Properties of Soil in Najaf Governorate

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Received in:2/July/2017, Accepted in:15/May/2018

Abstract

Eight soil samples were selected around Najaf governorate at depth levels 40-50 cm. X-Ray Fluorescence (XRF) was used to determine the concentrations of major and trace elements. Liner and mass attenuation coefficient (μ, μ_ρ) have been determined at gamma energies (662, 1172,1332) keV using NaI (Tl) detector. The range of linear attenuation coefficients for calculated samples were (0.553-1.163) cm^{-1}, (0.122-0.178) cm^{-1} and (0.049-0.105) cm^{-1} at (662, 1172,1332) keV respectively. The range of mass attenuation coefficients obtained (0.39-0.76) cm^2/gm, (0.087-0.117) cm^2/gm and (0.0336-0.074) cm^2/gm at (662, 1172,1332) keV respectively. The results showed that Fe content in the samples has a strong effect on the mass attenuation coefficient and this parameter is inversely proportional to the gamma energy.

Keywords: X-Ray Fluorescence (XRF), mass attenuation coefficients, soil samples

Introduction

The soil characteristics were studied in a different directions depending on its importance area from the viewpoint of specialists. Farmers are interested in the ingredients for plant growth and fertility. The changes of geology soil due to climate extremes and erosion are the geologists interest. American Society of Soil Science (SSSA), has more comprehensive look. Soil is a living system, a complex mix of minerals and compounds. The properties of soil are changing according to the weather condition such as wind, rain and erosion. Therefore, the soil quality is associated with the benefit from it. Soil is not specific but it is always susceptible to environmental fluctuations. This means that we need to get complete information about a particular type of soil characteristics and continuously [1].

Determination of the chemical properties of soil composition such as C, Na, S, Ca, Mg, P, K, etc in addition to the physical properties such as density, porosity, sand, clay and humidity are the most important elements to determine soil quality. Gamma ray interaction with the soil depends on chemical and physical properties [2].

The attenuation coefficient is an important criterion for describing the transmission of radiation within the soil. The accurate measurement is important to obtain the physical properties of the soil [3]. Gamma ray which passes through the material makes either absorbed or scattered. The degree of attenuation coefficient depends on many factors which are: the material density, sample composition, photon energy and the length of the radiation path within the material. The attenuation of a gamma-ray flux passing through a path of length x in a sample with linear attenuation coefficient μ can be expressed as [4]:

$I = I_o e^{-\mu x}$ ---------(1)

Where

I_o: the area under the peak during a certain time without any absorber, I: the area under the peak during the same time, x: the path length of gamma radiation inside the absorber material in (cm) units and μ is the linear attenuation coefficient in (cm^{-1}) unit. The mass attenuation coefficient (μ_m) of the material is given by:

$\mu_m=\mu/\rho$ ---------(2)

where ρ is the density of the absorber material in (gm/cm^3) unit. Equation (1) may then be expressed using the mass attenuation coefficient and the density of the material.

$\text{Lin } I = \text{Lin } I_o - \mu_m X_m$ ---------------------(3)

Many published reports calculated the linear and mass attenuation coefficients for different soil samples. [5-10].

Experimental details

Samples were collected from different sites around the Najaf Sea. The governorate of Najaf as seen in table (1) 170 km south-west from city of Baghdad (capital city of Iraq). The coordinates of area is 30° 3” 29” N, 31° 13' 44” E at depth of 50 cm from the ground surface of soil . This area was selected for an important geology, that containing groundwater reservoirs.

X-Ray florescence (XRF):

In this work the soil samples were crushed to dimeter range of less than 125 μm and greater than 63 μm. Samples were dried in an oven at temperature between 100-120 ^{0}C for 24 h . Samples were cooled and pressed in hydraulic press into 15 Ton/cm^2 in dimeter 32 mm. The chemical composition of the soil samples was analyzed using an energy-dispersive X-ray fluorescence (EDXRF) spectrometer from SPECTRO (X-LAB 2000) . X-ray tube used with a detector silicone – lithium with energy resolution 45ev for 5.9keV of iron (Fe-55) isotope. Three target were used to generate different X-ray energy.

