Plant Archives Vol. 21, Supplement 1, 2021 pp. 1338-1344 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
doi link : https://doi.org/10.51470/PLANTARCHIVES.2021.v21.S1.2010

IDENTIFICATION AND COMPARISON OF CLAY MINERALS IN SOME GYPSIFEROUS SOILS IN NAJAF AND SALAH AL-DIN GOVERNORATES

Basim Sh. Obaid AL-Obaidi, Mahmood A. Lateef* and Jassam S. Jasim
Department. of Soil & water Science., College of Agriculture., University. of Tikrit, Iraq
*Email: mhoo_1979@yahoo.com

ABSTRACT

This study was conducted to identify clay minerals in the soils of the sedimentary plain and compare their composition and minerals content to the clays of gypsiferous soils located within the sediments of the Tigris and Euphrates, as six pedons were chosen distributed by three to the sediments of the Tigris River (Salah al-Din) and three others within The sediments of the Euphrates River (Najaf) revealed the pedons and described their morphologically and obtained soil samples from the surface and subsurface horizon for the purpose of conducting mineral analysis on them using the reflection method of X-rays, where the results showed the following: The heterogeneity of the mineral arrangement of the clays in the horizons diagnosed for the pedons of the study soil, with the exception pedon 5 uncultivated. The dominance Palygorskite in all the studied horizons except for the surface horizons pedon 1 and 2,site of Salah al-Din, as the dominance of chlorite and smectite respectively, as well as the pedon 6, site of Najaf, where chlorite occupied the first place. Increase in the percentage of palygorskite in the subsurface horizons In return, it was accompany him by decrease in the proportion of smectite for those horizons and for both sites. Increasing the relative abundance of Illite in the horizons of Najaf compared to Salah al-Din. The pedons exploiting the Tigris and Euphrates deposits showed a marked increase in the ratio of expanded minerals 2:1 (smectite) compared to the untapped pedons. Similarity mineral composition of the sediments of the Tigris and Euphrates, with the relative content of the two between them different.
Keywords : Gypsiferous soils, Najaf , Salah al-Din, clay minerals.

Introduction

It has long been known that clay minerals strongly influence the main physical and chemicals properties of soils, and thus, questions regarding the origin, distribution and composition of these minerals have occupied a prominent place in soil research. (Owliaie *et al*., 2006; Wilson, 1999).

Abbaslou and Abtahi (2007) observed during their study of the origin and distribution of clay minerals in the soils of southern Iran that the mineral composition in them is of the type of palygorskite, chlorite, Illite, and smectite with absence of kaolinite and vermiculite due to unfavorable and unstable conditions for their formation. That the abundance of these two minerals in the soil is largely related to their presence in the parent rocks, chlorite is inherited in the studied soil, and Illite in the soil arises from rock fragmentation (mechanical weathering), while Khademi and Mermut (1998) indicated that these minerals serve as a precursor to pedogenic formation. For other clay minerals in arid and semi-arid regions. Hasan (1981) studied the mineral composition of soils in the Gezira region found the predominance of the minerals of Illite, palygorskite, and kaolinite in the clay part and the soils that were all studied except for one of them, where was the dominion for chlorite, also noted the presence of palygorskite in all studied horizons.

Hashemi, (2013) showed when studying the relationship between clay minerals and different soil moisture regimes in gypsiferous soils of Fars Province in southern Iran represented by arid and semi-arid climate that parent material and climatic conditions the most important factor affecting clay minerals distribution,Through which ithas been determining Palygorskite, smectite, chlorite, illite, and kaolinite were identified as the main clay minerals in gypsiferous soils are inherited from parent material and their contents in the different moisture regimesare almost constant,Therefore the present study aims to identify clay minerals in the soils of the study area, and then comparison of the mineral composition of clay in gypsiferous soils of the Tigris and Euphrates precipitations.

Materials and Methods

Preliminary and field proceedings

Field surveys were execution in order to determine the pedons representing for selected locations according on method (Free soil survey) As stated in the US Soil Survey manual Division (1993), The different sites for gypsiferous soil were selected depending on the physiographic location, The nature of sedimentation of the Tigris and Euphrates rivers, The nature of agricultural exploitation, The nature of soil management, The relative content of gypsum in the surface horizons distributed by six pedons, consideration the distance of more than 500 meters from the paved roads, and the pedons locations were determined using a GPS device table (1).

