Determination of Natural Radioactive Concentration Levels in a Selection of Halfaya Oil Drilling Wells in Maysan Governorate, Iraq

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Concentrations of NORM and radiological hazard indices were surveyed and assessed in well numbered of one, two and three from the Maysan oil field in southern Iraq. The geographic distributions of natural-radionuclide-ray activities and their hazard indices in 226Ra, 232Th, and 40K nuclei were all determined in samples collected from different depths, including Halfaya wells in Maysan Governorate. 226Ra observation was mainly between 2 (average radiation concentration). 63 to18. 8 Bq. kg-1, 1. 18 to18. 6 Bq. mg-¹for 232Th is 150, and for 40K it is 156. 4 to 561 Bq. kg-1. Radium-equivalent activities (Raeq), the internal hazard index (Hin), the external hazard index (Hex), a gamma representative radiation level index (Iγr), and excess lifetime cancer risk (ELCR) have been calculated. During the Raeq range from 18 to a maximum and minimum Raeq. 39and 82. 33 Bq. kg-1, respectively. The ambient level dose rates in air arising from the concentration of these three radionuclides were in the range of 9. 26 to 40. 47nGy/h, after wars the external annual effective dose rate of the areas achieved was in between 005and 0. 22 mSv/y.

Keywords: Radioactive, NORM, hazard indices.

1. Introduction

Naturally occurring radioactive material (NORM) exists in the Earth's crust and can be enhanced by procedures associated with the production of oil and gas. The term "technologically enhanced NORM" (TENORM) describes this NORM. It might be concentrated in waste products from the oil industry, like sludge, drilling mud, and pipe scale. For the most part since the Earth's origin, long-lived nuclides have made up NORM. Primates is the name given to them [1, 2].Humans are exposed to natural radioactivity, which is assumed to be the primary source of radiation and accounts for more than 75% of all ionizing radiation[1, 3].They can be distinguished from one another by virtue of the intrinsic norm that each of them possesses. Another element is the environmental effects of NORM building up in rocks. We call the capacity to carry out duties "energy." Many different types of hydrocarbons that are found underground as gasses, liquids, or solids are together referred to as "petroleum". Crude oil and natural gas are the two most commonly used forms[4, 5]. Petroleum is composed mostly of a complex mixture of hydrocarbons, mostly alkanes and aromatic compounds[6, 7]. When illuminated by reflected light, the color can have a greenish tint, although it can also be pale yellow, red, brown, black, or greenish. Petroleum is a fossil fuel because it was formed from the remains of tiny sea plants and organisms that sunk to the ocean floor millions of years ago. global environmental problems that are getting worse [8, 9].

2. Iraq Subsurface Tectonic Structures

Any region's tectonic situation, as shown in Figure 1 describes how the elements, such as the main faults and tectonic zones, are arranged. Since 1984, there have been numerous changes made to Iraq's tectonic map. The tectonic map of Iraq has changed as a result of ongoing geological research, new interpretations of the available geological and geophysical data, and the evolution of the tectonic philosophy [10-12]. Several writers revised the Iraqi tectonic map numerous times between 1984 and 2015. Most of them work for the Iraqi Geological Survey as geologists. They mostly rely on the geological and geophysical data that is available from their company, in addition to the inventory seismic reflections data section and the geological interpretation of Oil Exploration Company. Professionals at the Iraqi universities could provide more information. The boundaries, zones, and faults that make up the tectonic elements can occasionally alter from edition to edition depending on the geological data utilized or the writers' changing philosophical views. The majority of authors agreed that the stable and unstable shelves (inner and outer).