Liner and Mass Attenuation Measurement

The samples were crashed via an agate electric mill, grinded with the particle size of approximately 200 µm to obtain homogeneous samples to reduce the error due to preparation of the samples and dried to 100^0C for 24 h The radioactive sources used in this study such as ^{137}Cs (662 KeV), ^{60}Co (1173, 1332 keV). The whole system was enclosed in lead shielding to reduce the background counts. The system utilized in this work NaI(Tl) detector. Genie 2000 gamma spectroscopy system was employed for this purpose (Canberra Industries, USA for the anslysis). The counting time fixed for 1800 sec to remove error due to the random nature of radioactivity.

Table (1): The region code with the region name

No.	Region code	region name
1-	KS-1	First kasser
2-	KS-2	taktak
3-	KS-3	Al-sad
4-	KS-4	Al-rohanya
5-	KS-5	Abo-kamsat
6-	KS-6	Al-rehmauy
7-	KS-7	Al-maleh
8-	KS-8	Second kasser

Result and discussion

The concentration elements for various soil samples are given in Table 2, 3, and 4. Table 5 gives the linear and mass attenuation coefficients using gamma transmission measurements that taken from figures (1-14) in regions (KS-1 – KS-8) respectively. The liner and mass attenuation coefficients of the soil samples decrease with increasing the energy as shown in Figure (15-16). The liner and mass attenuation coefficients depends on the strength and chemical composition of the soil samples particularly iron ratios as shown in Figure 17. Table (6) and figure (18) show the comparison of the results from the current study with the other soils of country.

Table (2): The major concentration % elements for various soil samples

Soil sample	Na	Mg	Al	Si	S	K	Ca	Ti	Mn	Fe
KS-1	0.28	0.041	0.028	0.729	0.0002	0.36	9.55	0.065	0.017	1.09
KS-2	0.3	0.044	0.0091	0.77	0.023	0.128	12.84	0.022	0.010	0.328
KS-3	0.37	0.055	0.015	0.65	0.0002	0.21	12.02	0.03	0.013	0.44
KS-4	0.29	0.043	0.028	0.746	0.0002	0.368	8.03	0.089	0.0198	1.433
KS-5	0.29	0.042	0.01	0.83	0.0002	0.13	9.81	0.0067	0.0145	0.203
KS-6	0.32	0.051	0.0094	0.801	0.002	0.178	6.722	0.006	0.008	0.19
KS-7	0.3	0.046	0.009	0.64	0.053	0.33	5.32	0.035	0.014	0.88
KS-8	0.31	0.048	0.01	0.68	0.0002	0.207	6.84	0.081	0.013	0.36

Table (3): The trace concentration % elements for various soil samples

Soil sample	P	Cl	V	Cr	Co	Ni	Cu	Zn	Mo	I
KS-1	19.0	2.0	11.0	68.0	58.5	8.8	6.1	6.6	31.0	14.8
KS-2	35.5	2.0	14.0	70.0	77.0	10.2	6.6	8.7	5.8	30.0
KS-3	16.1	2.0	16.0	97.0	33.8	27.2	10.2	15.4	30.0	19.0
KS-4	18.0	13.3	13.0	75.0	29.9	19.1	5.8	9.8	5.3	18.1
KS-5	19.0	2.0	20.0	75.0	93.2	7.3	7.2	7.7	40.0	20.0
KS-6	18.0	2.0	12.0	69.0	69.0	6.4	5.4	7.2	34.0	21.0
KS-7	16.0	2.0	9.3	44.0	35.9	7.8	5.2	3.8	27.0	26.0
KS-8	16.9	2.0	14.0	91.0	35.6	21.4	9.7	13.0	36.0	34.2

