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The Nature of Iron Oxide Distribution in Some Calcareous and Gypsiferous Soils

ABSTRACT

The study area is located within two regions. The first site in Tikrit city (Tikrit University) represents gypsiferous soils and the second site represents calcareous soils in Erbil Governorate. Two pedons were chosen in Tikrit P1 (rainfed) and P2 (cultivated), and two other pedons in Erbil P3 (rainfed) and P4 (cultivated) . Tikrit pedons showed presence of gypsum crystals of spindle and lenticular type with a length ranging between (0.2 - 0.5) mm , the pores type of vughs and chamber, while the dominance of the planer and interconnected chamber pores in Erbil pedons. Iron oxides appeared in different forms of single discrete particles or Ferriargillans cutan especially in Erbil's pedons, The values of iron oxides varied, as the dominance of the total, free ,and the amorphous iron oxides in Erbil pedons were ranged between (8.77 -12.81), (8.17 - 10.30), (6.82 - 9.19) $g.kg^{-1}$, respectively, compared with the iron oxides themselves for Tikrit pedons, which ranged between (2.98 - 5.39), (2.45 - 4.86), (1.19 - 2.67) $g.kg^{-1}$, respectively. While the amorphous iron oxide values showed an increasing in the Tikrit pedons compared with Erbil pedons, as their values in Tikrit ranged between (1.26 - 2.19) $g.\ kg^{-1}$ while in Erbil pedons ranged between (1.01 – 1.81) $g.\ kg^{-1}$.

INTRODUCTION

Gypsum soils are a soil containing more than 2% gypsum, and that is either in the form of a true gypsum or anhydrite in the surface horizon and more than 14% gypsum on the subsurface horizon (Van Alphen and Romero ,1971) . Al-Naimi (2003) was studied various areas of Iraq, among them the south of the city of Samarra, Fallujah, and the western Habbaniya lake, Al-Khaldiyah and Khan Dari that the thin section of gypsum soils, especially the horizons with a high content of gypsum, indicate the presence of gypsum in various forms, including lenticular or spindel gypsum crystals, as nests or white nodules, the size of these crystals depends on the size of the pores and the age of the crystal. Gypsum soils have been defined according to Soil Survey Staff 1975,1994,2006 as "soil containing gypsic horizon where the amount of precipitation is less than 400 mm per year.

Calcareous soils are composed of calcium carbonate have often mor than 15% CaCO3 in the soil .It may occur in various forms (nodules, crusts, crystals and powdery ,FAO ,1990 . The most important form of carbonate minerals is calcite Ca CO3, which constitutes about 90% of the total carbonate, then aragonite, and then magnesite (Mg CO3). It is found most frequently in sedimentary sediments and then Dolomite Ca Mg (CO3) consisting of Dolomite limestone and there are other images in very small quantities such as anchorites and ferrite, , Lindsay,1991, FAO, 1990 , Iraqi soils contain high content of carbonate minerals, especially $CaCO_3$, which amounts to 500 $g.\ kg^{-1}$

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soil . It constitutes 5% of the earth's crust minerals and its presence in the soil is very important as it affects and is influenced by many physical and chemical properties of the soil, the size of soil clusters, clay and silt separations. (Jelic et al, 2011).

Formation of iron oxides in the soil starts during weathering of iron-bearing minerals such as silicate and sulphide minerals (Schwertmann and Cornell, 2003) and the process of forming iron oxides in the soil includes many processes, including dissolving, sedimentation, aggregation, oxidation and reduction The most important forms of iron oxides are Goethite, Lipidocrocite, Akaganetite, and Hematite, is an important iron oxide after Goethite has pigmenting effect on soils. Iron oxides in the soil affect the amount of carbonate and reduce its reactions and that the active carbonates (the size of clay) have a significant effect on the soil reactions. This is due to its large surface area which increases its activity in chemical reactions, (Rahi et al. 1991) . The content of free oxides in the soil depends on the degree of their development. . Shekh- Bzeni, 1999 explained that the content of free oxides in developed soils is more than the undeveloped soils, and it has also been found that the degree of soil development greatly affects the content of these . Greenland et al, 1968, explained that iron oxides may appear in the soil in various forms, they may appear as coatings on the surfaces of clay minerals, or may be in a single discrete particle (size of clay) . Ulery, 2011 defined amorphous iron oxides as materials that do not have a formalized shape. He also indicated that amorphous materials in the soil are generally in the form of oxides and that these compounds are in the form of coating around the clay particles, and may exist in a separate body inside the soil body . (Al-Hamdani, 2005) also indicated that the percentages of amorphous iron oxides decreased with increasing soil development, and attributed this because iron, over time, tends to form the most stable image, the crystalline state of iron, which reduces the values of amorphous iron oxides. In a research study (Inskeep, 2011) he indicated that iron oxides are affects many chemical properties within the soil body due to the high surface area of these compounds. Crystalline free iron oxides as important compounds and are common in various environments, and that its small minutes range between (10-3nm) so it has a high surface area that enables it to ionize and influence the various characteristics of the soil. The research aims to study the case of iron oxides in their various forms in gypsiferous and calcareous soils.