Table 1 : Locations and specifications of pedons under study

Site specifications	GPS	Location	Pedon. No
soil pedons Salah Al-Din			
A field planted with wheat and yellow corn throughout the year by means of flood irrigation. The period of exploitation has exceeded 20 years and the natural vegetation in it is diverse.	38 S 0374979 UTM 3836716	Al-Fursan cultivated	**P_1**
Unused fallow land, 2 km from the center of Al-Alam region, high ground and very little natural vegetation.	38 S0381336 UTM 3843283	AL-Alam un cultivated	**P_2**
Near the petrol station, a field planted with wheat it is irrigated with well water using sprinkler irrigation, and the period of exploitation has exceeded 15 years.	38 S 0375844 UTM 3838453	Tikrit University cultivated	**P_3**
soil pedons Al-Najaf			
The beginning of the entrance to the zarka from the western side, near the block plant, a field exploited with various vegetable crops, irrigated with well water using a flood irrigation method. The period of exploitation exceeded 20 years.	32° 7¯ 8.9=N 44^{0} 20¯ 40.24 E	Al-Zarka cultivated	**P_4**
The beginning of the entrance to Al-Zarka from the eastern side, near the Police Academy, Nearby the new Kufa water project, unexploited plowed land, former type of exploitation, various vegetable crops,exploitation period of approximately 10 years.	32º 7¯ 20.5=N 44º 20¯ 10.14=E	Al-Zarka un cultivated	**P_5**
The village of Abhoul is Unused fallow land there is almost no existent natural plant in it.	31º 55¯ 45.3=N 44º 12¯ 05.7=E	Bahr Al-Najaf	**P_6**

The soil of Salah al-Din included three pedons, as the first pedon represented the highway (Tikrit-Mosul) west of the opposite side of the University of Tikrit specifically in the Al-Fursan area, and it was 63 meters away from the highway, which varied in exploitation with wheat and corn crops, and the irrigation method used in it was the surfaces irrigation method.
either the second pedon, AL-Alam (Arabseen) region east of the Tigris River, up to 1,663 meters, and on the paved road in the area of Alam, at a distance of 695 meters, unexploited,While the third pedon included the University of Tikrit (Fields of the College of Agriculture) a crop research station exploiting the cultivation of the wheat crop, and the irrigation method used in it was the sprinkler irrigation method (Figure 1).
the pedons at soils of Najaf Governorate, which is located within the sediments of the Euphrates River, which were divided into three pedons, the Zarka area located on the Karbala-Najaf road, the first was exploited by cultivating various vegetable crops and the second was unexploited, while the third pedon, which is located within the Najaf Sea, was unexploited also.

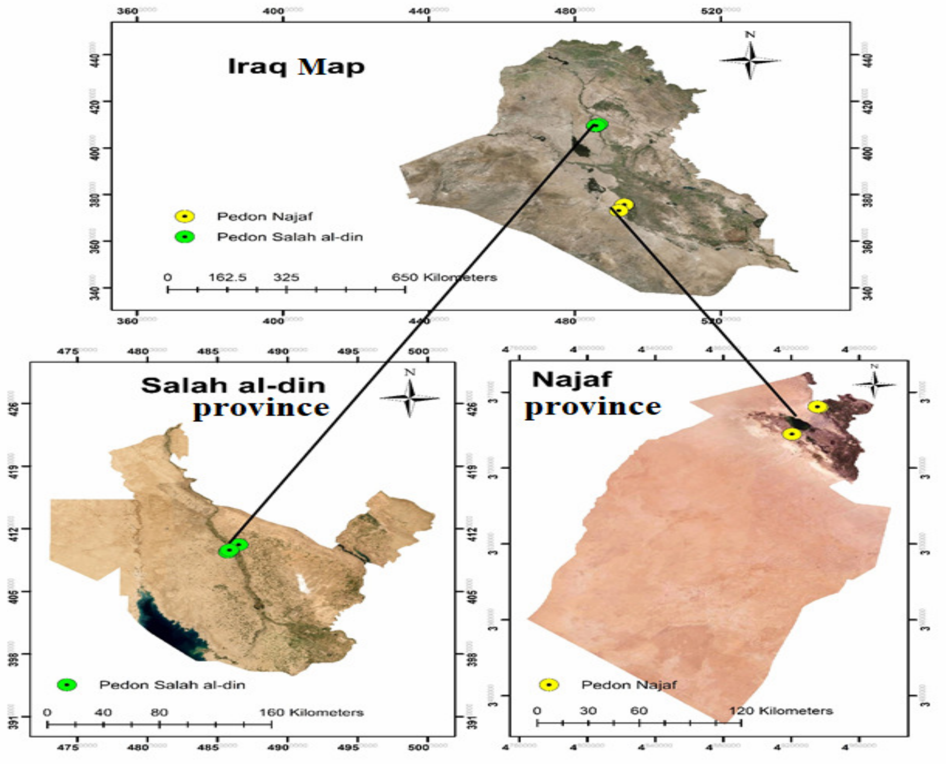

Fig. 1 : Study area and location of representative pedons

Preparing soil samples for mineralogical analysis

After collecting samples from each horizon, the soil samples were air dried and sieved with a diameter of 2 mm, and stored in plastic bags prepared for this purpose to be ready for mineralogical analysis.

Mineralogical analyses

before to mineralogical analysis, samples were repeatedly washed to remove gypsum and soluble salts Kunze (1962). Carbonates were removed using 1N sodium acetate(NaOAc), buffered at pH 5 with Acetic acid (Rabenhors and Wilding, 1984); this reaction was performed in a water bath at 80C. Organic matter was oxidized by treating the carbonate-free soils with (pH=9.5) 14% NaOCl Anderson (1963). Iron oxides were removed from the samples by dithionite citrate bicarbonate method (Mehra and Jackson, 1960).The sand particles were separated using a 50-micron sieve, then the silt were separated using the sedimentation gravity method. according to Stocks Law, and as stated in Jackson (1979), to prepare samples for XRD test clay was weighed (40 mg) and saturated with Mg and K Suspensions were transferred on standard (40 x 25 x 1 mm) glass slides Mg-saturated clay samples were solvated by ethylene glycol vapors10% to identify for expanded minerals,while The K-saturated clay samples were studied both after heating (for 2 h) at 330 and 550 ºC.