Table (4): The trace concentration elements in ppm for various soil samples

Soil sample	As	Sr	Ag	Cd	Sn	Sb	Hg	Pb	Th	U
KS-1	0.6	11.65	4.8	5.1	9.7	7.6	2.4	6.3	1.8	1.8
KS-2	1.1	17.7	5.8	6.7	10.0	9.3	4.9	9.5	2.7	2.0
KS-3	1.3	104.1	4.6	5.7	9.8	7.8	2.2	6.6	4.3	1.9
KS-4	1.5	30.07	5.3	5.4	9.8	16.0	2.2	12.3	5.2	7.0
KS-5	1.6	13.46	6.5	7.1	10.0	8.6	2.5	8.0	5.0	2.3
KS-6	1.6	12.02	4.7	6.2	11.0	8.8	2.9	11.8	6.7	1.4
KS-7	1.3	12.68	4.2	5.4	9.0	7.6	2.5	8.1	1.6	2.4
KS-8	1.3	14.27	5.0	5.1	9.4	6.6	3.9	8.4	1.0	2.1

Table (5): the linear and mass attenuation coefficients using gamma transmission measurements

samples	Liner attenuation coefficients (cm^{-1})			Mass attenuation coefficients (cm^2/ g)		
	Energy 661KeV	Energy1172 KeV	Energy1332 KeV	Energy661 KeV	Energy1172 KeV	Energy1332 KeV
KS-1	1.106	0.134	0.058	0.753	0.091	0.039
KS-2	1.1638	0.162	0.094	0.671	0.093	0.075
KS-3	1.006	0.148	0.071	0.679	0.10	0.048
KS-4	1.155	0.178	0.0991	0.76	0.117	0.065
KS-5	0.83	0.144	0.103	0.599	0.104	0.074
KS-6	0.553	0.122	0.105	0.392	0.087	0.074
KS-7	1.075	0.147	0.0722	0.694	0.095	0.046
KS-8	0.903	0.153	0.049	0.615	0.104	0.0336

Table (6): The comparison of results from the current study with the other soils of country.

	Mass attenuation coefficients (cm2/ g)			
Century	Energy 661KeV	Energy 1172 KeV	Energy 1332KeV	Ref
Syria	0.077	0.058	0.055	[11]
Nigeria	0.084	0.078	0.079	[12]
India	0.49	0.48	0.49	[13]
Brazilian	0.08	0.07	0.058	[5]
Present work	0.63	0.099	0.053	Present work