MATERIALS AND METHODS

Two pedons were chosen in Tikrit city (Tikrit University), representing the gypsiferous soils, the pedon P1(rainfed) and pedon P2 (irrigation), height above sea level 107 - 110 m, and two other pedon representing the calcareous soils in the governorate of Erbil, one of them is (rainfed) in the area of Korda Rashh (P3), its height is 432 m above sea level, and the other pedon (P4) in the Tawarq region its height above sea level 429 m (Figure 1) . According to the rainfall rates (FAO, 1988) The study area located within two domains: zone 2, which includes arid Tikrit pedons, the rate of precipitation ranged between (100-300) mm / year, while Erbil pedons located within the semiarid zone3 to semi-wet and in which the rate is precipitation ranged from (300-500) mm / year. Pedons for both regions were described according to the Soil Survey Staff,2006. Disturbed soil samples were taken in each horizon and placed in plastic bags to perform physical and chemical analyses. Also the undisturbed soil samples preserved for the purpose of measuring the bulk density and making the soil thin section slides for micromorphology studies The soil samples were air-dried and then ground with a wooden hammer. After that, passed through a sieve with a diameter of 2 mm and kept in plastic boxes to perform the following analyses .

Figure1. Location of the study area

Physical Analysis

Particle Size Distribution

Particle size distribution of soil samples was determined following international pipette method as described by Kilmer and Alexander, (1949).

Bulk Density: The bulk density (Pb) was estimated according to the paraffin wax method described by Black, 1965).

Total Porosity (*f*)

The total porosity of the application was calculated by applying the relationship between bulk density and true density according to the equation described by (Vomocil, 1965) as follows

$$f = 100\left(1 - \frac{Pb}{Ps}\right)$$

Chemical analysis

Soil reaction (pH): a measure of a 1: 1 soil extract using the pH meter wtw device according to the method given in Richards, 1954

Electrical conductivity (1: 1 EC)

Estimated from soil extract: water (1: 1) and using meter EC WTW Richards, 1954

Organic matter:

Estimated according to Black and Walkely's wet digestion in (Jackson,1979).

Total Carbonates:

Calcimeter was estimated according to Hesse, 1971 using (3N) of hydrochloric acid.

Active Calcium Carbonate

Estimated using (0.2N) ammonium oxalate according to Kozhekov and Yakovelva method, 1977

Cation Exchange Capacity (CEC)

Estimated according to methylene blue method, Savant (1994)

gypsum ($CaSO_4.2H_2O$):

It was estimated by dilution method as distilled water is used in extracting in a solution containing acetic acid and acetone for deposition of gypsum, according to the method mentioned in (Lagerwerff et al. 1965).

Determination of iron oxides in soil

- Total iron oxides

Determined according to the Mehra and Jackson, 1960 method using a solution of Na-dithionite-citrate-bicarbonate using the Atomic absorption.

- Free iron oxides (Fet)

Iron present was extracted as free oxides in Jackson, 1979 method, where ferrous was estimated by the method chromaticity then converted the iron ratio to Fe2O3 as a percentage.

-Amorphous free iron oxides (Fe_o)

The amorphous free iron oxides were extracted for soil samples using a solution of acid ammonium oxalate (pH = 3) according to Schwertmann method, 1964. The iron was estimated in the extract by an atomic absorption spectrophotometer, which, after its conversion, represented the amorphous free iron oxides. The estimate was made at the Faculty of Agriculture / Tikrit University.

-Crystalline free iron oxides (Fe_d)

Their proportions were calculated from the difference between the amount of total oxides and amorphous oxides.

Micromorphological Analysis

The micromorphological characteristics were studied using soil thin sections technique by taking undisturbed soil samples well known directions , according to the method presented in Brewer, 1964 and Stoops, 1998. Slides were prepared and examined at the College of Science - Baghdad University - Department of Earth Sciences

RESULTS AND DISCUSSION

Morphological description of study pedons

The results of the morphological description of the study soils indicate that there is a case of variation in the soil development as a result of the variation of geomorphological processes, the effect of factors and processes of soil formation and the nature of agricultural land use , which is reflected on the activity of pedogenic processes, which in turn led to the difference of large morphological characteristics. The results in table (1) showed the morphological description of study pedons. Pedons of Tikrit did not show any features of a clear development in its horizons due to the desert dry conditions. Soils have an (aridic) moisture regime with Hype thermic temperature regime (Aridisols order) (Soil Survey Staff, 1999, 2006). Parent materials were gypsiferous- calcareous. Soil colors ranged between 10YR6 / 3 to 10YR8 / 4 (dry) and 10YR4 / 3 to 10YR7 / 4 (wet). The dominant soil structure was the angular blocky , spongy and massive for sub-surface horizons, while soil texture tend to coarse texture ,it was ranged between loam to loamy clay sand , this reflects the effect of the gypsum parent material, which also affected the relative height of the salts, and the increase in permeability. Formation of gypsum pendant under gravels was dominant with limited moisture.

The two pedons of Erbil showed varying degrees of development due to the difference in the influence of soil formation factors (climate, vegetation, and origin material, which are active soil formation factors in addition to that the effect of special factors for each of the study areas and the nature of the internal factors of the soil, which was reflected on the morphological characteristics such as the type, thickness and nature and the arrangement of the genetic horizons of each pedon . It showed the presence of pedogenic development horizons, especially the irrigated pedons as they were of A-B-C sequence. The activity of the elluvation and illuvation processes was active, which was reflected in the presence of some horizons such as the argillic clay horizon and the calcic horizon.