Calculation of clay minerals quantity

The percentage of clay minerals was calculated for the samples that were identified by measuring the area under curve semi-quantitatively method according to the Gjems (1967) method, depending on the crystal distance d-spacing, which is a constant characteristic of each mineral.

Results

XRD results of clay samples in general in all figures showed the presence of peaks (9.70-10.5 Aº) which indicate the first diffraction of Illite. Jackson (1979) has shown that the above-mentioned diffractions can at least be considered as the diffraction of the mineral site, indicating that the weathering processes do not affect the site of the first diffraction of Illite, especially the coefficients saturated with magnesium and air dried, whose reflections range between (10-10.2Aº), Moreover to appearance of the peak (10.5Aº) is indicative of the first diffraction of Palygorskite Dioxen *et al.* (1977). The results also showed decrease in the D- spacing (10.5Aº) in all pedons except for pedon 6, which indicates that Illite was at early stage of weathering processes. Figs. (1-11) indicated that was decrease in the intensity of Palygorskite, for the treatment saturated with potassium and heated to temperatures of 350 and 550C .the reason for this due to the Zeolitic water which was removed from the inner crystal structure of the mineral, especially the samples saturated with potassium and heated at 350°C,while the heated samples at 550°C lost the canal water and begin of the breakdown of the crystal structure as a result of the breakdown of the hydroxyl bonds (Hormuz,1989), while the mineral still stable in the samples of clays saturated with magnesium and treated with ethylene glycol.

The results of samples of clays saturated with magnesium showed the presence of both smectite and chlorite with diffraction(14 Aº),and the increasing of the D-spacing in the magnesium samples treated with ethylene glycol to the range (15-17 Aº).This indicates to the presence of smectite.

