

ROLE OF MINERAL COMPONENT IN CONTAMINATION OF SOIL AND PLANT BY SOME HEAVY METALS FOR AL-MUSAYYIB ELECTRICITY THERMAL POWER STATION RESIDUES

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Abstract

This research included study of Barium, Copper, Rubidium, Bromine, Lanthanum and Thorium by XRF in soils and plant of Musayyib and Alexandria-Babylon Governorate between Longitude °32 99' 861''N and Latitude °44 29' 00''E. As well as estimation them in plant. They were (228.10-241.01, 54.40-56.20, 51.10-54.30, 23.90-32.40, 13.30-14.10 and 4.40-4.50mg kg⁻¹) respectively in impacted soil (Ss₁, Ss₂) by Al-Musayyib electricity thermal power station residues. Also, they ranged in sand Ss₁₁ and Ss₂₁ of mentioned soil samples (18.20-20.18, 11.04-12.30, 10.45-10.76, 2.66-3.80, 1.21-2.10 and 0.85-1.01mgkg⁻¹), while they were (138.16-109.80, 25.80-27.10, 25.20-28.50, 16.80-21.90, 6.70-10.79 and 2.20-2.50mgkg⁻¹) in clay fraction (Ss₁₂, Ss₂₂). Consequently, in dry matter of Vicia faba L. plant leaves were (38.90-65.10, 25.80-45.90, 30.30-30.80, 4.90-6.03, 2.01-3.10 and 2.01mg kg⁻¹), and they were (35.40-55.30, 27.10-39.90, 23.70-28.80, 4.80-5.20, 2.01-5.20 and 1.50-1.80mg kg⁻¹) respectively in dry matter of roots growing at polluted soil samples (Ss₁, Ss₂). Pollution load index (PLI) for heavy metals group in each of contaminated Musayyib soil samples (Ss₁, Ss₂) compared with soil Alexandria samples (S₀₁, S₀₂) was (1.21-1.47). It was (1.12-1.45) in sand samples, while in clay samples was (1.29-1.70). Geo-accumulation index (I_{geo}) recorded the highest values for Br and La compared to other heavy metals in the study samples affected by the power station residues, and La was higher than Br in contaminated soil sample Ss₁ comparison with S₀₂ was (0.63), and contaminated sand sample Ss₁₁ with comparison S₀₂₁ (Ss₁₁-Ss₀₂₁) was (0.43). While I_{geo} for Br was the highest (0.75) in clay sample Ss₁₂-Ss₂₂. For Th and Ba, I_{geo} was the highest in the sand sample Ss₁₁- S₀₁₁: 0.37 and 0.23 respectively. I_{geo} for La was the highest: 1.03 followed Br: 0.57 in clay sample Ss₂₂-S₀₂₂. Ba and Th maintained the increase in the sand sample Ss₂₁-S₀₁₁: 0.73, 0.44 consecutively. Mineral concentration factor (MCF) of clay fraction contributed to soil pollution more than MCF for sand which was (0.08-0.23, 0.46-0.68) respectively. While bioaccumulation factor (BCF) of sand fraction contributed to plant pollution more than BCF of clay (0.45-14.55 and 0.18-2.53) consecutively with regard to heavy metals in the study soils. X-ray diffraction results showed present of montmorillonite, true chlorite, kaolinite and mica minerals for impacted clay sample in electricity Al-Musayyib thermal power station residues (Ss₂₁). Also, the intensity of peaks appeared percentages of these minerals 23.29, 24.90, 12.85, 18.87 and 20.09% respectively.

Keyword: Clay and Sand, Soil and plant pollution, Rubidium, Barium, XRF and XRD

Introduction

The mineral configuration is considered the effective part and dominant in arid and semi-arid soils, especially clay due to its high specific surface area (SSA) and a cation exchange capacity (CEC) high that plays a large role in adsorption, exchange and release ionic of heavy metals and other ions regardless of the organic matter and oxides that predominate in soils of heat rainy and cold humid regions such as equatorial and polar regions respectively, Thus, the movement of heavy metals is restricted in clay soils compared to sandy soils which have a low specific surface area and low cation exchange capacity, consequently, the movement of heavy metals become in them quick and easy, in contrast to clay minerals existence controlling the behavior of heavy metals (Alloway, 2008; Abdel Moneim and Turkish, 2012). Heavy metals are found in different forms, either soluble in soil solution or adsorbed on the surfaces of ion exchange complexes such as organic matter and clay minerals which in turn contain some heavy metals in their crystalline structure. These forms affect the availability of heavy metals in soil and plant (Navas and Lindhorfer, 2003).