Table (1) Morphological characteristics of study pedons

Pedons	Horizons	Depth Cm	Color		Texture	structure	Consistency		Boundary	Notes
			Dry	Moist			Dry	moist		
Tikrit pedons										
P1	Ap	0-14	10YR6/3	10YR4/3	L	1fsbk	S	L	Cs	Very fine roots
	Cky1	14-58	10YR8/3	10YR7/4	LCS	2msbk	S	Fr	Gs	Powdery gypsum
	Cky2	58-73	10YR8/3	10YR7/4	L	2msbk	Sh	Fr	Gs	Gypsum noduels
	Cky3	73-100	10YR8/3	10YR7/4	L	Om	Sh	Fr	-----	=
P2	Ap	0-18	10YR5/4	10YR4/4	LS	1fabk	S	L	Cs	Abundant fine roots
	Cy1	18-33	10YR7/4	10YR5/6	L	1fsbk	Sh	fr	Cs	Gypsum,gravels
	Cky2	33-46	10YR8/4	10YR6/6	LCS	3hsbk	Sh	fr	Gs	Gypsum nodules
	Cky3	46-100	10YR8/4	10YR6/6	LCS	3hm	H	fr	---	=
Erbil pedons										
P3	Ap	0-20	7.5YR4/2	7.5YR3/2	CL	2shsbk	Fr	Fr	Cs	Abundant fine roots
	Ck1	20-53	7.5YR5/4	7.5YR4/4	CL	2msbk	Sh	Fr	Ds	Carbonate nodules
	Ck2	53-80	7.5YR8/4	7.5YR7/4	CL	3vdsbk	H	Sh	Gs	Carbonate nodules
	Ck3	80-110	10YR8/3	10YR7/3	L	3vhsbk	H	Sh	----	=
P4	Ap	0-24	10YR7/2	10YR6/2	C	2mg	Fr	Fr	Cs	Abundant fine and coarse roots
	Btk	24-44	10YR6/2	10YR5/2	C	2hsbk	Sh	Fr	Cs	Few coarse roots
	Ck1	44-77	10YR7/3	10YR6/2	C	2hsbk	Sh	Sh	Cs	Carbonate nodules
	Ck2	77-110	10YR7/3	10YR6/3	C	2vhsbk	H	Sh	----	=

Structure.0=non,1= weak ,2 = moderate,3=strong ,sbk=subangular blocky ,m=massive,I = loose,s= soft ,sh=slightly hard , fri=friable ,fi=firm,Cs=clear smooth ,Gs=gradual smooth ,Ds =difuse smooth

Erbil was non-saline soils with relatively high organic matter values , high clay and lime values , the soil color ranging from 7.5YR4 / 2 to 7.5YR8 / 4 (dry) to 7.5YR3 / 2 to 7.5YR7 / 4(moist) . As for the structure, it was from the granular type to the sharp-angular blocky structure in the surface horizons to the angular blocky structure in the sub-surface horizons. The texture tended to the soft texture, as it ranged from the loam to a clay loam in the P3, while it was clay texture for P4 .
The irrigated pedon notes the high porosity, which corresponds to the high clay ratio for most horizons. Erbil pedons were aridisols order located within the Aridic- Xeric moisture regime and the Thermic temperature regime. The results indicated that there is a difference in the main morphological characteristics between the soils of one region, but there is a wide difference between the two regions which affect the formation of soil and its development such as climate, topography and parent material .

Physical characteristics for study Pedons
Particle Size Distribution

Table (2) shows the results of the practical size distribution of the soil separations of the study pedons and the nature of their distribution with the depth from which it is means that there was a state of variation in their content of the particles. Rainfed Tikrit pedon appears as an undeveloped that has an almost constant sand ratio with depth ranged between (435- 544) g. kg $^{-1}$ the lowest value was on the horizon Cky3 and the highest value was on the horizon Cky1, while it is noticed that the ratio of the silt with the depth ranged between (233- 360) g. kg $^{-1}$ the lowest value was on the sub-surface Cky1 horizon but the largest value was present on the Cky3 horizon. The clay ratio ranged between

(193-222) g. kg $^{-1}$ the lowest value is present on the surface horizon Ap but the highest value was on the horizon Cky1 .

Table (2) physical properties of study pedons

Pedons	Irrigation type	Horizon	Depth (cm)	Soil particles gm-kg^{-1}			texture class	Bulk density g.cm^{-3}	porosity%
				Sand	silt	clay			
Tikrit pedons									
P1	rainfed	Ap	0-14	501	304	193	L	1.36	48
		Cky1	14-58	544	233	222	LCS	1.20	55
		Cky2	58-73	511	270	218	L	1.38	47
		Cky3	73-110	435	360	203	L	1.40	46
P2	cultivated	Ap	0-18	557	311	130	LS	1.19	54
		Cy1	18 -33	503	370	126	L	1.32	50
		Cky2	33-46	552	290	156	LCS	1.22	51
		Cky3	46-110	526	295	178	LCS	1.45	45
Erbil pedons									
P3	rainfed	Ap	0-20	260	259	480	CL	1.21	54
		Ck1	20-53	293	237	470	CL	1.22	54
		Ck2	53-80	236	483	206	CL	1.23	53
		Ck3	80-110	233	429	137	L	1.32	50
P4	cultivated	Ap	0-24	350	330	320	C	1.29	46
		Btk	24-44	262	309	429	C	1.29	51
		Ck1	44-77	281	318	401	C	1.30	50
		Ck2	77-110	290	320	390	C	1.45	45

AS for p2 horizons were homogeneous values , the sand content ranged from (503-557) g. Kg $^{-1}$, the lowest value on the horizon Cy1 and the largest value on the horizon Ap, the silt ranged between (290 -370) g. Kg $^{-1}$ the lowest value on the horizon Cky2 but the highest value found on the horizon Cy1 while the clay ratio (126 – 178) g. Kg $^{-1}$ the lowest value is present on the surface horizon Cy1 were the highest value on the horizon Cky3. . It showed that there was no any significant increase in the clay particles which means that the precipitation (150mm/year) and land use are noneffective in redistribution the soil particles with depth .