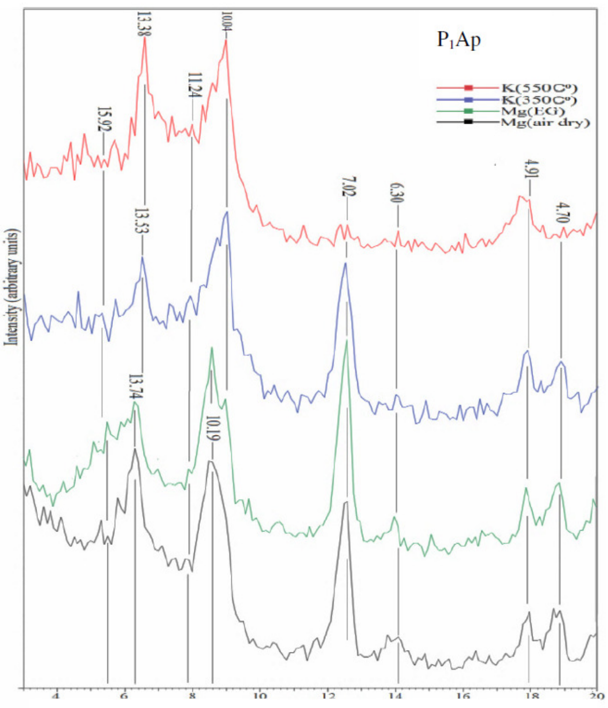

Fig.2 X-ray diffraction curves for soil pedon Salah- Din Fursan site

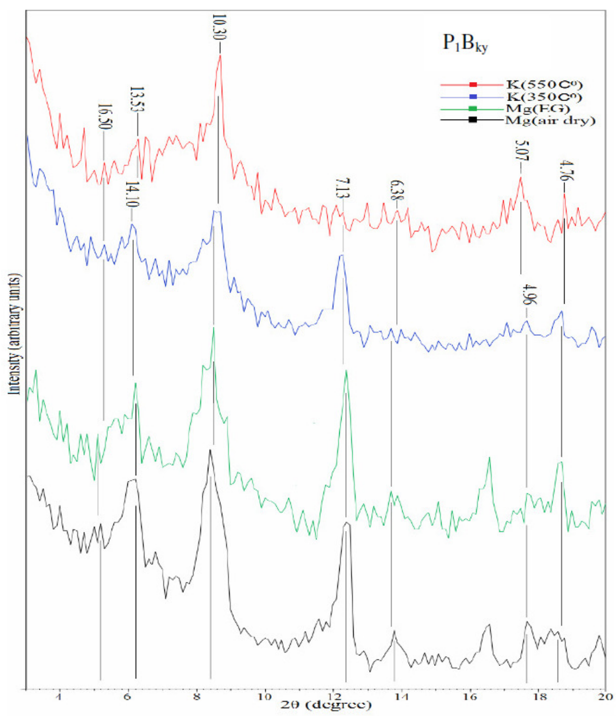

Fig.1 X-ray diffraction curves for soil pedon Salah- Din Fursan site

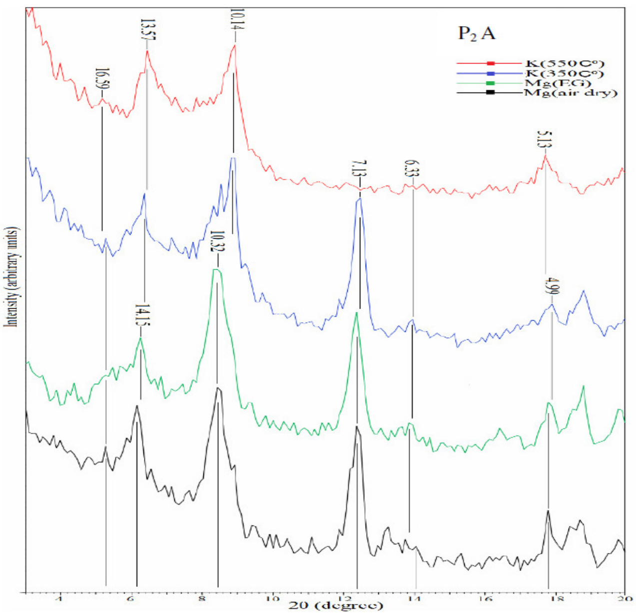

Fig.3 X-ray diffraction curves for soil pedon Salah- Din AL-Alam site

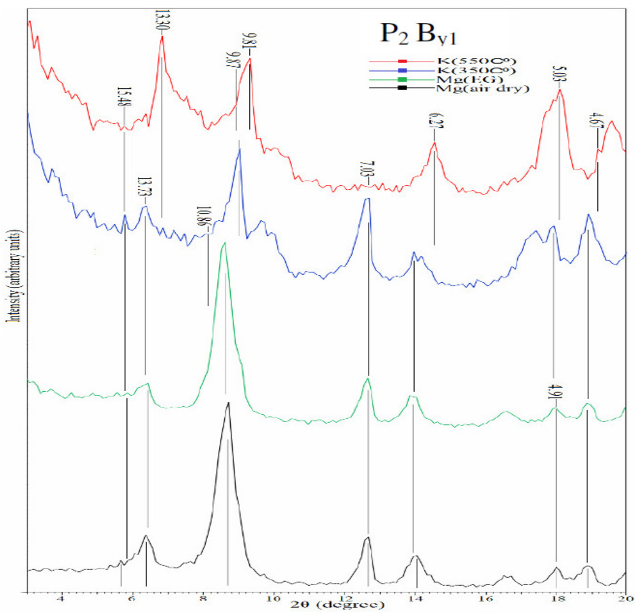

Fig.4 X-ray diffraction curves for soil pedon Salah- Din the AL-Alam site

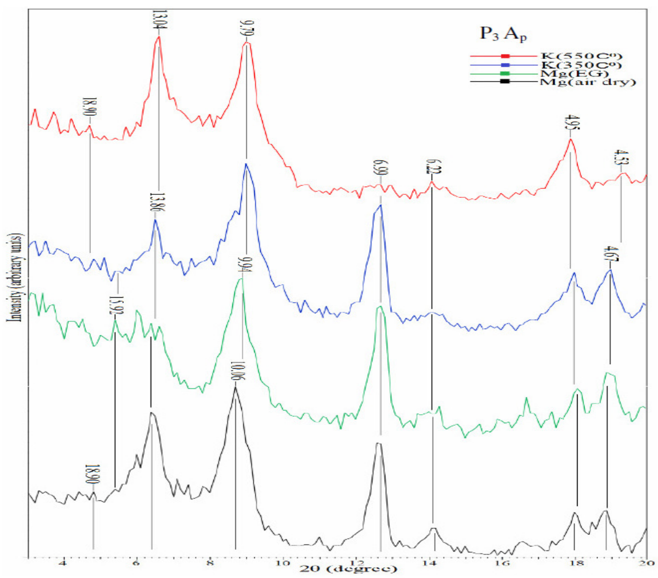

Fig.5 X-ray diffraction curves for soil pedon Salah- al Din AL-Alam site

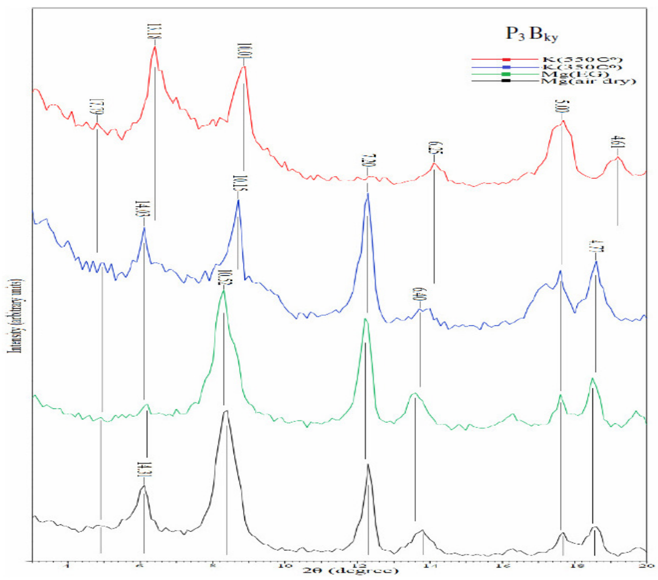

Fig.6 X-ray diffraction curves for soil pedon Salah- Din AL-Alam site

the diffractions of Najaf soils, were between (16.80-17.65A°) figures (7-11), that indicate the presence of smectite in these soils for the samples saturated with magnesium and air dried.