The heavy metals in the soil come from the effect of physical, chemical and biological weathering processes on the rock parent material (Baize and Sterckeman, 2001), and are constantly increasing due to the inputs of human activity in the ecosystems, including the residues of power station and the chronological age that led to the emission intensity gases and vapors rising in the air and sedimentation on the soil, as well as the exploitation of the Euphrates river for the generation of energy caused the leakage of heavy metals to soil and plant through irrigating processes (AL-Wotaiyf and AL-Msafree, 2018).

Clay minerals vary in susceptibility to adsorption, release and exchange of nutrients according to their physiochemical properties, for example, the expanded clay minerals (2:1) as montmorillonite minerals have a SSA and CEC many higher than kaolinite minerals (1:1) (Murray, 2007), which affects it the nature of the retention of heavy metals and the amount of their release in soil solution (Bhattacharyya and Gupta, 2008). In spite of these differences clay minerals play an active role in removing toxicity and storing environmental contaminants compared to sand minerals that may contribute to their release and increase their toxicity to living organisms (Dos Santos et al. 2015). The research aims to achieve the following objectives: (1) Determination of the soil, plant, sand and clay content from heavy metals on the impact of electricity Al-Musayyib thermal station residues. (2) Employ some pollution standards for heavy metals according to their content with soil and plants, as well as sand and clay. (3) The extent to which sand and clay contribute to soil and plant pollution, and the diagnosis of clay minerals by XRD to show their role in pollution.

Materials and Methods

In order to study the effect of electricity Musayyib thermal station in soil pollution with heavy metals, surface soil samples were selected at a depth of 0-50cm according to Ngole (2011). The S_{s1} and S_{s2} samples selected from the soil of the Musayyib agricultural and Alexandria S₀₁ and S₀₂ as comparison, these located between Longitude °32 99' 861''N and Latitude °44 29' 00''E. Mineral soil components were separated after removal of bonding substances (Anderson, 1963). The sand was separated from the silt and clay by using sieving 50 μ , and clay by precipitation method (Jackson, 1979). Thus, sample S_{s11}, S_{s12}; S_{s21},

Ss22 represented sand and clay in the soil sample Ss1 and Ss2 respectively. While S011, S012; S021, S022 represented sand and clay in the soil sample S01 and S02 respectively. Parts of grown *Vicia faba* L. plant in polluted soils Ss1 and Ss2 were SL1, SL2; SR1 and SR2 for leaves and roots respectively. While plant parts were SL01, SL02; SR01 and SR02 respectively. Estimation of the soil content from La, Br, Rb, Cu, Th and Ba by XRF. And through the soil content of these heavy metals were assessed the state of pollution according to the following Equations:

$$PLI = (CF_1 \times CF_2 \times CF_3 \times \dots \times CF_n)^{1/n} \dots(1)$$

Where: PLI is pollution load index; CF1 and CF2 to CFn are values of the pollution agent for a group of heavy metals in each site; n: means number of heavy metals in that site (Tomlinson et al., 1980). Grades and pollution levels of PLI in Table1 (Kohinoor et al., 2014).

$$I_{geo} = \log_2 [C_{metal} / 1.5 \times C_{metal(control)}] \dots(2)$$

Where: I_{geo} is Index of Geo-accumulation. C_{metal} is the concentration of heavy metal in enrich sample and C_{metal(control)} is the concentration of metal in unpolluted sample. The factor 1.5 is used for possible variations of background or control values due to lithological variations in soil (Müller, 1969). Degrees and pollution levels of I_{geo} in Table1 (Alfred et al., 2013).

Equation3 suggested by AL-Wotaify (2019) for the contribution of sand and clay to soil pollution:

$$MCF = C_{Fraction} / C_{soil} \dots(3)$$

Where: MCF is mineral concentration factor which expresses contribution of sand or clay in soil pollution, C_{Fraction} and C_{soil} concentration of heavy metal in fraction (sand or clay) and soil respectively.