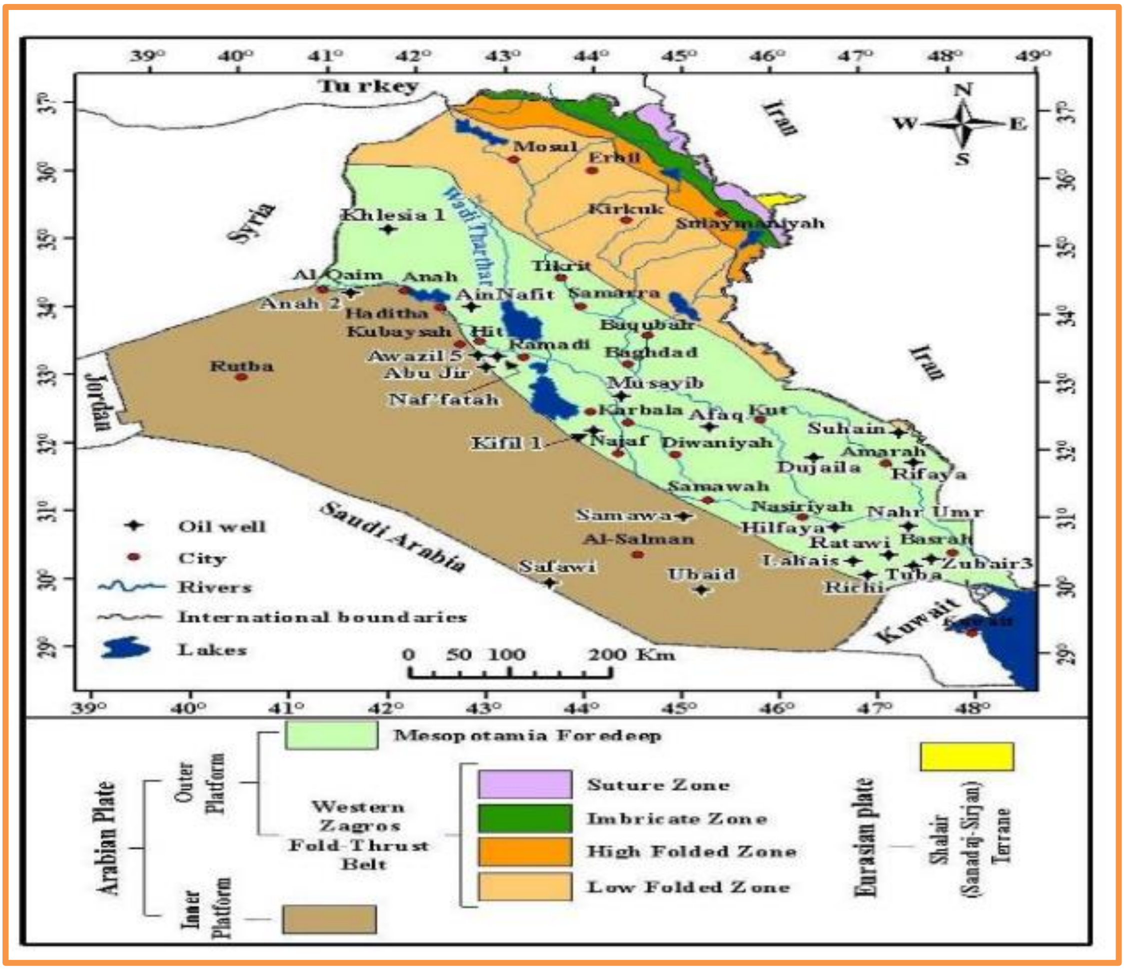

Figure 1. Tectonic division of Iraq [13]

3. Study area

The site of the Halfaya field is 35 km southeast of Amara city, which is located to the south of Iraq in Missan province, as shown in Fig2. This complex structure is composed of dome and NW-SE directed main runs as well as a gentle elongation anticline about 38 km long and 12 km wide. [14, 15].