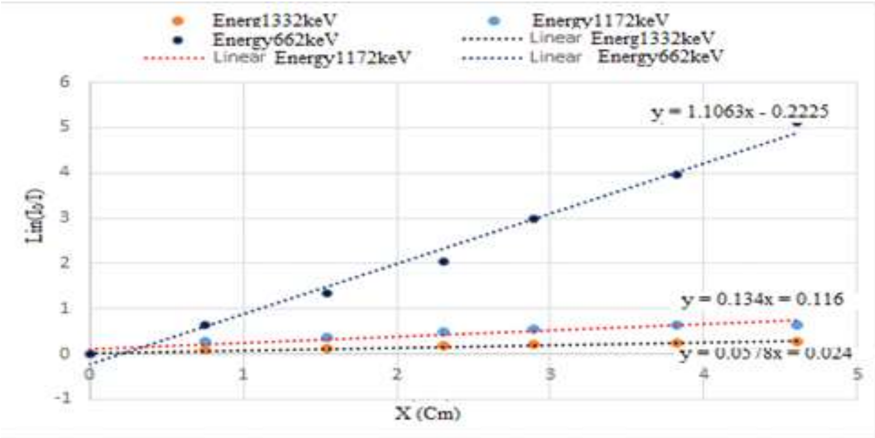

Figure (1): Linear attenuation coefficient of the KS-1

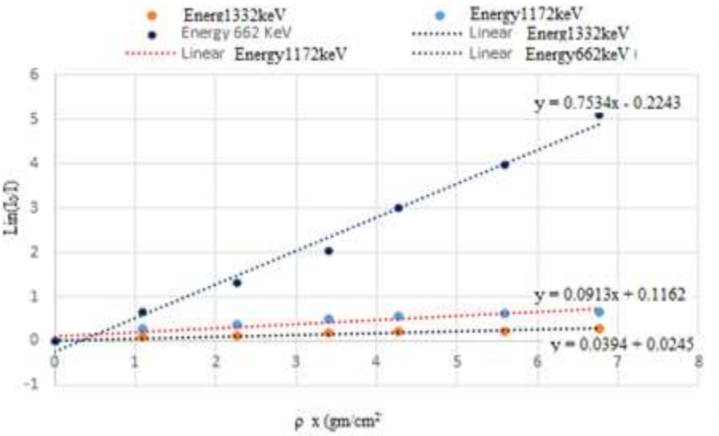

Figure (2): Mas attenuation coefficient of the KS-1

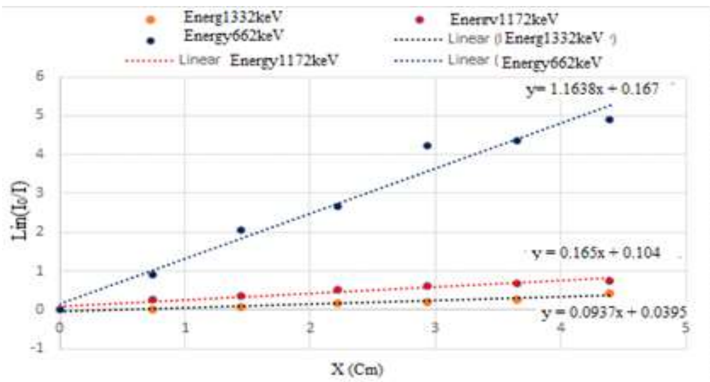

Figure (3): Linear attenuation coefficient of the KS-2

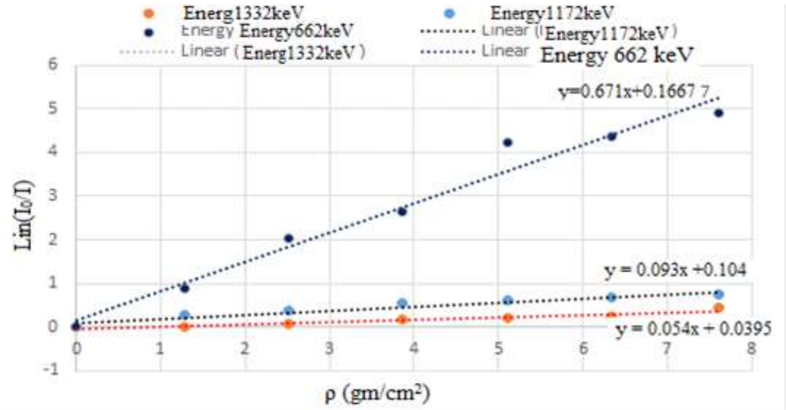

Figure (4): Mass attenuation coefficient of the KS-2

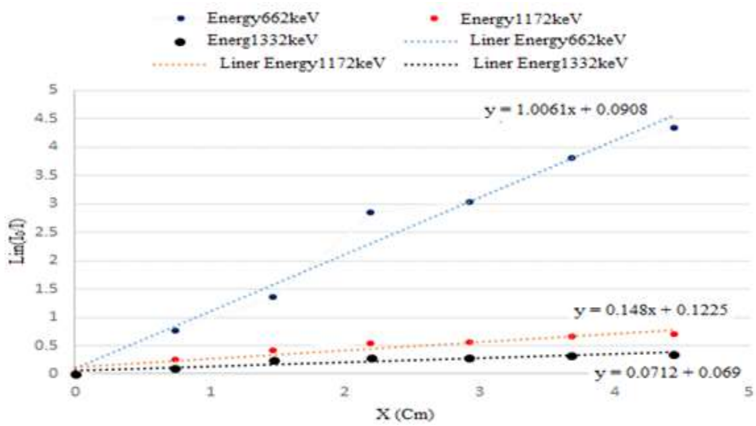

