identified globally at many sites; therefore, measures for preventing its assimilation by plants need to be considered as the first step in the remediation of contaminated sites [9&14].

Shanshal *et al*, 2019, studied radioactive pollution in the soils of Fallujah city, west Iraq, at the ground depths of 0-20, 20-40 and 40-60 cm [15]. The results indicated the dispersion of the radioactive material, described as depleted uranium, down within the 3 levels of soil layers studied.

Bacteria and archaea, being original inhabitants on earth, act as microorganism models of the planet. These microbes have constantly demonstrated their mettle by living in extreme environments, including even dangerous ionizing radiations [16]. Their capabilities to accept and undergo steady genetic mutations have led to changes in recombinant mutants that could control remediation from several chemical contaminants, such as heavy metals, hydrocarbons, and even radioactive waste (radwaste). Therefore, microbes have been frequently introducing themselves as major candidates for

appropriate remediation of radwaste. It is exciting to learn the behind-the-scene relations which these microbes possess in the existence of radionuclides [16-21].

It is important to look at the radiation tolerance of microbial groups. Radiation may also impression upon the extracellular location, which may subsequently affect the capacity for microbial processes. For instance, the radiolysis of water produces molecular hydrogen, which might be used as an electron supporter for a variety of microbial electron accepting processes. Additionally, radiation has been displayed to break down natural organic matter in soils, resulting in rises in dissolved organic carbon (DOC), this radiolytic deprivation of organic matter may enhance the bioavailability of organic carbon for microbial metabolism [17].

The evolution of biogeochemical processes is implicated with microbial activity in the contiguous geosphere, comprising microbial gas production and utilization, corrosion, and the mobility of radionuclides [6].

In addition, there will be raised concentrations of potential electron donors in and nearby the repository, including organics from cellulose degradation in waste [3]. In a recent study on this region, identified the nature of Al-Rohban region and its suitability to cultivate essential economic plants, e.g. *Triticum aestivum* L (wheat), in addition to the radioactivity information of its constituents[4].

Due to the religious significance of Al- Najaf city which is visited by millions of pilgrims each year, it is additionally required to study this area and define the radioactivity of its constituents. Radiation pollution means the existence of radiant components that may be part of the nature of the terrain or resulting from nuclear experiments, armed actions or other causes. The vegetation or particular life manners are released to the exterior and could be spread by food chain to human body and transferred straight to humans by environmental impacts that led to severe environmental complications [3,4; 18]. Therefore, the objective of the present study is to determine the relationship between radioactivity and microbial content in Al-Rohban area soil.

## Materials and methods

### 1- Sample preparation and quantification models

Samples of soil were collected from Al-Rohban area. Soil models were analyzed at the Radiation Protection Center laboratories (Ministry of Environment) based on equivalent standard conditions for relevant models. Physical modeling was performed on dry soil samples by removing impurities, whereas drying processes were conducted on wet models using standard devices (electric furnace and sieve). Sample weights ranged from 713 to 1000 grams. Each model took one hour for complete quantification, which was achieved after measurement of background radiation under similar conditions (Figures- 1, 2, 3 and 4).

### 2- Gamma spectral analysis

1- Gamma spectral analysis was conceded by using two types of methods. First, the qualitative analysis to determine total radionuclides.

2- The quantitative analysis to determine  $\gamma$ -ray spectrometry using purity.

Germanium detector (HPGe, ssize 3x3, efficiency 30%, FWHM 2 Kev for the 1332 Kev peak of Co-60) was used, connected with multi-channel analyzer (MCA) with Genie™2000 gamma analysis software and power supply.  $\gamma$ -ray spectrometry analysis results are demonstrated in Figures- 5, 6, 7 and 8.

### 3- Microbial total count in soil samples

Pour plate method and serial dilution of soil samples were used for the estimation of the microbial total count on different basic and selective media (nutrient agar, MacConkey agar, and potato dextrose agar PDA). Identification of Gram negative and Gram positive bacteria was carried out according to Bergy's manual (1994) by using Gram stain, biochemical identification (e.g. IMViC, urease, catalase, oxidase, H<sub>2</sub>S production, sugar fermentation), and morphological and cultural characteristics [19].

### 4- Statistical analysis

Chi-square test was used to analyze the results, while the rejection level was set at 0.05. The software used was SPSS V23[20].

## Results and discussion

Table-1 demonstrates samples from different locations of selected soil specimens. The samples were collected from the surface area (10 cm depth) at distances of 50 and 100m of burned areas. Also, the different types of soils were studied, such as slightly fossilized, highly humid, and clay soils.