Table1. Grades and standard pollution levels of CF, PLI and I_{geo}.

PLI		I _{geo}	
Grades	Levels	Grades	Levels
		I _{geo} ≤ 0	Unpolluted
PLI > 0.5	Unpolluted	0 < I _{geo} ≤ 1	Unpolluted to Moderate
1 > PLI < 0.5	Site monitoring	1 < I _{geo} ≤ 2	Moderate
PLI = 1	Baseline Level	2 < I _{geo} ≤ 3	Moderate to Heavy
		3 < I _{geo} ≤ 4	Heavy
PLI > 1	Polluted	4 < I _{geo} ≤ 5	Heavy to Severity
		I _{geo} ≤ 5	Severity

The grained size distribution of soil fractions sand, silt and clay was estimated by the pipette international (Pansu and Gautheyrou, 2006). According to the methods mentioned by Jackson (1958), clay samples were saturated by magnesium chloride solution and other with potassium. Magnesium samples treated at room temperature, others by ethylene glycol. The samples saturated with potassium were heated at temperatures of 350 and 550C°. These treatments were prepared to diagnose the clay minerals in XRD, and the ratios of metals were calculated according to the intensity of x-ray curves in a semi-quantitative method (Norrish and Taylor, 1962).

The equation for plant pollution is as follows:

$$BCF = (C_R / C_s) \dots(4)$$

Where: BCF is bioaccumulation factor; C_R means concentration of metal in root; C_s refers to metal concentration in soil, sand or clay (mg kg⁻¹), the plants can be accumulators if BF > 1;

BF=1 is no influences and if BF<1 the plant can be an excluder (Radulescu et al.,2010). In this study employed Equation4 for the contribution of sand or clay to plant pollution.

Results and Discussion

The clay fraction was predominant in study soils, so the texture of soil became clay loam-clay (Table2), they may have been far from the source of fluvial sedimentation that carries fine particles for long distances, Unlike the coarse particles precipitated near the source as sand(Mustafa,1985).This plays a major role in restricting the movement and transport of heavy metals in the soil when it contains clay texture (Krishna and Govil,2007). Perhaps this one reasons increased the content of heavy metals in study soils(Table3).

Table2. The grained size distribution of soil fractions sand, silt and clay.

Samples	Grained size distribution of soil fractions(g kg ⁻¹)			Texture
	Sand	Silt	Clay	
Ss ₁	377.9	229.2	392.9	CL
Ss ₂	255.8	325.5	418.6	CL
S ₀₁	105.7	170.0	724.3	C
S ₀₂	77.7	125.3	797.0	C

Table3 shown the content of heavy metals in soil, sand and clay samples, where Ba was 228.10-241.01mg kg⁻¹, Cu: 54.40-56.20, Rb: 51.10-54.30, Br: 23.90-32.40, La: 13.30-14.10 and Th: 4.40-4.50 mg kg⁻¹ in polluted soil samples Ss₁ and Ss₂. These results indicated to the high content of heavy metals in soil samples, even in comparative soil samples S₀₁ and S₀₂. This is evidence that contamination is common due to improper practices by human activity and the absence of a mechanism for the disposal of contaminants and industrial wastes scattered throughout the region. In fact, the soils contain many of military manufacturing residues, and the comparator soils include electric power stations(AL-Msafree, 2018), as well as they consider an agricultural soil supplied with mineral and organic fertilizers and pesticides consisting of some heavy metals(Kabata-Pendias and Pendias ,2000; Azita and Seid, 2008).

Table3. The content of heavy metals in soil, sand and clay samples(mg kg⁻¹).