Figure (5): Linear attenuation coefficient of the KS-3

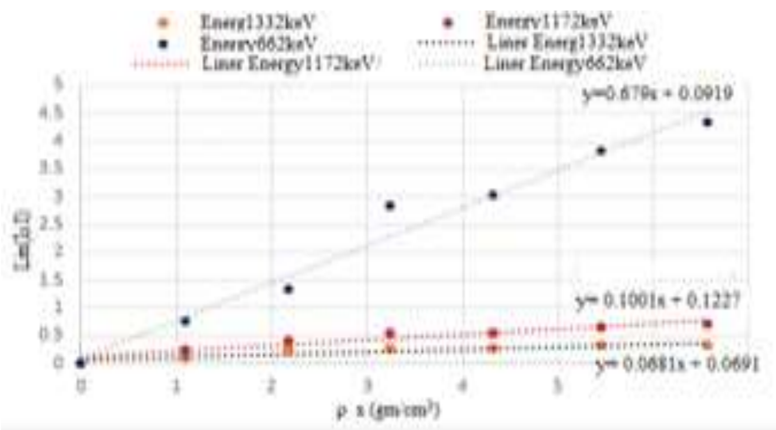

Figure (6): Mass attenuation coefficient of the KS-3

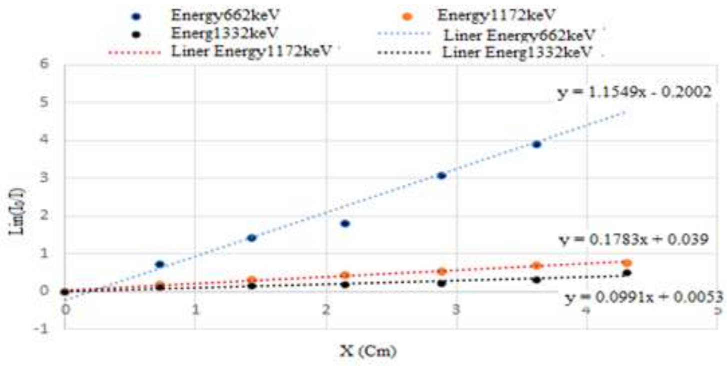

Figure (7): Linear attenuation coefficient of the KS-4

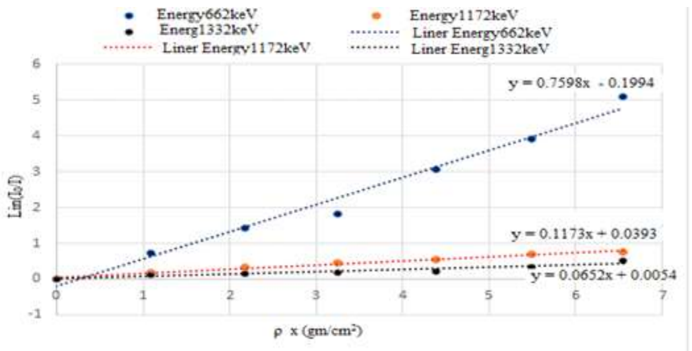

Figure (8): Mass attenuation coefficient of the KS-4

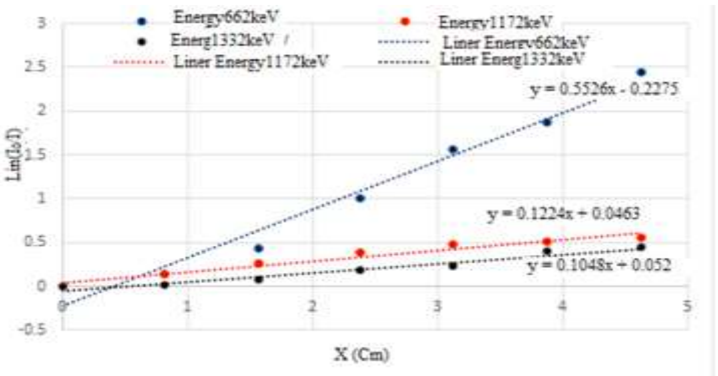

Figure (9): Linear attenuation coefficient of the KS-6