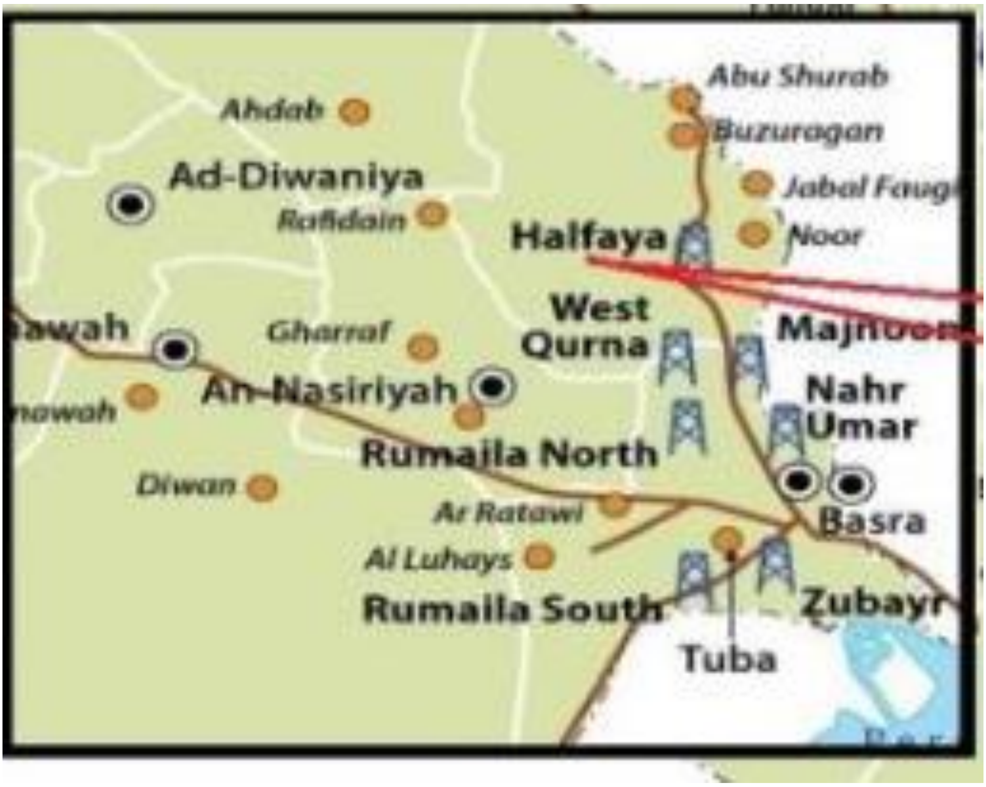

Figure 2. Maysan oil fields shown the study area [16]

4. Sample preparation

Eight soil and three crude oil samples were collected from different penetrating depths of Halfaya oil well in Maysan Governorate, including HFO-735 which is located in southern Iraq range from 1900 to 4500 m depth. Figure 3 illustrates the formation and the depth from which the samples were taken. These gathered samples would be then put in an air drier to evaporate moisture, crushed and milled into fine powder and then sieved using a 0. 3 mm mesh size. For gamma determinations, masses of the samples were taken, then loaded into Marinelli beakers and sealed.