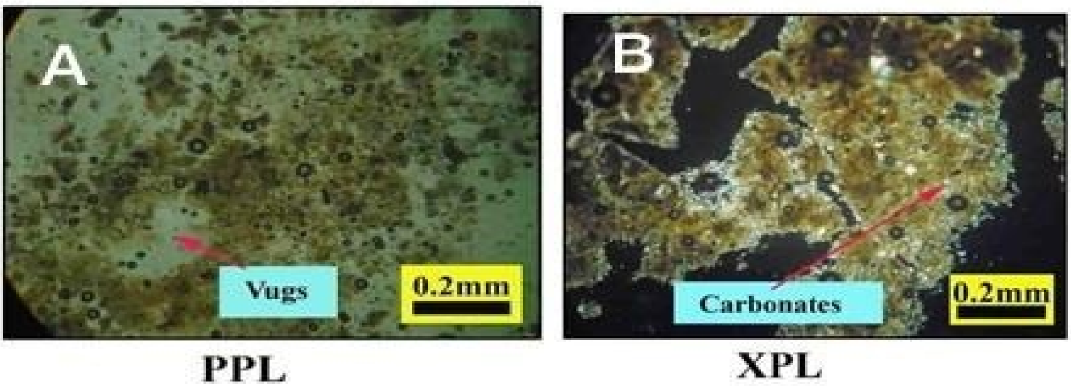
As P3 (Erbil rainfed pedons) has little development with calcareous parent materials . The sand content was ranged between (233-293) g. Kg $^{-1}$ the lowest value was found On the Ck3 horizon and the highest value was found on the horizon Ck1, the silt ratio ranged from 237 to 483 g. Kg $^{-1}$ the lowest value found on the horizon Ck1,as the highest value found on the horizon Ck2, the clay content ranged between (137-480) g. Kg $^{-1}$, the lowest value on the horizon, Ck3and the highest value was found on the Ap horizon. We notice that P3 has a noticeable increase in the content of silt with depth. As for the clay content , its value was increased on the surface horizon (480) g kg $^{-1}$, it may return to the role of weathering on the surface horizon, and clay rich parent material . As for the developed cultivated pedon (P4), the sand ratio ranged between (262- 350) g. Kg $^{-1}$ the lowest value on the horizon Btk and the highest value on the horizon Ap, while the ratio of the silt ranged between (309 -330) g. Kg $^{-1}$ The lowest value is found on the horizon, Btk, and the highest value was found on the horizon Ap. Silt and sand were decreasing with depth. The content of clay ranged between (320 - 429) g. Kg $^{-1}$ the lowest value was found on the Ap horizon and the highest Value on the horizon Btk. The increasing of the clay value with depth indicates the effect of weathering and land use on the movement of colloidal soil components, especially the clay from the surface horizon to the Btk horizon and the activity of the illuviation process that led to the formation of the weak argillic horizon. Generally, it is observed that increasing of clay values in Erbil pedons compared to the Tikrit pedons, may be due to the influence of soil formation factors and processes, especially the effect of climate and the parent material.

Bulk Density

The results in Table (2) indicate a relative variation in the values of the bulk density of study soil pedons that are related to the texture , organic matter, gypsum, calcium carbonate and the impact of agricultural land use . The values of the bulk density in Tikrit rainfed pedon ranged between (1.2 - 1.4)g .cm^{-3}, the lowest value was on the horizon Cky1, while the highest value was on the horizon Cky3, while the bulk density values in the cultivated pedon between (1.19 -1.45) g .cm^{-3} the lowest value was on the Ap horizon, while the highest value was on the horizon Cky3, the variance of the bulk density values may be due to the high sand values that constitute more than 50% of most of the pedons, as well as the variance of the porosity distribution and type minerals, organic matter values, gypsum and lime (Al-Hamdani, 2005). The values of the bulk density of the P3 (rainfed) in Erbil showed an increasing with depth, as they ranged between (1.21- 1.32) g.cm^{-3}, the lowest value was on the horizon Ap, and the highest value on horizon Ck3. While the bulk density values in the cultivated pedon ranged between (1.29 - 1.45) g .cm^{-3} the lowest value was on the surface horizon Ap and the horizon Btk and the highest value was on the horizon Ck2.

Total Porosity

Table (2) shows the existence of a relationship between the bulk density and total porosity of most of the pedons, and notes the convergence and increasing of the porosity values for the both sites. The porosity values in Tikrit pedons ranged between 45% in the Cky3 horizon, to the highest value was 55% in the Cky1 horizon . The porosity values in the Erbil pedons ranged from 45% in the Ck2 horizon to 54% in the Ap and Ck1 horizon , which means there are good aeration conditions for all the pedons.



Picture (1) A-pore type vughs in the Tikrit pedons (p1) on Ap horizon. B - The pores of the interconnected chamber type in the Erbil irrigated pedon.