Samples	Ba	Cu	Rb	Br	La	Th
Ss ₁	228.10	56.20	54.30	32.40	13.30	4.50
Ss ₁₁	18.20	12.30	10.45	3.80	2.10	0.85
Ss ₁₂	109.80	27.10	28.50	21.90	6.70	2.50
Ss ₂	241.01	54.40	51.10	23.90	14.10	4.40
Ss ₂₁	20.18	11.04	10.76	2.66	1.21	1.01
Ss ₂₂	138.16	25.80	25.20	16.80	10.79	2.20
Comparative samples						
S ₀₁	213.03	50.90	49.90	17.80	9.10	3.60
S ₀₁₁	15.58	10.83	8.45	1.37	2.02	0.46
S ₀₁₂	98.88	22.07	21.81	11.71	3.98	1.78
S ₀₂	218.10	51.60	50.40	13.60	4.20	4.40
S ₀₂₁	15.79	10.41	9.01	2.17	0.98	0.84

S ₀₂₂	102.31	21.69	21.02	5.89	2.10	1.81
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Ba in sand polluted samples S_{s11} and S_{s21} ranged from 18.20-20.18mg kg⁻¹, Cu: 11.04-12.30, Rb: 10.45-10.76, Br: 2.66-3.80, La: 1.21-2.10 and Th: 0.85-1.01mg kg⁻¹, while these metals were less in comparative sand samples S_{o11} and S_{o21}. Clay polluted samples were more than sand, Ba: 138.16-109.80, Cu: 25.80-27.10, Rb: 25.20-28.50, Br: 16.80-21.90, La: 6.70-10.79 and Th: 2.20-2.50mg kg⁻¹, as well in comparative clay samples. Sand is characterized by ionic retain few because it has a low specific surface area, while clay has a high specific surface area that has the ability to adsorb heavy metals (Shakeri et al., 2009) (Table 3). In general, Ba reached the highest values, followed by Cu, Rb and Br in both study soils. CCME (2013) shown that Ba is one of the main components of organic and inorganic pollutants, particularly agricultural and industrial. As for sources of Cu are known and visible in many industries and accumulated wastes, and that's what Issa and Qanbar (2016) evidenced that the sediments of the Euphrates river were contaminated with Cu (10.8-47.9mg kg⁻¹). Rb is characterized by its strong tendency to correlation with the potassium-bearing minerals that predominate in arid and semi-arid soil, and also more strongly sorbed by clay minerals than is potassium, therefore Rb is largely controlled by the stability relationships of K-bearing phyllosilicate minerals (biotite and muscovite) (Kabata-Pendias, 2001, Al-Jubori, 2017). Bromine compounds are widely used in the agricultural as effective pesticides (Schnebele, 2015). The values of Ba and Br in the present study were higher than those mentioned by Hope et al. (1996) and Takeda et al. (2011) (104.2 and 3.8-13.5mg kg⁻¹ respectively) in fluvisols.

Br in parts of grown *Vicia faba* L. plant in polluted soils in Table 4 was (38.90-65.10mg kg⁻¹), Ba: 25.80-45.90, Cu: 30.30-30.80, Rb: 4.90-6.03, La: 2.01-3.10 and Th: 2.01mg kg⁻¹ in dry matter of leaves. While in dry matter of roots were (35.40-55.30, 27.10-39.90, 23.70-28.80, 4.80-5.20, 2.01-5.20 and 1.50-1.80mg kg⁻¹) respectively. Parts of grown *Vicia faba* L. plant in comparative soils were less pollution (Table 4). Br values were higher than Ba and Cu in dry matter of vegetation parts, this is confirmed by WHO (2003) that bromine exist high concentrations in the plant and can in the leaves to 130mg kg⁻¹. As for Ba, although accumulated in the soil, but its quantities are limited in the plant except in legumes, grain stalks and fodder plants (IPCS, 1990). Hope et al. (1996) refers to Ba reaches 29.8mg kg⁻¹ in plant samples which were less than results of study. Perhaps Rb decrease in the dry matter of vegetation parts, although its high amounts in the soils are evidence of adsorption and fixation by clay minerals and potassium-bearing minerals indicated in XRD results (Fig. 1).

Table 4. The heavy metals in parts of grown *Vicia faba* L. plant in soils (mg kg⁻¹).