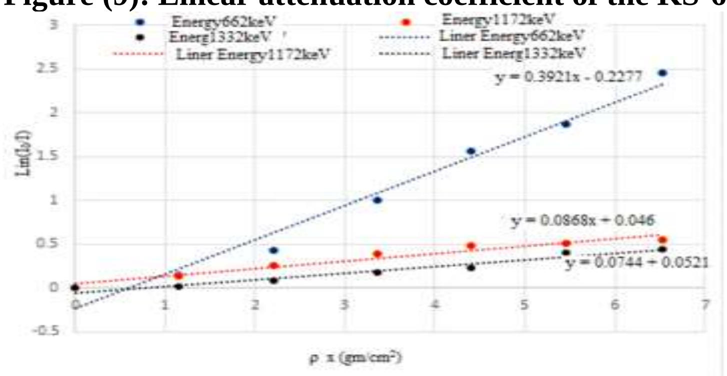

Figure (10): Mass attenuation coefficient of the KS-6

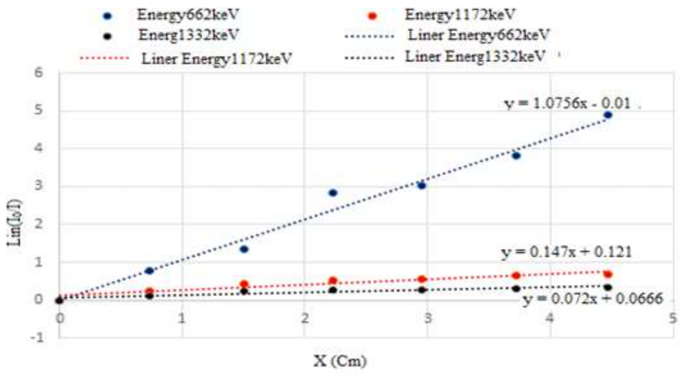

Figure (11): Linear attenuation coefficient of the KS-7

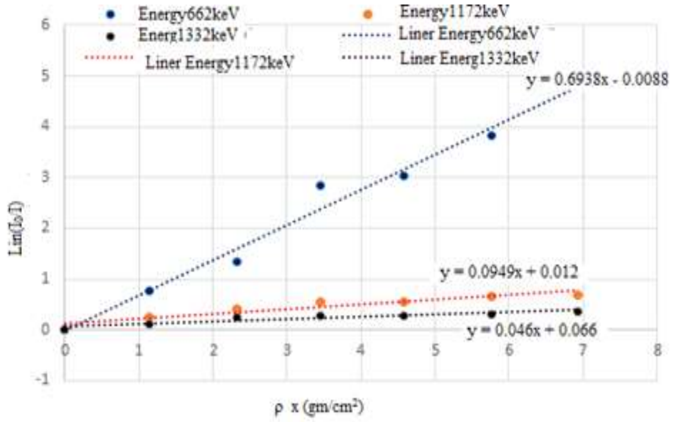

Figure (12): Mass attenuation coefficient of the KS-7

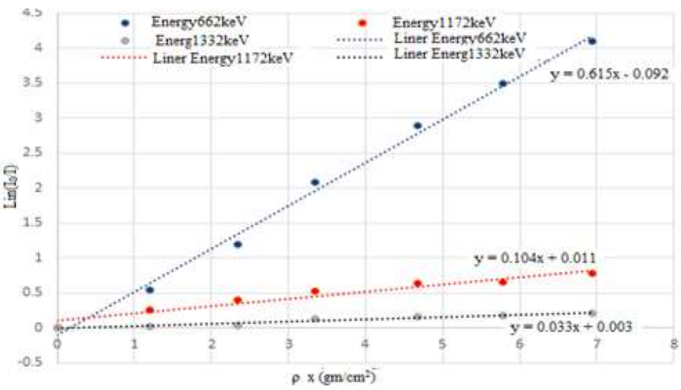

Figure (13): Linear attenuation coefficient of the KS-8

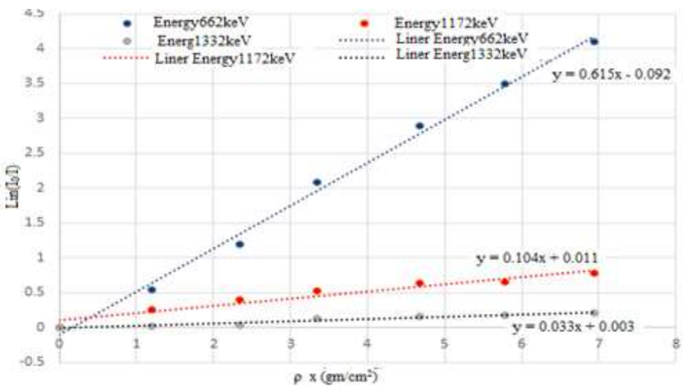