Chemical characteristics for study pedons

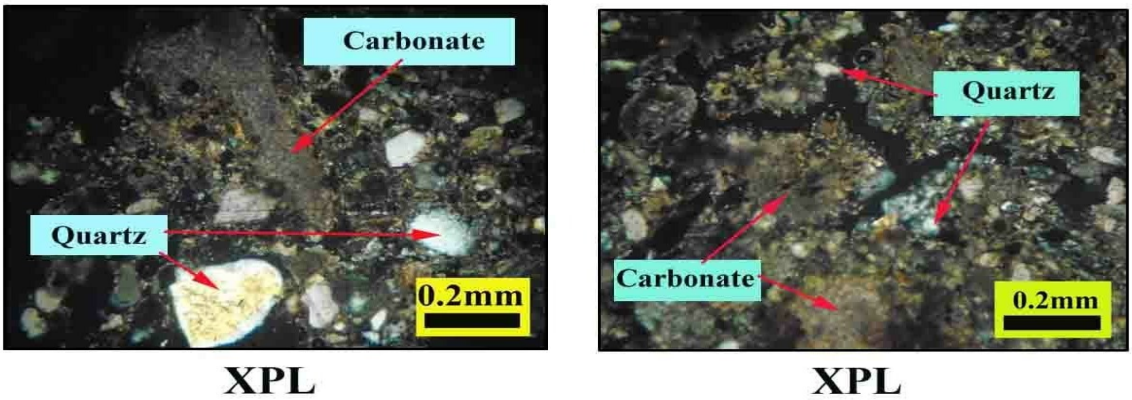
The pedon of Tikrit showed moderate salinity, ranging from 1.77 dS m^{-1} at the Ap horizon to 3.18 dS.m^{-1} at Cky3 horizon. The high electrical conductivity is due to the lack of rain in this area and the accumulation of salts from salty wells water, while the pedons of Erbil were non to very low salinity , as they less than 0.5 dS.m^{-1} .The pH of the soil in general medium to neutral as it ranged in Tikrit pedons from 7.39 on the horizon Cky1 to 8.31 on the Cky3 horizon for (P1) , while in Erbil, the soil pH values ranged from 7.2 to 8.31 . The organic matter values for Erbil pedons were higher than the values for Tikrit pedons, as the lowest value was (2.0 $g.kg^{-1}$) on the Cky3 horizon for (P1), and the highest value was 39.77 ($g.km^{-1}$) on Ap horizon (P 4) . The study pedons showed different values due to variability in climate which was reflected in the increase of vegetation, soil fertility and the activity of microorganisms which increasing decomposition of organic matter , in general the organic matter decreased with depth. The cation exchange capacity values, showed that the lowest value was 3.1 $Cmol.kg^{-1}$ on the Cky3 horizon(P1) which contained the lowest organic matter value while the highest value was 45.0 $Cmol.kg^{-1}$ on Ap horizon (P4).In general, Erbil pedons had a high value of the cation exchange capacity compared to Tikrit pedons.

Table (3) chemical properties of study pedons

pedons	Irrigation type	Horizon	Depth cm	pH	EC $DS.\ m^{-1}$	Organic matter	Total calcium carbonate	Active carbonate	Gypsum	Cation exchange capacity $cmol.\ Kg^{-1}$
						gm. kg -1				
Tikrit pedons										
P1	Rainfed	Ap	0-14	7.88	1.77	4.0	231	63	15	6.4
		Cky1	14-58	7.39	1.90	3.3	259	45	19	8.0
		Cky2	58-73	7.40	2.05	3.0	268	54	30	6.9
		Cky3	73-100	8.31	2.75	2.0	273	47	46	3.1
P2	cultivated	Ap	0-18	7.7	2.99	10.0	201	71	7	9.1
		Cy1	18-33	7.7	2.90	8.5	199	68	12	7.4
		Cky2	33-46	7.6	3.11	6.0	195	69	19	7.0
		Cky3	46-100	7.8	3.18	5.0	196	65	28	7.4
Erbil pedons										
P3	Rainfed	Ap	0-20	7.62	0.50	13.0	296	98	Nill	18.1
		Ck1	20-53	7.60	0.17	10.1	315	105	Nill	17.4
		Ck2	53-80	7.77	0.12	8.9	367	122	Nill	17.3
		Ck3	80-110	7.78	0.12	8.1	325	110	Nill	14.0
P4	cultivated	Ap	0-24	7.2	0.27	39.7	135	78	Nill	45.0
		Btk	24-44	7.6	0.40	15.5	376	79	Nill	43.6
		Ck1	44-77	7.7	0.35	13.3	491	130	Nill	40.2
		Ck2	77-110	7.7	0.24	10.1	400	128	Nill	40.4