Samples	Br	Ba	Cu	Rb	La	Th
SL ₁₁	65.10	25.80	30.30	4.90	2.01	2.01
SR ₁₁	55.30	27.10	23.70	5.20	2.01	1.80
SL ₂₁	38.90	45.90	30.80	6.03	3.10	2.01
SR ₂₂	35.40	39.90	28.80	4.80	5.20	1.50
Comparative samples						
SL ₀₁	31.30	25.80	20.40	4.03	1.50	0.80

SR ₀₁	33.90	2.02	19.30	4.30	1.01	1.01
SL ₀₂	30.17	31.60	18.20	4.50	1.60	1.02
SR ₀₂	28.10	20.40	18.04	4.03	1.90	0.90

Table5 shown PLI results for CF heavy metals group in each of Ss₁, Ss₁₁ and Ss₂₁ compared with S₀₁ and S₀₂ between 1.28-1.47 of soil, sand: 1.35-1.45 and clay: 1.29-1.66, and 1.21-1.36, 1.12-1.20 and 1.60-1.70 each of Ss₂, Ss₂₁ and Ss₂₂ compared with S₀₁ and S₀₂ respectively. According to standard pollution levels in Table1, the study samples consider polluted. PLI for clay reached the highest values because of contamination factor which depended on quantity of metal in clay sample.

The I_{geo} in Table5 reached the highest values for Br and La compared to other heavy metals in the study samples affected by the power station residues, and La was higher than Br in Ss₁-S₀₂ (0.63) and Ss₁₁-S₀₂₁(0.43). While Br was the highest in Ss₁₂-Ss₂₂(0.75).

Table5. The PLI and I_{geo} of heavy metals in study samples

PLI for all heavy metals in each of sample						
Ss ₁ - S ₀₁	Ss ₁₁ - S ₀₁₁	Ss ₁₂ -S ₀₁₂	Ss ₁ -S ₀₂	Ss ₁₁ -S ₀₂₁	Ss ₁₂ -S ₀₂₂	
1.28	1.45	1.29	1.47	1.35	1.66	
Ss ₂ -S ₀₁	Ss ₂₁ -S ₀₁₁	Ss ₂₂ -S ₀₁₂	Ss ₂ -S ₀₂	Ss ₂₁ -S ₀₂₁	Ss ₂₂ -S ₀₂₂	
1.21	1.20	1.36	1.36	1.12	1.70	
Heavy metals	I _{geo}					
	Ss ₁ - S ₀₁	Ss ₁₁ - S ₀₁₁	Ss ₁₂ -S ₀₁₂	Ss ₁ -S ₀₂	Ss ₁₁ -S ₀₂₁	Ss ₁₂ -Ss ₂₂
La	0.29	0.21	0.34	0.63	0.43	0.64
Br	0.37	0.56	0.37	0.48	0.35	0.75
Rb	0.22	0.25	0.12	0.22	0.23	0.27
Cu	0.22	0.23	0.25	0.22	0.24	0.25
Th	0.25	0.37	0.28	0.21	0.20	0.28
Ba	0.21	0.23	0.22	0.21	0.23	0.22
Metals	Ss ₂ -S ₀₁	Ss ₂₁ -S ₀₁₁	Ss ₂₂ -S ₀₁₂	Ss ₂ -S ₀₂	Ss ₂₁ -S ₀₂₁	Ss ₂₂ -S ₀₂₂
La	0.54	0.40	1.81	0.67	0.25	1.03
Br	0.27	0.39	0.29	0.35	0.25	0.57
Rb	0.21	0.26	0.23	0.20	0.24	0.24
Cu	0.21	0.20	0.23	0.21	0.21	0.24
Th	0.25	0.44	0.25	0.20	0.24	0.24
Ba	0.23	0.73	0.28	0.22	0.26	0.27

For Th and Ba, I_{geo} was the highest in the sand sample Ss₁₁- S₀₁₁: 0.37 and 0.23respectively. I_{geo} for La was the highest in the clay sample Ss₂₂-S₀₂₂:1.03 followed Br: 0.57, and Ba and Th maintained the increase in the sand sample Ss₂₁-S₀₁₁: 0.73 and 0.44respectively as shown in Table5. This may be due to the heavy metal concentration in the comparison sample if it is few, the value of the I_{geo} is high according to Equation2, and vice versa, as well as the content of these metals in the soil minerals of clay and sand. I_{geo} Levels of the study samples was between Unpolluted to Moderate (Table1), This is evidence that the pollution is not of parent material, but the result of the impact of human activity as electricity thermal Al-Musayyib

station residues, perhaps contributed to soil pollution through increasing of heavy metals under study.