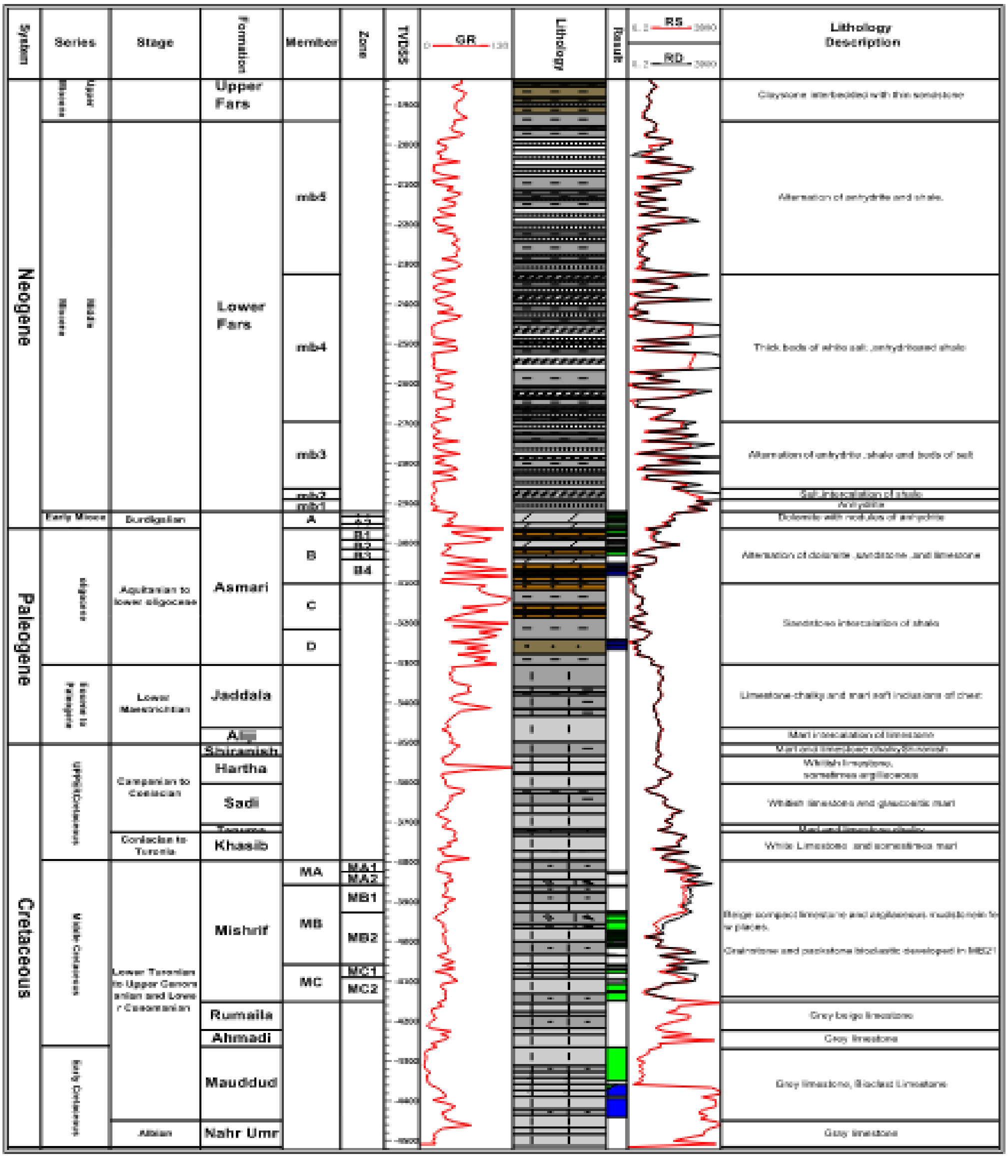

Figure 3. Stratigraphic column of south Iraq, Maysan region, with hydrocarbon generation parameters

5. Gamma spectrometry systems

5.1High purity germanium(HPGe)

Gamma spectrometry constitutes a fast and easy method for the qualitative and quantitative investigation of gamma-ray emitting radionuclides. It is a non-destructive radiometric technique widely used for the measurement of gamma-emitters applying discrete gamma energy lines of the various radionuclides.

1. High-purity germanium (HPGe): The detector is a noun that is used this way.

2. Preamplifier: This component forms a crucial section of the detector unit. It should be installed almost next to the detector in order to maintain low noise in detector operation.

3. Linear amplifier: This often is integrated in MCA to power up the pulse with a few hundred of gain factor. It has a voltage of about several volts, and it also is used to transform the pulse for more informative measurements.

4. Bias high-voltage power supply: This is done to provide high voltage to the detector and range from 0 to 5000 D. C. volts. The need is to increase it very gradually for the detector safety.