Total and active carbonate minerals and gypsum

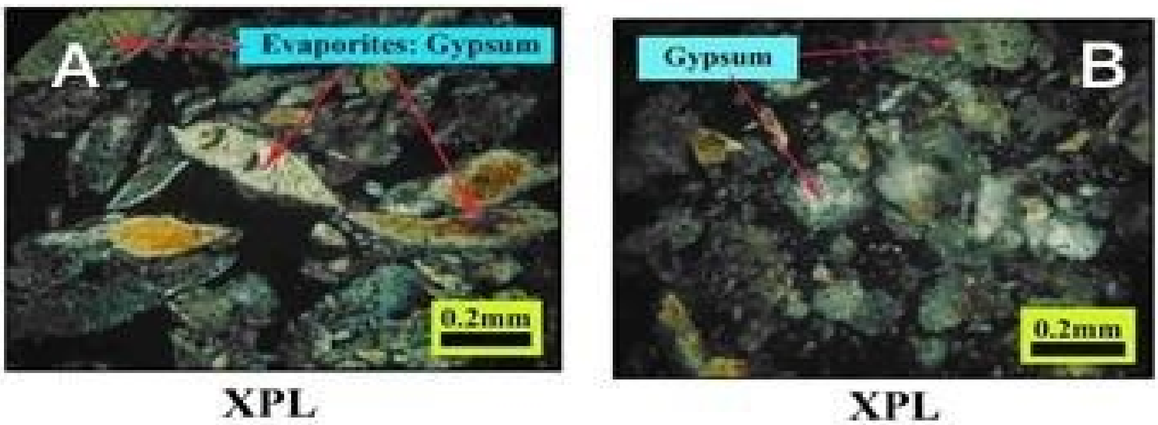
The accumulation and distribution of carbonate minerals is one of the important pedogenic processes in arid and semi-arid regions due to its importance in determining many of the soil properties, the most important of which is the movement and precipitation of soil particles , especially clay and iron oxides. Table (3) indicated the values of total calcium carbonate in Tikrit pedons between (195 -273) $g.kg^{-1}$, the lowest value on the Cy1 horizon, and the highest was on the Cky3 horizon for (Rainfed pedon) . It is noted that the total carbonate increases with the depth of the (P1) rainfed pedon and this may be related to the gypsum-calcium origin while the distribution of carbonate in the cultivated pedon was Semi-static . The active carbonate values ranged between (71 - 45 $g.\ Kg^{-1}$) the lowest value on the Cky1 horizon while the highest value was on the Ap horizon. The calcareous pedons of Erbil have a different content of carbonates, and the pattern of their distribution with depth is somewhat different. The total calcium carbonate values ranged between (135-491) $g.kg^{-1}$ the lowest value on the Ap horizon, and the highest value has been on the Cy1 horizon for the cultivated pedon, while the active calcium carbonate values ranged between (78-130) $g.\ kg^{-1}$. The total and active carbonate values were increasing with depth due to the relative height of precipitation as well as the land use in cultivated pedon , which contributes to the movement of soil particles to the lower horizons. The rich parent material carbonate and semi-arid conditions encourage formation of the decalcification process , especially at the subsurface horizons(illuviation horizon) .Picture (2) shows the presence of calcium carbonate as it was Infilling the pores in rainfed CK_2 horizon (A) while they were in the form of aggregate coating for filling and semi-filling pores on the Ck1 horizon for cultivated pedon (P4), this is agree with the increasing in the proportion of lime to 491 g.kg-1.



Picture (2) A - infilling calcium carbonate on Ck2 horizon (P3) . B-Aggregate coating calcium Carbonate and semi-filling pores of the Erbil-Ck1 horizon .

Gypsum:

Table (3) and picture (3) showed that the gypsum values increased in Tikrit pedons, and it was increased with depth, as the gypsum ratio in rainfed Tikrit pedons ranged from (7-46) g.kg^{-1} the lowest value on Ap horizon (P2) were the highest value on Cky3 horizon (P1) . As for the calcareous soil of Erbil, the percentage of gypsum is almost non-existent. The reason was attributed to the calcareous parent material and the moist conditions, picture (3) showed the gypsum crystals at both lenticular type or spindle hedral and anhedral forms. According to the weathering and crystallization conditions in which the horizons were exposed led to the formation of gypsum crystals at the size 0.2 mm ,. Few brown iron oxides crystals appeared on some surface gypsum crystals.



Picture (3) A-lenticular gypsum crystals with coated iron oxides B - Hedral and anhedral spindle gypsum crystals

Total iron oxides

The result of iron oxides in study soil showed different values depending on the conditions of pedons . Table (4) showed the values of total iron oxides (FeT) for Tikrit pedons from 2.98 g .kg $^{-1}$ in the rainfed Ap horizon to 5.39 g. kg $^{-1}$ in the horizon Cy1 for the cultivated pedon .

Table (4) Iron oxides forms in the study pedons

pedons	Irrigation type	Horizon	Depth (cm)	FeT	Fet	Feo	Fed	Fed/FeT	Feo/Fed
				gm.kg-1					
Tikrit pedons									
P1	rainfed	Ap	0-14	2.98	2.45	1.26	1.19	0.41	1.06
		Cky1	14-58	4.38	3.85	1.69	2.16	0.49	0.78
		Cky2	58-73	4.22	3.69	2.00	1.69	0.40	1.18
		Cky3	73-110	4.51	3.98	2.09	1.89	0.42	1.11
P2	cultivated	Ap	0-18	4.61	4.08	2.19	1.89	0.41	1.16
		Cy1	18-33	5.39	4.86	2.19	2.67	o.50	0.82
		Cky2	33-46	5.16	4.63	2.03	2.60	0.50	0.78
		Cky3	46-110	4.89	4.36	2.30	2.06	0.42	1.12
Erbil pedons									
P3	rainfed	Ap	0-20	9.33	8.17	1.35	6.82	0.73	0.20
		Ck1	20-53	10.26	8.95	1.02	7.93	0.64	0.13
		Ck2	53-80	8.77	8.24	1.13	7.11	0.81	0.16
		Ck3	80-110	9.06	8.82	1.01	7.81	0.86	0.34
P4	cultivated	Ap	0-24	10.26	8.73	1.81	6.92	0.67	0.13
		Btk	24-44	12.81	10.30	1.11	9.19	0.72	0.12
		Ck1	44-77	11.80	9.27	1.08	8.19	0.69	0.25
		Ck2	77-110	11.91	9.38	1.57	7.81	0.66	0.33

The values of (FeT) for Erbil pedons increased as it ranged between 8.77 - 12.81 g.kg^{-1} the lowest value of iron oxides was on the horizon Ck2(P3) and the highest value was on the horizon Btk (P4) The high total iron oxides in Erbil may be related to the parent material and the high weathering conditions compared with Tikrit pedons .