Figure (14): Mass attenuation coefficient of the KS-8

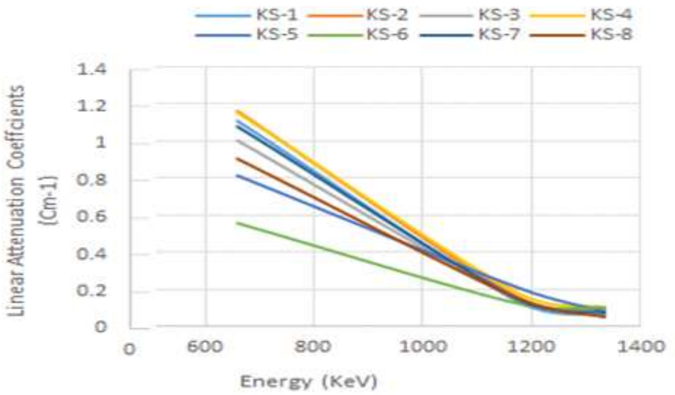

Figure (15): The Relationship between energy and linear attenuation coefficient

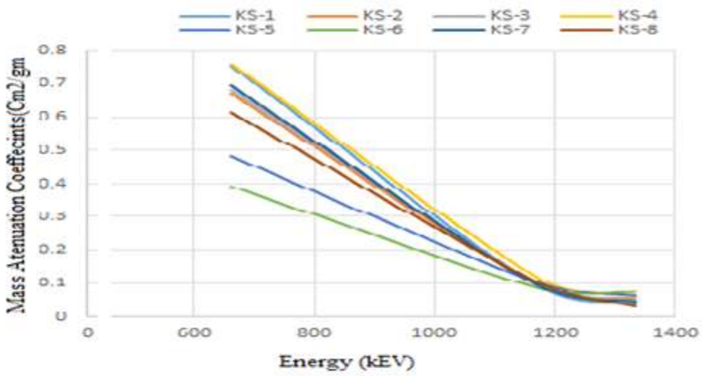

Figure (16): The relationship between energy and mass attenuation coefficient

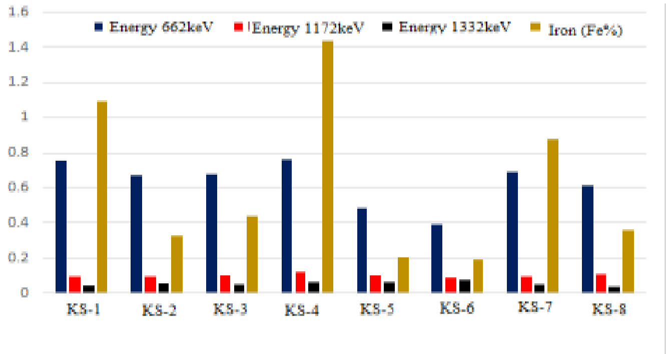

Figure (17): The relationship of Mass attenuation coefficient for iron preparation