MCF for all heavy metals in sand samples was 0.08-0.23, while it was 0.46-0.68 in clay samples (Table 6). Results refer to the clay contributed to soil pollution more than sand, because of its high content of heavy metals shown in Table 3. While sand contributed to plant pollution more than clay through results of BCF in Table 7: 0.45-14.55 and 0.18-2.53 respectively. The results confirm the ability of the clay to adsorb heavy elements and retain them in the soil more than sand, restricting their mobility and transfer from soil to plant. Dube et al. (2001) refers to the mobility of heavy metals depends on the mineral composition of the soil. Thus, the clay soil restricts the path and movement of the heavy elements and reduces their availability, while sand soils progress higher availability because of free movement.

BCF for Br in soil samples was bigger than 1, and according to Zhang et al. (2002) the plant under study is an accumulator of this metal and it has the ability to assemble it without the emergence of any symptoms of toxicity, perhaps for its physiological role.

Table 6. Mineral concentration factor (MCF) of heavy metals in polluted samples

Heavy Metals	MCF of heavy metals in polluted samples			
	Ss11/Ss1	Ss12/Ss1	Ss21/Ss2	Ss22/Ss2
La	0.16	0.50	0.09	0.76
Br	0.12	0.68	0.11	0.70
Rb	0.15	0.52	0.21	0.45
Cu	0.22	0.46	0.20	0.47
Th	0.17	0.56	0.23	0.50
Ba	0.08	0.46	0.08	0.57

Table 7. Plant concentration factor (PCF) of heavy metals in polluted samples

Heavy Metals	PCF of heavy metals in polluted samples					
	SR11/Ss1	SR11/Ss11	SR11/Ss12	SR22/Ss2	SR22/Ss22	SR22/Ss21
La	0.15	1.49	0.25	0.37	1.98	0.29
Br	1.17	2.12	0.72	1.48	1.49	0.68
Rb	0.09	1.93	0.87	0.09	0.80	0.34
Cu	0.42	0.50	0.18	0.53	0.45	0.19
Th	0.40	14.55	2.53	0.34	13.31	2.11
Ba	0.12	0.96	0.30	0.17	4.30	0.48

While BCF for other heavy metals was less than 1, therefore, the plant is excluder and considers one of the plants that maintain the concentration of these metals at the critical limit even if they are low to a wide extent of concentrations in soil (Zhang et al., 2002).

The X-ray diffraction results showed for Ss21 sample (Fig. 1) that the basal distance 14.31 Å was present in Mg-saturated and dry-air treatment (Mg-AD). It expanded to reach the peak 16.76 Å in Mg-saturated and ethylene glycol treatment (Mg-EG), at treatment of K-saturated and heated upon 350 and 550 °C was collapsed indicates the presence of expanded smectite minerals (2:1) such as montmorillonite clay, which plays an active role compared to other clay minerals in adsorption of ions and retention of heavy metals (Borchardt, 1989; Brown, 1998). While its continuance in heating treatments 14.30 and 14.01 Å confirm the

presence of true chlorite mineral (Bailey, 1988). Continuation of basal distance 7.13\AA and its collapsed upon heating treatment 550C° indicates kaolinite mineral (Whittig and Allardice, 1986). The results also showed the presence of irregular interstratified minerals in the sample mentioned by basal distance 11.78\AA confined between the montmorillonite and mica peak (Moore and Reynolds, 1997). Mica minerals appeared basal distance $9.99\text{-}10.13\text{\AA}$ that was constant in all treatments (Fanning et al., 1989).

Fig.1 shown XRD results for S_{012} sample that indicated occurrence of chloritization phenomenon in montmorillonite clay through its limited dilation 15.88\AA in Mg-EG treatment (Post et al., 1997), indicating the presence of swelling chlorite arising from a montmorillonite transformation due to deposition of the brucite (Mg-hydroxy interlayered) between its inner layers (AL-Wotaify, 2012), this interlayer was high stability and formation for its resistance of temperature 350C° (Dixon et al., 1977). As well as the presence of kaolinite and mica minerals in mention sample (S_{012}).