Free iron oxides (Fet)

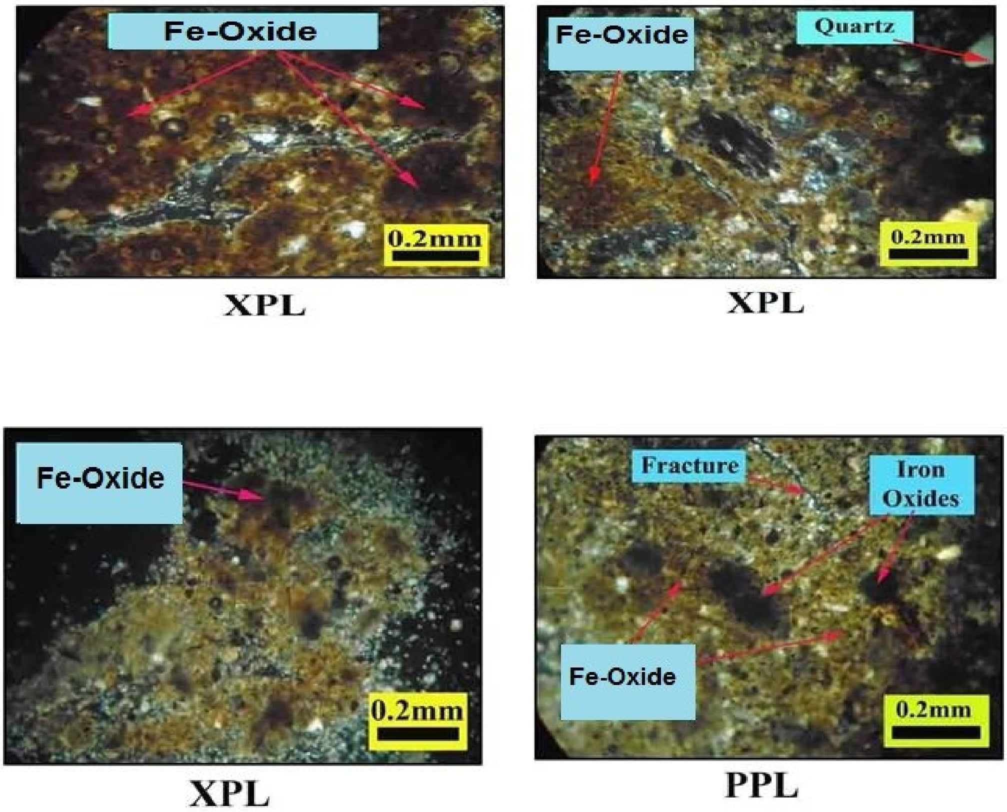
The values of free iron oxides (Fet) in Tikrit ranged between (2.45-4.86) g. kg $^{-1}$, the lowest value in the rainfed Ap horizon and the highest value in the cultivated Cy1 horizon, whereas the Erbil pedons also showed an increase in the values of free iron oxides compared to the Tikrit pedons, as the value ranged between (8.17 - 10.30) g. kg $^{-1}$ the lowest value on the rainfed Ap horizon and the highest value on the cultivated horizon Btk. The values of the free iron oxides in both two pedons of Erbil are greater compared to Tikrit pedons due to the variation in the effect of soil formation factors and processes, especially the effect of the variability of the climate factor and the parent material ,it is also noticed that the values of the total iron oxides are closely related to the values of the crystallized iron oxides and that the vertical distribution of oxides was compatible with the distribution of clay, especially in Erbil pedons. Picture (4) showed iron oxides, which were in different forms as they were in the form of ferriargillans clay coating on the surfaces of soil aggregates, or within the soil pores or voids in Erbil pedons.

Amorphous iron oxides (Feo)

Table (4) shows the amorphous iron oxides (Feo) in Tikrit pedons from (1.26 - 2.30) g.kg^{-1} the lowest value was in the horizon Ap (P1) while the highest value in the horizon Cky3 (P2) , while the values of (Feo) in Erbil ranged between (1.01 - 1.81) g.kg $^{-1}$ the lowest value was on the rainfed horizon Ck3 while the highest value was in the cultivated horizon Ap (P4) .It notes a relatively high amount of iron oxides in Tikrit pedons, compared to Erbil pedons due to the variation in the factors of soil formation and drought conditions. The results showed that the amount of amorphous iron oxides (Feo) was somewhat high within the surface horizons in Tikrit pedons compared to Erbil pedons .The high content of organic matter in the surface horizons especially in Erbil that works to inhibit the crystallization process (inhibits crystallization) Through its reduction of iron, as Comell and Schwertmann (1979) showed that the organic acids adsorbed on the surfaces of iron oxides form a complex bond with iron, which leads to an increase the amount of amorphous oxides in surface horizons.