The results of all figures showed that was collapsing in the diffraction (14A°) of potassium samples heated 550C^0 to (10 A^0). In contrast, this effect was reflected in the diffraction of (10A°). the reason for this deterioration of smectite is the transformation of Illite towards smectite. These results agree with Al-Obaidi (2008) and Al-Jabouri (2011).

the reason for the high intensity of diffraction (10 A°), its level deviation, and its appearance with a peak less than that in all figures except for figure (1,9,10), which represents the surface horizon of the pedon 2, the surface and subsurface horizon, pedon 5, despite of Biotite dominancy and the low intensity of diffraction (5A°), the weathering process (transformation) of Illite towards the expanded minerals It was very little or not clear, and this was confirmed by the results of Table (2), with the evidence of the small amount of smectite (14A°), as well as the narrow distance between the diffraction (10 A°) and the diffraction (14 A°) and the absence of the of interstratified minerals. thus Illite dose not significantly affected by the transport and sedimentation processes. Which accompanied with an increase biotite content in the sources of these deposits.

It was observed through the results of the emergence of diffraction (14.10, 14.31A°) and its stability in the two treatments of air dry magnesium and ethylene glycol, and then its transformation to the basal distance (13.3A°) upon heating in temperature of 350 and 550ºC for the models of clays saturated with potassium as in the figure (2,3,5) return to pedon 1 subsurface horizon, surface horizon pedon 2, and the subsurface horizon pedon 3 respectively, which indicates the presence of swelling chlorite**.**

In general chlorite was determined in all the horizons of the studied soils on the basis of the first order (14A°), the second order (7Aº) and the third order (4.7Aº), it was possible to identify kaolinite in clay samples saturated with magnesium air dry and ethylene glycol with peaks that ranged between (6.99-7.20A) in Salah al-Din soils and (6.95-7.26Aº) in the soils of Najaf and remained constant at 350 ºC while it was disappeared in the heating 550 ºC, which proves the presence of kaolinite in the clays of these soil.

the main source of kaolinite is the sedimentary parent material transported by river in both sites, (Al-Obaidi, 2008).