5. Personal computer: This is the way how MCA stores the number of pulses detected and with what size(voltage) into a memory channel. Later this information is analyzed to express information baggage about gamma rays. Every pulse that the number of memory increases its stored counts is called "accumulate counts". This is the distribution of counts for MCA memory channels is a spectrum range. The Figure4 displays the block diagram of the HPGe detector subordinates..

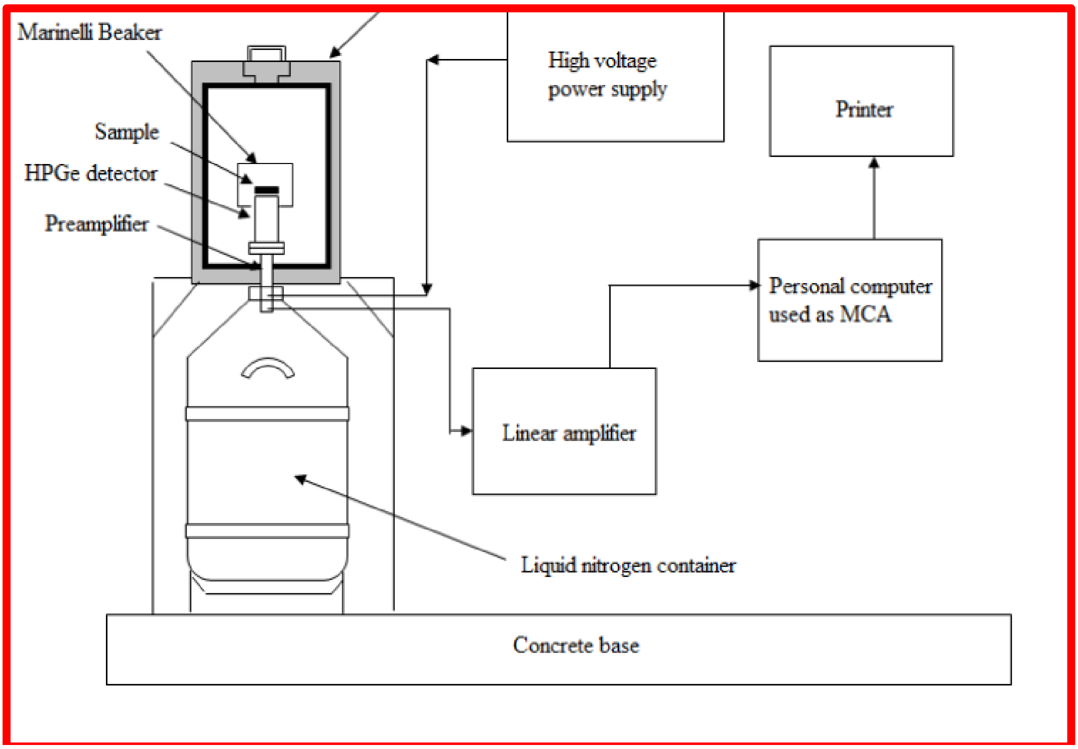

Figure 4.Gamma -ray spectroscopy system diagram for the present study

6. Results

6.1NORM in Soil and Rocks Samples for Halfaya Oil's Field

The extracted data for investigated soil and rock samples for NORM isotopes belongs to group HFO-735 and is given as . Finally, the maximum value of specific activity for 40K was 561. 0 Bq/kg in sample 10 but the minimum value of specific activity was 156. 1 Bq/kg for sample 1. 4 Bq/kg in analyzed matter . Table1 shows that the maximum value for the SA of the ^{226}Ra radioactive isotope was 18.8 Bq/kg in sample 4 for Lower Fars formation , while the minimum value was 2.63 Bq/kg in sample 7 for Lower Fars formation due to the nature of the rocks characterized.