Crystalline iron oxide (Fed)

The results of Table (4) showed the amount of crystalline oxides (Fed) of the study pedons, which showed a marked superiority of their values in Erbil pedons compared to the Tikrit pedons, as their values in Tikrit ranged from 1.19 g. kg to 2.67 g. kg^{-1} the lowest value was on the horizon Ap(P1) the highest value was on the Cy1 horizon (P2) , and the crystallized iron oxides values in Erbil ranged between 6.82 g . kg^{-1} in the rainfed horizon (P3) to 9.19 g .kg -1 in the Btk cultivated horizon. The results showed that there is an increase in the content of crystalline iron oxides (Fed) in the soil of Erbil, which closely approximates the total level of free iron (Fet) compared to amorphous iron oxides (Feo), which confirms the activity of the process of converting iron from the amorphous formula to the most crystallized formula Stability in the soil due to the increase in rainfall rates, the type of vegetation, the nature of the parent material that helped in the activity of some pedogenic processes in these soils .The presence of crystallized iron oxides with a high content in the soil compared to amorphous iron oxides is caused by the transformation of amorphous iron oxides into crystallized iron oxides, and that the amount of precipitation is one of the important factors that affected the weathering of minerals iron-bearing. The results showed that the vertical distribution of crystalline iron oxides was consistent with the vertical distribution of the clay particles due to the bond between crystalline iron oxides (Fed) represented by oxide minerals and clay minerals. Also, the vertical distribution of amorphous iron oxides (Fed), and for all study soils, was consistent with the vertical distribution of total iron oxides (Fet), with their overall proportions approximating, while the vertical distribution of amorphous iron oxides differed from them, with the high decrease in their values..



Picture (4) forms of iron oxide distribution in Erbil pedons.

These results confirm that most of the iron oxides in these soils are in an amorphous state, the reason is due to the soil development that led to the transition of most of the iron oxides into the crystallized state, since Bzeni, 1991, showed that the degree of soil development had an effect in the case of iron oxide crystallization, and that the developed Iraqi soil in the northern regions contained high levels of crystallized oxides compared to with amorphous oxides, and this was attributed to the state of evolution and the time factor that caused these oxides to shift towards crystallization.

To confirm the state of influence of soil formation factors and processes on the development and formation of soils for study pedons, then calculating a ratio (Fed / FeT) ratio of the crystallized iron Fed to the value of the total iron FeT, as it is noticed, as in Table (4), the percentages in the poorly developed Tikrit pedons compared to the more developed Erbil pedons, where the Fed / FeT ratio of the Tikrit pedons ranged between 0.41 g. kg^{-1} on Ap horizon (P1) to 0.50 g. Kg^{-1} on Cy1 and Cky2 horizons (P2) horizons whereas the values of (Fed / FeT) for Erbil's pedons ranged between 0.64 g kg^{-1} to 0.86 g. kg^{-1} on Ck1 and Ck3 (P3) . The active ratio between the amorphous iron oxides to the crystallized iron oxides (Feo / Fed) showed a decrease in the ratio values in Erbil pedons compared to the Tikrit pedons due to The amorphous iron oxides were converted to the crystallized oxides, and they considered this ratio to be a function of soil development, as the ratio for Tikrit pedons ranged between 0.78 g. kg^{-1} in the Cky1(P1) and Cky2 horizon (P2) to 1.18 g. kg^{-1} on the horizon Cky2 (P1), Whereas in Erbil pedons, it ranged between 0.12 g. kg^{-1} at Btk horizon (P4) to 0.34 g. kg^{-1} at Ck3 horizon (P3) .

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طبيعة توزيع اكاسيد الحديد في بعض الترب الكلسية والجبسية

ابها منذر كمال وعبدالله عزاوي رشيد

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المستخلص

تقع منطقة الدراسة ضمن موقعين الموقع في مدينة تكريت (جامعة تكريت) تمثل الترب الجبسية والموقع الثاني يمثل الترب الكلسية في محافظة اربيل .تم اختيار بيدونين في محافظة تكريت هما البيدون P1 يزرع ديما وبيدون P2 ري سيحي ,وبيدونين في محافظة اربيل P3 يزرع ديما و (P4) يروى سيحا .اظهرت البيدونات الممثلة للترب الجبسية في جامعة تكريت تواجد بلورات جبسية من نوع مغزلية spindle وعدسية Lenticular بطول تراوح بين (0.2 –0.5) ملم والمسام من نوع vughs و chamber بيما في اربيل كانت السيادة للمسام من نوع planer و Interconnected chamber.تواجد عمليتا الفقد والكسب والتي أدت الى تواجد الأفق الارجلي الطيني والافق كالسك .ظهرت اكاسيد الحديد بهيئات مختلفه على شكل حبيبات منفرده discrete particles اوبهيئة اغلفة coatingsعلى شكل ferriargillans خاصة في بيدونات اربيل و تباينت قيمها اذ كانت السيادة لاكاسيد الحديد الكلية والحرة والمتبلوره في بيدونات اربيل تراوحت بين (8.77 –12.81) ,(8.17 – 10.38),(6.82– 9.19) غم كغم$^{-1}$على التوالي مقارنة مع الاكاسيد نفسها لبيدونات تكريت والتي تتراوح بين (2.98 – 5.39) , (2.45 – 4.86) ,(1.19 – 2.67) غم كغم$^{-1}$ على التوالي .فيما ابدت قيم اكاسيد الحديد غير المتبلورة تفوقا في بيدونات تكريت عن بيدونات اربيل اذ تراوحت قيمها في تكريت بين (1.26 – 2.19) غم كغم$^{-1}$ بينما في بيدونات اربيل تراوحت بين (1.01 – 1.81) غم كغم$^{-1}$

الكلمات المفتاحية : مايكرومورفولوجية اكاسيد الحديد في التربة, الترب الجبسية , الترب الكلسية.