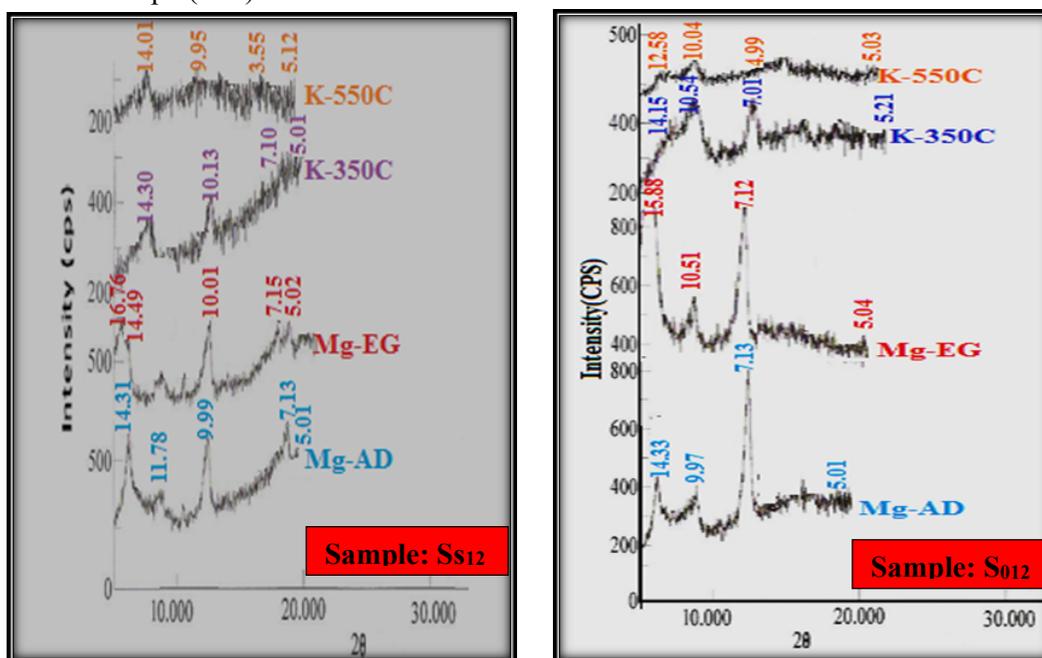


Fig.1 Minerals in the sample of polluted clay S_{s12} and comparison S_{012} by XRD.

Minerals in S_{s21} sample were (23.29, 24.90, 12.85, 18.87 and 20.09%) respectively as in Table 7. In sample S_{012} , montmorillonite clay will not be appeared due to its transformation into swelling chlorite that 47.41%. As a result of this transformation, ion exchange sites will be closed and reduced adsorption activity of the elements in the soil (Barnhisel and Bertsch, 1989). In general, the presence of k-bearing minerals in clay and sand samples such as mica: muscovite (8.40-8.50%) and biotite (2.8-5.30%), as well as feldspars (4.10-5.40%) (Table 7) may have contributed to the increase of rubidium in soil samples and other heavy metals. Disparity in the presence, ratios and kinds of minerals in the study soils, perhaps led to the variation of heavy metals quantities in soil and plant.

Table7. Percentages of minerals in selected clay and sand samples.

Clay samples	Minerals	Intensity	Percentage (%)	Sand samples	Minerals	Percentage (%)
Ss21	Montmorillonite	580	23.29	Ss11	Chlorite	11.60
	Kaolinite	620	24.90		Biotite	5.30
	Chlorite	350	12.85		Muscovite	8.50
	Interstratified	470	18.87		Feldspars	5.40
	Mica	500	20.09			
S012	Swelling Chlorite	1100	47.41	S011	Chlorite	9.90
	Kaolinite	810	34.91		Biotite	2.80
	Mica	410	17.67		Muscovite	8.40
			Feldspars		4.10	

Conclusions

The high concentrations of some heavy metals in the soil and plant of the study evidence that contamination is common due to improper practices by human activity and the absence of a disposal mechanism of contaminants and industrial wastes scattered throughout the region. In fact, the soils contain many military manufacturing residues, as well as effects of an electric power station in Al-Musayyib. Total of heavy metals, PLI and I_{geo} in clay reached the highest values compared sand, therefore MCF for all heavy metals in clay more than sand, as a result clay contributed in soil pollution more than sand. But the sand contribution in plant pollution was higher, through the high values of BCF. Particles size distribution and results of XRD shown the increased clay content and type of minerals, perhaps played an important role in the adsorption of heavy metals, as well as led to a reduction content them in plant.

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