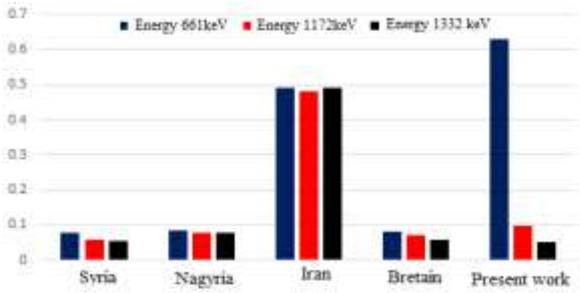

Figure (18): The comparison of results from the current study with the other soil country

Conclusion

The chemical components like S, P, Ca, Na, Cu, Fe, Mg, Zn, etc. are effect on linear and mass attenuation coefficient of soil samples. Linear and mass attenuation coefficient are usually depending on the energy of the radiations. The iron (Fe) in content in soil has a significant effect on the values of attenuation coefficients.

References

1- IAEA-TECDOC-1415, (2004), Soil sampling for environmental contaminants, IAEA, VIENNA.
2- Raje, D. V.L and Chaudhari,M. (2010). Mass Attenuation Coefficients of Soil Samples in Maharashtra State (India) by Using Gamma Energy at 0.662 MeV, Bulg.,J. Phys. , 37 158–164.
3- Costa,J C; Borges, J.A.R; Arthur,R.C.J and Bacchi, O.O.S. (2014) Soil Mass Attenuation Coefficient Analysis and Evaluation, J.Annals of Nuclear Energy , 64, 206–211 .
4- Robu,E and Giovani, C. (2009) ,Gamma-Ray Self- Attenuation Corrections in Environmental Samples , Romanian Reports in Physics, 61 (2) 295–300.
5- Beamish,D. (2013) ,Gamma Ray Attenuation in the Soils of Northern Ireland, with Special Reference to Peat, Journal of Environmental Radioactivity, 115: 13–27.

6- Salh,H. M; Kakil,D. O; Karim, H. H; Hamad,A. M and Othman,Q. H. (2016) Mass Attenuation Coefficient of Soil Samples in Kurdistan Region of Iraq by Using Gamma Energy at 0.662 MeV, J.Advances in Energy and Power 4(2): 7-10.
7- Laxman, M. Ch and Dayanand,V. R (2012) Study of Photon Attenuation Coefficient of Soil Samples from Maharashtra and Karnataka States (India) from 122 keV to 1330 keV., Research Journal of Chemical Sciences .
8- Medhat, M. E. and Abdel-Hafiez, A. (2016) Application of Gamma-Ray Attenuation in Studying Soil Properties, J. Physical Science International Journal, 10(2) :1-6.
9- Chaudhari, L. M and Raje,D. V. (2013) Measurement of Photon Attenuation Coefficient of Soil Samples at Energy 360 keV , Journal of Chemical, Biological and Physical Sciences, 3 (2): 1504-1510.
10- Kucuki,N; Tumsavas,Z and Cakir, M (2012), Determining photon energy absorption parameters for different soil samples, Journal of Radiation Research, 4: 1–9.
11- Al-Masry, M.S; Hasan, M; Al-Hamwi Amin, AY and Doubal, A.W. (2013) Mass attenuation coefficients of soil and sediment samples using gamma energies from 46.5 to 1332 keV Journal of Environmental Radioactivity: 11628–33.
12-Okunade, I.O; Adebe,G.I; Jonah, S.A and Oladipo, A.O. (2008),Measurmebt of Mass Attenuation Coefficient of Zaria Soil Using Gamma Ray Transmission Method , Nigerian Journal of Physics ,20(1) .
13-Laxman, Ch and Dayanand,R. (2012) Attenuation Coefficient of Soil Samples by Gamma Ray Energy, Research Journal of Recent Sciences, 1(9) :41-48.