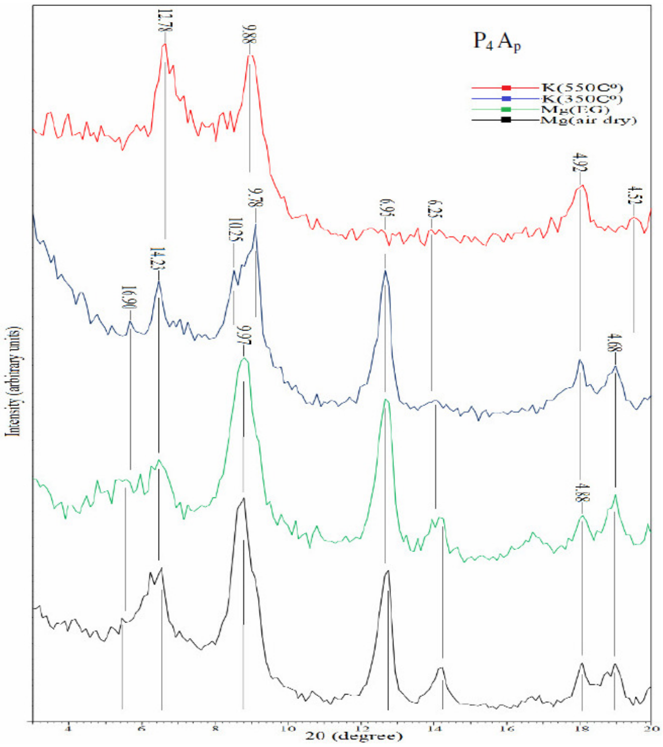

Fig.7 X-ray diffraction curves for soil pedon Al-Najaf Zarka site

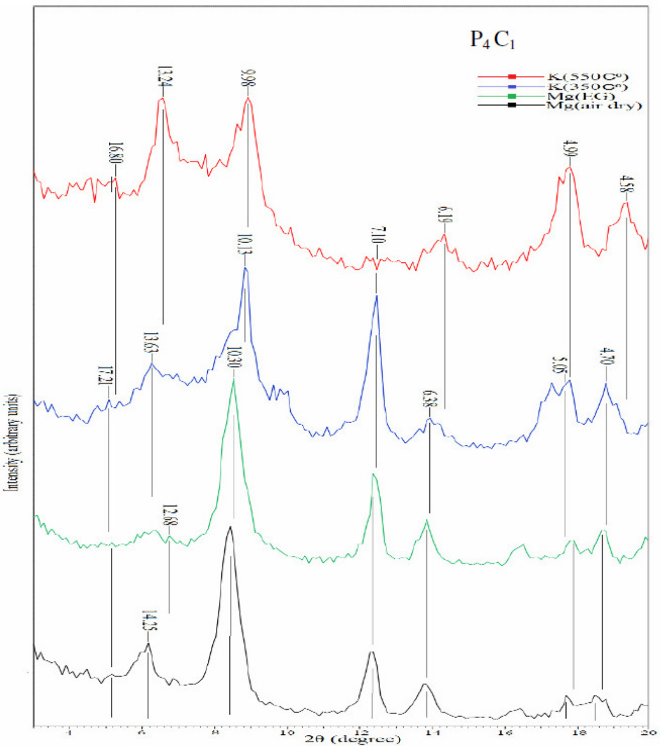

Fig.8 X-ray diffraction curves for soil pedon Al-Najaf Zarka site

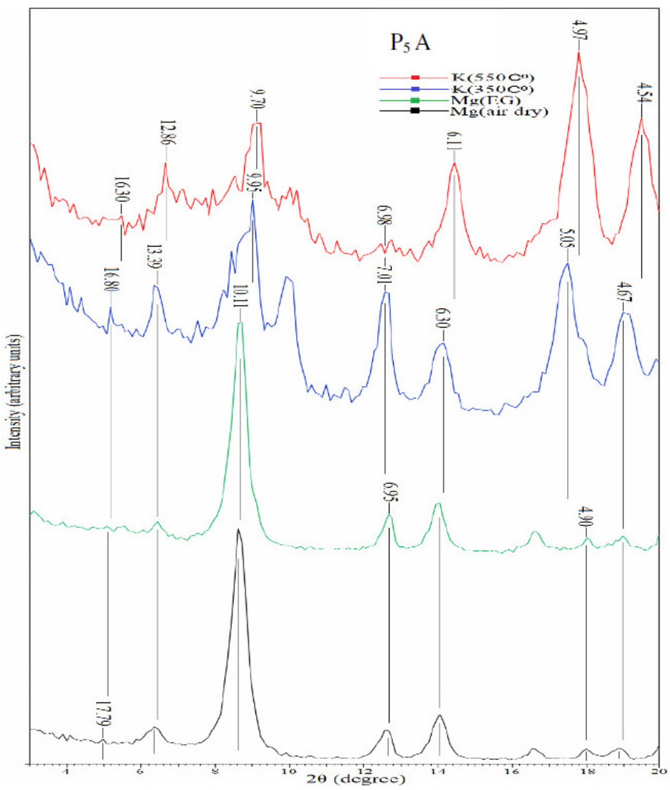

Fig.9 X-ray diffraction curves for soil pedon Al-Najaf Zarka site

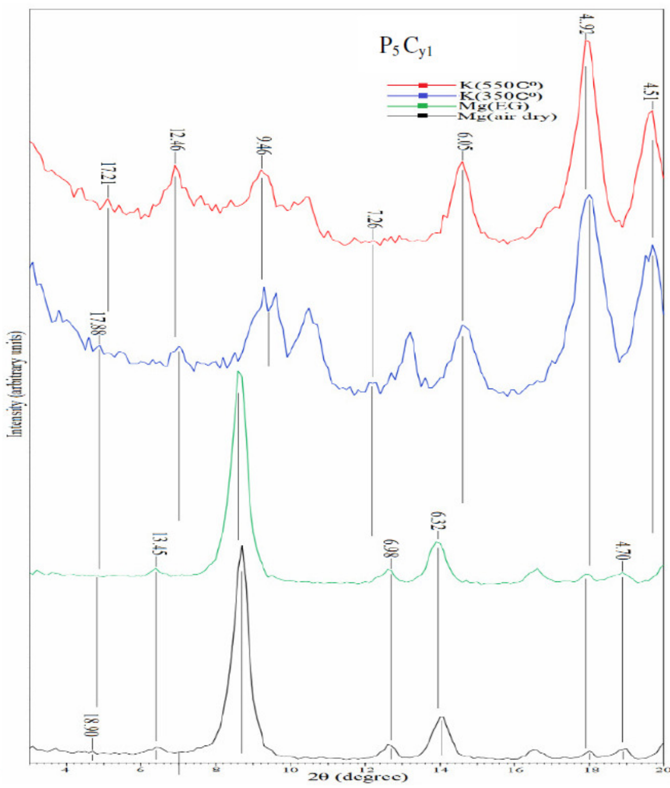

Fig.10 X-ray diffraction curves for soil pedon Al-Najaf Zarka site

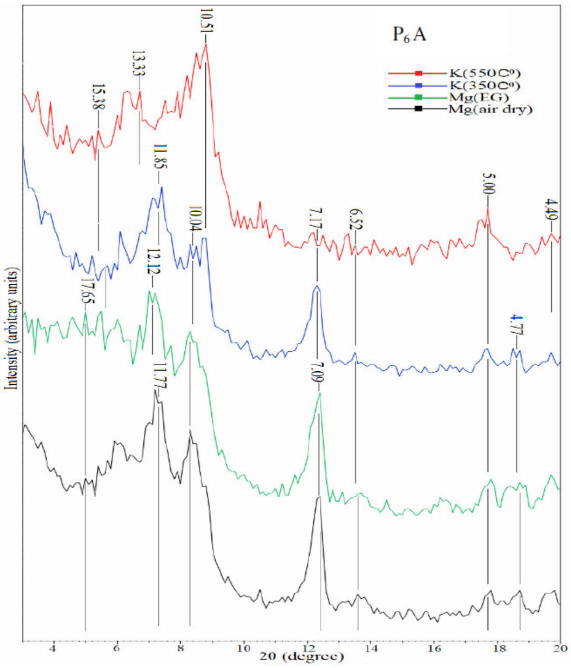

Fig.10 X-ray diffraction curves for soil pedon Al-Najaf Bahr Al-Najaf site

The results of Table (2) and Figures (1-11) indicate the predominance of the Palygorskite in the surface and subsurface horizons and for both sites except for the surface horizons for each of pedon1 and 3 Salah al-din. it was dominance of chlorite and smectite respectively, As well as pedon 6 Najaf was distinguished by the predominance of chlorite also, It can be said that the reason for the increase palygorskite in the soil horizons, especially under the subsurface, confirms what Al-Tamimi (1984) and Al-Obaidi (2008)later concluded that palygorskite is one of the clay minerals present within fine clay and as a result of the varying irrigation operations or the amount of rain falling on the surface it works On the transfer of the fine particles of clay to the down and thus the transfer of its fine mineral components while the coarse clay remains in its place at the surface, in return for this the proportion of smectite decreased according to the mineral sequence in the surface and subsurface horizons, especially pedon 2 and 3 unexploited pedons, as shown in the table (2), On the other hand, the surface horizons of pedon 3 and 6 showed increased its in percentage of smectite at those horizons through its appearance in the first and second ranks, respectively, Perhaps due to the formation of smectite originally from palygorskite, according to (Golden *et al*., 1985 and Badraoui *et al*., 1992) that the conversion of palygorskite to smectite takes place through two methods, either by breaking the Si-O-Si bonds between Silicate units. Layer 2: 1 followed by reorganization to form a smectite- structure; Or complete dissolution and reprecipitation under basal tilted soil conditions that were studied (Golden *et al*., 1985) indicated that breaking bonds between Si-O-Si units is more likely.To convert palygorskite to smectite.