Table-2 shows the bacterial count of different selected soil samples from four regions (R1, R2, R3 and R4), revealing varied total counts. The statistical study, using Chi – square [ $X^2= 0.86$ , d.f =1,  $\alpha=0.05$ ], revealed no relationship between the different soils and the number of bacterial content. The most resistant microbes belonging to the genera *Bacillus*, *Serratia*, *Arthrobacter*, *Pseudomonas*, and *Rhodococcus* were isolated. Resistance was shown to be due to intrinsic features of the bacteria [16&21]. Intracellular sequestration of U was reported to contribute to resistance, while processes such as bioprecipitation and biomineralization were found to limit the toxic effects of U [16]. Denaturing gradient gel electrophoresis (DGGE) was used to compare the patterns of bacterial community, which was established by existence of complex inhabitants in both uranium-rich samples and control. Bacterial populations found in uraniumiferous soils showed a stable state overtime in comparison with control [22&23].

Table-2 shows the results of spectra measured by using a measurement system with the Genie 2000 program. The results include the specific quality in Bq / Kg of measured isotopes and show the extent of the containment of the soil models for natural radiation activity that affects the contiguous location in Najaf governorate. IAEA reports (International Atomic Energy, 1989)[24], and the local studies indicated that there is definitely no radioactive contamination. Rather high concentrations of Ra-226 (124.7 Bq / Kg) were recorded in the R2 soil model (i.e. soil of depth of 10 cm and 50 m from the fire center). These values are comparatively high compared with the environmental radioactivity concentrations reported in the Najaf governorate plan for 2010, with the maximum concentration of Ra-226 radium at 23.3 Bq / Kg. This upsurge is due to the geographical nature of this zone or because of the harmful effects of military operations in the southern, western and central areas of Iraq during the last decade. It was reported that the coalition countries used prohibited explosives that are coated with depleted uranium alloy. During the Gulf War, large parts of the Iraqi soil were possibly contaminated with uranium from burned and contaminated armor, but probably with low levels. In addition, Pb-214 was found in high levels in the soil of R1 and R2 sites (50 m as of the burning center, the external area / 50 m depth of 10 cm) with values of 17.2 and 65.1 Bq / kg, respectively. These values are indicators of agricultural soil pollution.

**Table 1-** Soil types and sites of AL-Rohban region in Al-Najaf province

Sample No.	Bacterial count (cell/gm)	Specific efficacy (Bq /Kg)					
		Cs-137 Bq/Kg	K-40 Bq/Kg	chain Th Th Isotopes Bq/Kg	Ac-228 or Tl-208** Bq/Kg	chain U/Ra Isotopes Bq/Kg	U/Ra Bi-214 or *Pb-214 Bq/Kg
R1	70000	6.1	102.8	Pb-212=1.3	4.2	Ra-226=31.04	17.2
R2	200	1.2	59.4	B.D.L	2.9	Ra-226=124.7	65.1
R3	65000	9.5	189.6	Pb-212=4.09	5.3	Ra-226=9.02	5.8
R4	300	1.6	95.3	Pb-212=2.2	4.8	Ra-226=8.7	6.8

\*U – 238

\*\* Th - 232

**Table 2-**Bacterial count and Isotopes concentration of selected soils in AL-Rohban region

Sample No.	Sample type and weight	The site of the samples
R1	Little fossilized Soil 0.713Kg	Soil surface 50 m away from fire center
R2	High humidity soil -1Kg	Soil of 10 cm depth, 50 m from fire center
R3	Soil- 1Kg	Soil surface 100 m away from fire center

R4	Clay soil- 1Kg	Soil of 10 cm depth, 100 m from fire center
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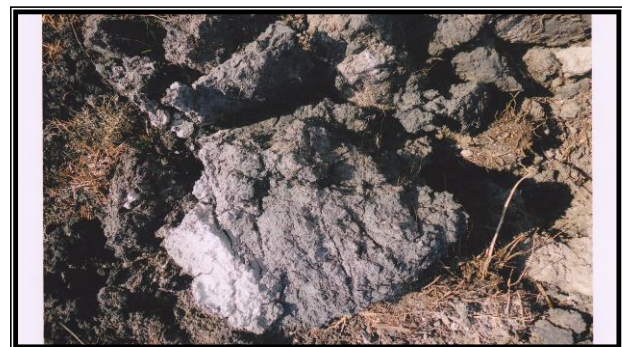
**Figure 1-** The burning soil surface at AL-Rohban mission (month of burning)