For the ^{232}Th isotope , the maximum value of specific activity was 18.6 Bq/kg in sample 2, while the minimum value was 1.18 Bq/kg in sample 7. Moreover, the maximum value of specific activity for ^{40}K was 561 Bq/kg in sample 10, while the minimum value of specific activity was 156.4 Bq/kg in sample 9.

Table 1.Halfaya HFO-735 well properties and the activity concentrations of ^{226}Ra, ^{232}Th, and ^{40}K for soil and rock samples

N	Sample type	Formation	Depth m	Ra-226 Bq/kg	Th-232 Bq/kg	K-40 Bq/kg
S1	**Soil**	**Uppere Fars**	**820**	**16.1**	**17.2**	401.6
S2	**Soil**	**Uppere Fars**	**920**	**15.05**	**18.6**	384.6
S3	**Rock**	**Uppere Fars**	**1000**	**17**	**17.3**	365.6
S4	**Rock**	**Lowerer Fars**	**1400**	**18.8**	**13.2**	382.3
S5	**Rock**	**Lowerer Fars**	**1500**	**7.9**	**3.3**	476.8
S6	**Rock**	**Lowerer Fars**	**1600**	**4.1**	**1.2**	351.6
S7	**Rock**	**Lowerer Fars**	**1700**	**2.63**	**1.18**	214.8
S8	**Rock**	**Lowerer Fars**	**1800**	**5.8**	**2.1**	216.7
S9	**Rock**	**Lowerer Fars**	**1900**	**3.2**	**2.2**	156.4
S10	**Rock**	**Top Jeribe**	**2000**	**17.25**	**15.3**	561
Max				**18.8**	**18.6**	561
Min				**2.63**	**1.18**	156.4
Mean				**10.783**	**9.158**	351.14

6.2 Gamma Dose Rate

The gamma dose average rate (D) of the full sample has a median value 25. 07 nGy⁄h . The highest number was 40. 47 nGy/h only in sample 10 and the value was less than the permitted value while the lowest value was 9. Sample 9 receives 26 nGy/h as showed in the

Table 2 and the Figure 5.

Table 2. Hazard indices in Halfaya HFO-735 Oil's Field

N	Ra_{eq} Bq/kg	D nGy/h	Hin	Hex	$I\gamma r$	AEDEin mSv/y	AEDEout mSv/y
S1	**71.62**	**34.59**	**0.24**	**0.19**	**0.55**	**0.17**	0.04
S2	**71.26**	**34.27**	**0.23**	**0.19**	**0.54**	**0.17**	0.042
S3	**69.89**	**33.59**	**0.23**	**0.19**	**0.53**	**0.16**	0.041
S4	**67.11**	**32.56**	**0.23**	**0.18**	**0.51**	**0.16**	0.04
S5	**49.33**	**25.25**	**0.15**	**0.13**	**0.4**	**0.12**	0.031
S6	**32.89**	**17.06**	**0.1**	**0.09**	**0.27**	**0.08**	0.021
S7	**20.86**	**10.75**	**0.06**	**0.06**	**0.17**	**0.05**	0.013
S8	**25.49**	**12.87**	**0.08**	**0.07**	**0.2**	**0.06**	0.016
S9	**18.39**	**9.26**	**0.06**	**0.05**	**0.15**	**0.05**	0.011
S10	**82.33**	**40.47**	**0.27**	**0.22**	**0.64**	**0.2**	0.05
Max	**82.33**	**40.47**	**0.27**	**0.22**	**0.64**	**0.2**	0.05
Min	**18.39**	**9.26**	**0.06**	**0.05**	**0.15**	**0.05**	0.011
Mean	**50.917**	**25.07**	**0.17**	**0.14**	**0.4**	**0.12**	0.03