Generally,The results of the forms of the studied horizons and Table (2) showed the emergence of the smectite at low percentages despite the availability of suitable conditions for formation. Al-Obaidi (2008) indicated the reason for this is the relative increase of the magnesium ion dissolved in the soil solution because the degree of soil reaction is tilted to basicity under dry conditions, in addition to the available quantities of gypsum, as Abtahi (1977) explained that one of the main reasons for a shift resulting from the great similarity in the chemical composition between them versus the difference in the crystal structure, which reinforces this the belief the soil content silica, magnesium and calcium.

The results confirmed the presence of Illite mineral in most horizons of these soils in the second order, except for pedon 1 and the surface horizons of pedon 2, 3, and 6, In addition, their relative abundance increased In the horizons of soil Najaf which could be attributed to its presence in dry and semi-arid climatic conditions as a result of increased precipitation processes, whether carried by wind or water, or possibly as a result of weak weathering processes (Netteltton *et al*., 1973).

Based on the aforementioned, the sequential arrangement of minerals can be determined depending on the quantities available to them in the clays of the study soil according to Table (2).

The results showed an increase in the percentage of kaolnite mineral in the subsurface horizons of the exploited soils by surface irrgation of pedon1 Salah Al-Din site, and 4 the Najaf site, compared pedon 3 the Salah aldin site, exploited by sprinkler irrigation, while its percentage decreased clearly in pedon 5 Najaf unexploited .As for chlorite, it was found in small quantities compared to other clay minerals, which indicates its low content in its parent substance.

Table 2 : The percentages of clay minerals in some horizons of the study soil

Sequenceses	Palygoroscite	Kaolonite	Illite	Chlorite	Smectite	Horizon	Location	Pedon No.
Soil pedons Salah Al-Din								
I□Ka□Sm□Pal· Ch	13.79	18.71	24.6	22.28	20.6	A_p	Al-Fursan cultivated	P_1
Ch□Sm□I□Ka· Pal	17.31	23.57	29.06	12.80	17.37	B_{ky}		
Sm□Ch□I□Kal· Pal	19.56	21.59	26.99	18.59	13.24	A	Al-alam un cultivated	P_2
Sm□Ka□Ch□I· Pal	29.51	9.90	47.04	14.92	4.21	B_{y1}		
Ka□Ch□I□Pal· Sm	15.58	15.26	28..15	16.08	24.90	A_p	Tikrit University cultivated	P_3
Ch□Sm□Ka□I· Pal	23.35	16.43	35.18	12.47	12.55	B_{ky}		
Soil pedons Al-Najaf								
Ch□Ka□Sm□I· Pal	18.56	17.79	30.29	15.20	18.14	A_p	Al-Zarka cultivated	P_4
Ch□Sm□Ka□I· Pal	13.24	25.67	40.56	9.40	11.10	C_1		
Sm□Ch□Ka□I· Pal	34.37	6.87	49.62	5.68	3.44	A	Al-Zarka un cultivated	P_5
Sm□Ch□Ka□I· Pal	39.17	3.97	51.02	3.95	1.87	C_{y1}		
I□Ka□Pal□Sm· Ch	5.27	17.47	12.31	38.73	26.19	A	Bahr Al-Najaf	P_6