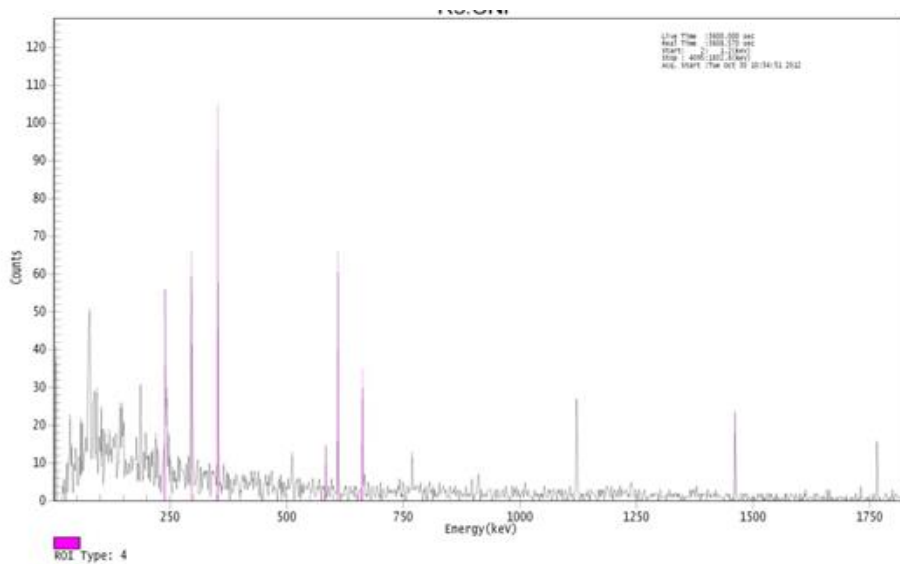
**Figure 2-**The center of fire filled with water.



**Figure 3-** The burning soil and the vegetation around it.



**Figure 4-** Burnt-block taken from the center of the emission fire after six months.



**Figure 5-** Represents  $\gamma$ -ray spectrometry for the R1 sample from AL-Rohban region

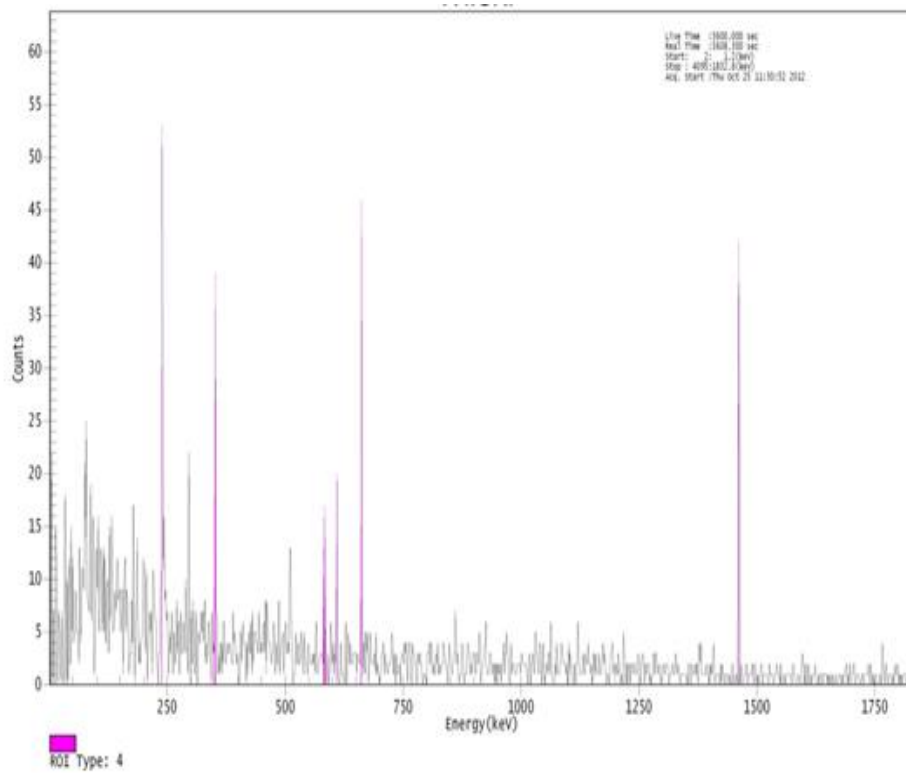


Figure 6-Represents  $\gamma$ -ray spectrometry for the R2 sample from AL-Rohban Region