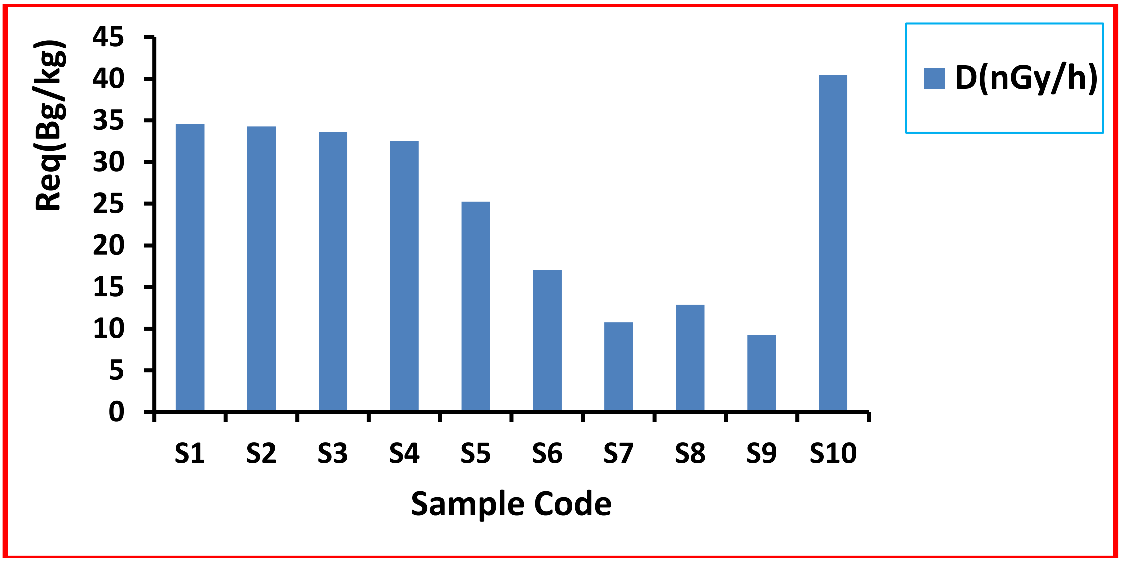

Figure 5. D(nGy/h) in soil and rock samples as a function of well name of Halfaya HFO-735 Oil's Field

The average figures of the external and internal hazard indices (Hex, Hin) are the same. 17 and 0. 14, respectively. the biggest value of Hin was zero. 10:27 in samples 10, and the optimum value was 0. We had an average value of 02 in cables 9, however, the highest Hex values attained were 00. The max value is 22 in sample number 10. and the min value is 0. 05 in samples 9. Then, for the complete earth and rock, the Hex and the Hin were, actually, within the normal range but fell below unity .

For all of the soil and rock samples studied, the mean annual effective dose equivalent (EDEAE) for terrestrial gamma rays is the same. 12MSv/y indoors and 0mSv/y outdoors. 03 mSv/y outdoors. The dose rates values of nGyh were shown in Table 2, to AEDE (indoor) and AEDE (outdoor) for the soil and rock samples. The peak score of AEDE (inside) was 0. In sample 10 the value of 2 mSv/y is upper, and the least one is 0. 05mSv/y in samples 9. The max value of AEDE (outdoor) is equal to zero. 5* mSv/ y in samples 10 and the minimum value was 0. 0,11 mSv/y in [samplings] 9 .

The average galvanization index (Iγr) for the soil and rock samples was 0. 4th overall, sample 10 has the max value of 0. 64 and sample 9 presenting the lowest value 0. 05.

7. Conclusion

The concentrations of radioactive elements are inversely proportional of depth as shown from the results. The amount of NORM from an oil producing field generally increases as the amount of produced water pumped from a petroleum formation increases, because of their relative insolubility, are not usually carried with the fluids to the surface in high concentration. However, is very soluble under some conditions and is easily mobilized and carried to the surface along with the produced water. Changes in pressure and temperature at the surface enable radium to co-precipitate with barium, calcium, and strontium in the form of complex com- pounds of sulfates, carbonates, and silicates .

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