References

Abbaslou, H. and Abtahi, A. (2007). Origin and Distribution of Clay Minerals in Calcareous, Gypsiferous, Saline Soils and Sediments of Bakhtegan Lake Bank, Southern Iran, Iran Agric. Res., 26: 1-2.

Abtahi, A. (1977). Effect of alkaline ground water on soil genesis in semiarid Southern Iran. Soil Sci. Soc. Am. Proc., 41: 583 – 588.

Al-Jabouri, A.M. (2011). Nature of the presence and transformations of mica and interstratified minerals in some gypsum soils in Salah al-Din Governorate, College Agriculture, University of Tikrit.

Al-Obaidi, B.S. (2008). Natural Occurance of Palygorskite in Some Iraqi Gypsiferous Soils, Phd. Thesis , College Agriculture ,University of Baghdad.

Al-Tamimi, R.A.K.H. (1984). Identifying of clay minerals in some Iraqi soils. M.S Thesis, College of Agriculture, University of Baghdad.

Anderson, J.U. (1963). An Improved Pretreatment for Mineralogical Analysis of a Samples Containing Organic Matter. Clays and Clay Minerals, 10: 380-385.

Badraoui, M.; Bloom, P.L. and Bouabid, R. (1992). Palygorskite–smectite association in a Xerocherept of the High Chaouia region of Morroco. Soil Sci. Soc. Am. J., 56: 1640–1646.

Dixon, J.B. and Weed, S.B. (1977). Minerals in Soil Environment. SSSA Book Series: 1sssA, Madison, WI.

Gjems, O. (1967). Studies on Clay Minerals formation in Soil Profiles in Scandinavia. Meddelser Fra . Det. Norke Skogfars Qksvesen, No. 18, Bind 21: 305-315.

Golden, D.C.; Dixon, J.B.; Shadfan, H. and Kippenberger, L.A. (1985). Palygorskite and sepiolite alteration to smectite under alkaline conditions. Clays Clay Miner. 33: 44-50.

Grim, R.E. (1968). Clay mineralogy, 2nd, edition. McGraw. Hillbook, New York, USA, 596P.

Hasan, K.F. (1981). Study of minerals and some characteristics of the soils of the Jazira region, Tal Afar - Sinjar – Baaj.thesis.master, Faculty of Agriculture and Forestry, University of Mosul.

Hashemi, S.S.; Baghernejad, M. and Ghiri, M.N. (2013). Clay Mineralogy of Gypsiferous Soils under Different Soil Moisture Regimes in Fars Province, Iran. J. Agr. Sci. Tech. 15: 1053-1068.

Hormuz, S.A. (1989). Mineralogical, geochemical, and properties of palygorskite mineral study, rocks and associated clays in the late Saffra-Maastricht organ in the Carra Akashat region, M.Sc. Thesis, College Science. Mosul University.

Jackson, M.L. (1979). Soil Chemical Analysis Advanced Course. 2nd ed.. 11th Printing. Published by the Author, Madison, W. I.

Khademi, H. and Mermut, A.R. (1998). Source of Palygorskite in gypsiferous Aridisols and associated sediments from Central Iran.Clay Miner., 33: 561-575.

Khademi, H.; Mermut, A.R. (1979b). Sulfur isotope geochemistry of gypsiferous Aridisols from central Iran. Geoderma, 80: 195-209.

Kunze, G.W. (1962). Pretreatment for Mineralogical Analysis. Reprint of Section Prepared for Method Monograph Published by the Soil Science of America, p. 13.

Millot, G. (1970). Geology of clays. Masson et Cie., Paris.

Nettleton, W.O.; Nelson, R.E. and Flach, K.W. (1973). Formation of illite in Surface horizon of dry land soils. Soil Sci. Soc. Am. Proc. 37: 473-480.

Owliaie, H.R.; Abtahi, A. and Heck, R.J. (2006). Pedogenesis and clay mineralogical investigation of soils formed on gypsiferous and calcareous materials, on a transect, southwestern Iran. Geoderma, 134: 62–81.

Rabenhors, M.C. and Wilding, L.P. (1984). Method to Obtain Carbonated Free Residues from Lime Stone and Petrocalcic Material. Soil Sci. Soc. Am. J. 84: 216-219.

Soil Survey Staff (1993). Soil survey manual, USDA. Handbook No. 18, US Government Printing Office, Washington. D.C. 20402.

Wilson, M.J. (1999). The origin and formation of clay minerals in soils: past, present and future perspectives. Clay Miner. 34: 7-24.