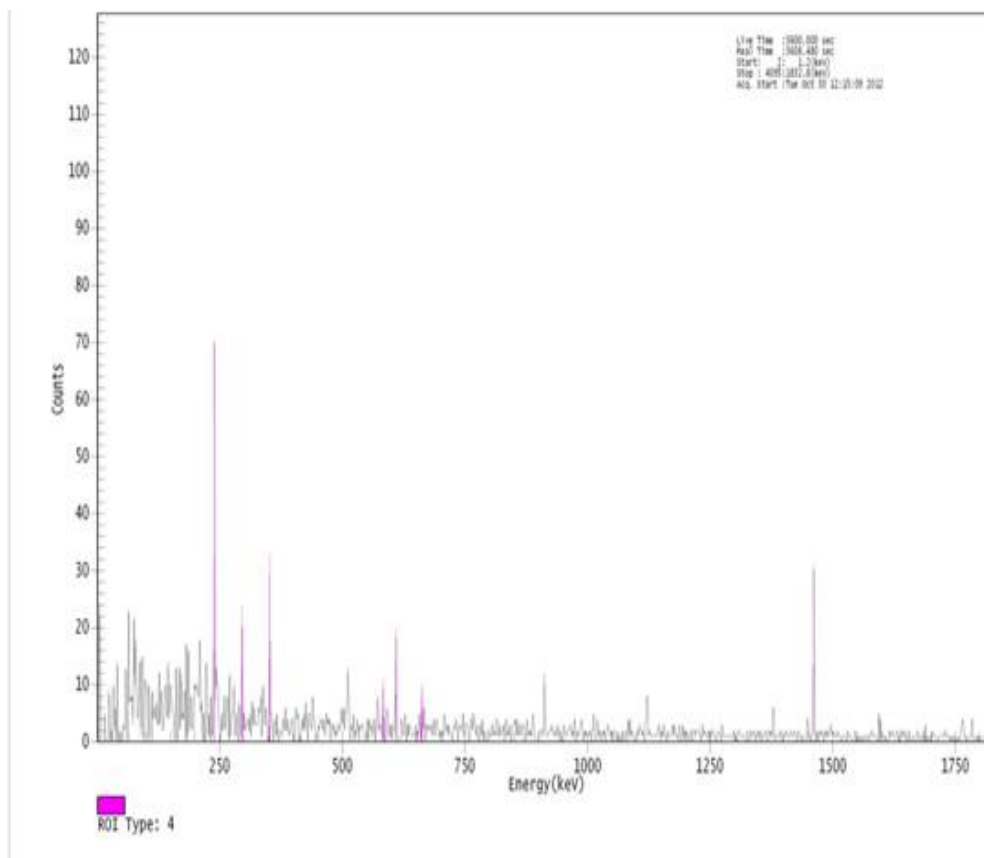
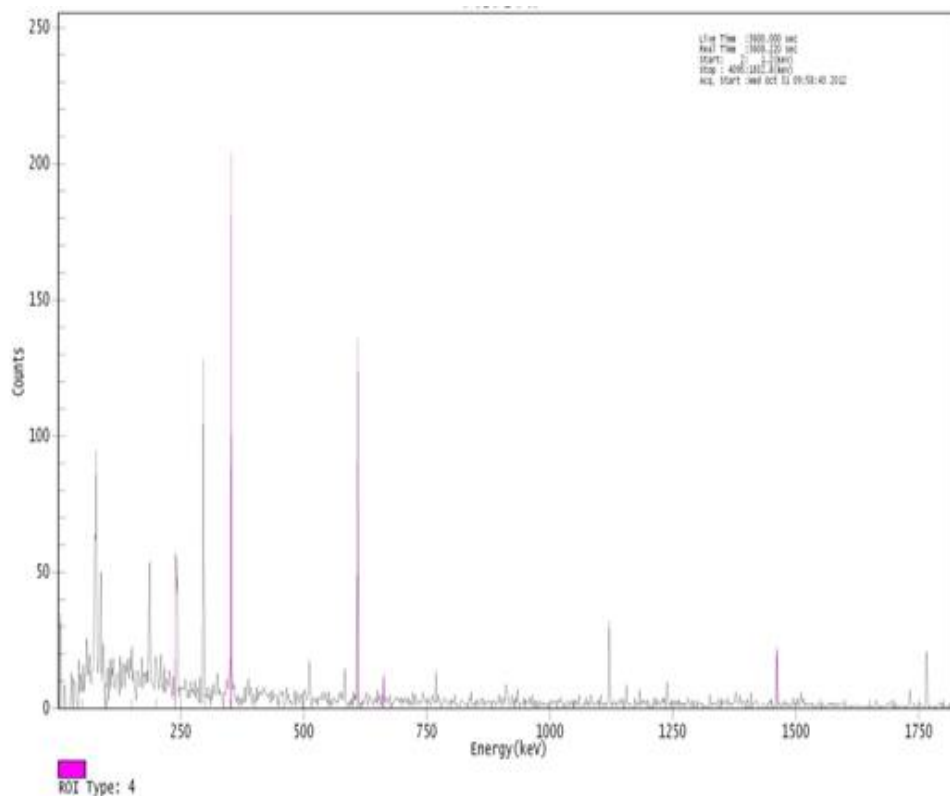


Figure 7-Represents  $\gamma$ -ray spectrometry for the R3 sample from AL-Rohban region



**Figure 8-** Represents  $\gamma$ -ray spectrometry for the R4 sample from AL-Rohban region

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