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EFFECTS OF DIFFERENT PARENT MATERIALS AND TOPOSEQUENCE ON STATUS AND DISTRIBUTION OF IRON OXIDES IN SOME SOILS OF SULAYMANIYAH GOVERNORATE / IRAQ

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ABSTRACT

Three transects were chosen in Sulaymaniyah governorate / Iraq. The first was located within the Bazian Plain, while the second was in Sulaymaniyah plain, and the third was located within the plain of Shahrazur, in order to study the effect of parent material and toposequence on the status and distribution of Iron oxides in these soils. Results Shows that there is a differences in the amount and distribution of free iron oxides between the studied pedons, and even within one Pedon. These differences can be attributed to the effect of the difference in the parent materials and topography. Also, the soils developed on Basalt rocks and Red Mudstone were characterized by their high iron oxides and dark brown color, while those developed on Limestone rocks were characterized by their low iron oxides and yellowish brown color. The topographic location also, affected the transport of weathering products of parent rocks from elevated areas and deposed in the plain areas.

Key words: amorphous, crystallization, deposition,transportation,

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INTRODUCTION

Parent material has a major influence on physical and chemical properties of soils, being one of the five traditionally recognised factors of soil formation (Yizhou and Grigorieva, 2023), along with climate, topography, organic matter and time. Parent material is one of the crucial pedogenetic factors governing soil genesis (Badía *et al*.,2013) and affecting soil properties (Burke, 2002; Kooijman *et al*., 2005; Rodrigo *et al*.,2018). Iron oxides, including oxyhydroxides, dominate many highly weathered tropical soils and may strongly influence their development, behaviour and management. Iron oxides are often dispersed throughout the soil matrix as finely divided microcrystalline particles and may occur as coatings on the surfaces of alumino-silicate or phyllosilicate crystals (AL-Shammare and Essa, 2020). Iron oxides are also major constituents of mottles, concretions and other segregations in soils. Goethite occurs in almost every soil type and climate, whereas hematite appears to be widespread only in soils under warmer climates (Zhang *et al*., 2007.). Iron oxides in soils vary by such parameters as mineral species, crystal size, structural order and isomorphous substitution. Differences in these properties may reflect differences in the environmental conditions of soils (Wiriyakitnateekul *et al*.,2007). Variations in properties of Fe oxides in soils may be affected by the nature of parent materials and climate (Zhang *et al*., 2012), but the mechanisms responsible for this effect are poorly understood. The nature of the parent materials affects soil texture and drainage, the composition of soil solution and soil pH, all of which could potentially affect the properties of pedogenic Fe oxides. The objective of this study was to know the effects of parent material on the status and distribution of Iron

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oxides in some soils of sulaymaniyah governorate / Iraq.

MATERIALS AND METHODS

Description of the studied area: The study area is located in northeastern of Iraq within Sulaymaniyah Governorate, which is about 330 km from the capital Baghdad, and is locate between longitudes (45°26'. 02) and (45°34'38) east and latitudes (35°33'07) and (35°55'19) north. In this location, it is close to the edge of the high folded zone in an unstable pavement. Three transects were chosen in the study area, the first one was located within the Bazian Plain and extends from Bazian Heights in the west to the Taslujah Heights in the east, includes three soil sites (Bazian, Tinal, and Taslujah), while the second transect was located within the Sulaymaniyah Plain, and extends from the north at the Haibat Sultan Heights to the Qara Dagh Heights in the south, and includes four soil sites (Haibat Sultan, Khalikan, Bakrih Joe, and Qara Dagh). The third transect was located within the plain of Shahrzour and extends from the Hormann Heights in the east and ends at the Sayed Sadiq plain in the west, which includes four soil sites (Hormann, Khurmal, Sirwan, and Syed Sadiq), (Fig. 1). The mean annual air temperature was 23°C. The mean annual rainfall was 392.2 ml, while the vegetations of study area were grasses, cereal, forests, and leguminous crops (Aziz,2006). The soil pedons were described in the field according to (Soil Survey Division Staff,1993). Disturbed soil samples for laboratory analysis were collected from each horizon and air dried, crashed, and passed through the sieve of 2 mm openings, then Various analytical procedures have been used to analyze soil components (Schwertmann, 1992.), including selective chemical dissolution analysis, such as dithionite-citrate used to determined crystalline form of Fe (Fe_d) (Schwertmann, 1992.), and using ammonium oxalate extraction to determined the amourphas form of Fe (Fe_o) (McKeague and Day 1966.).

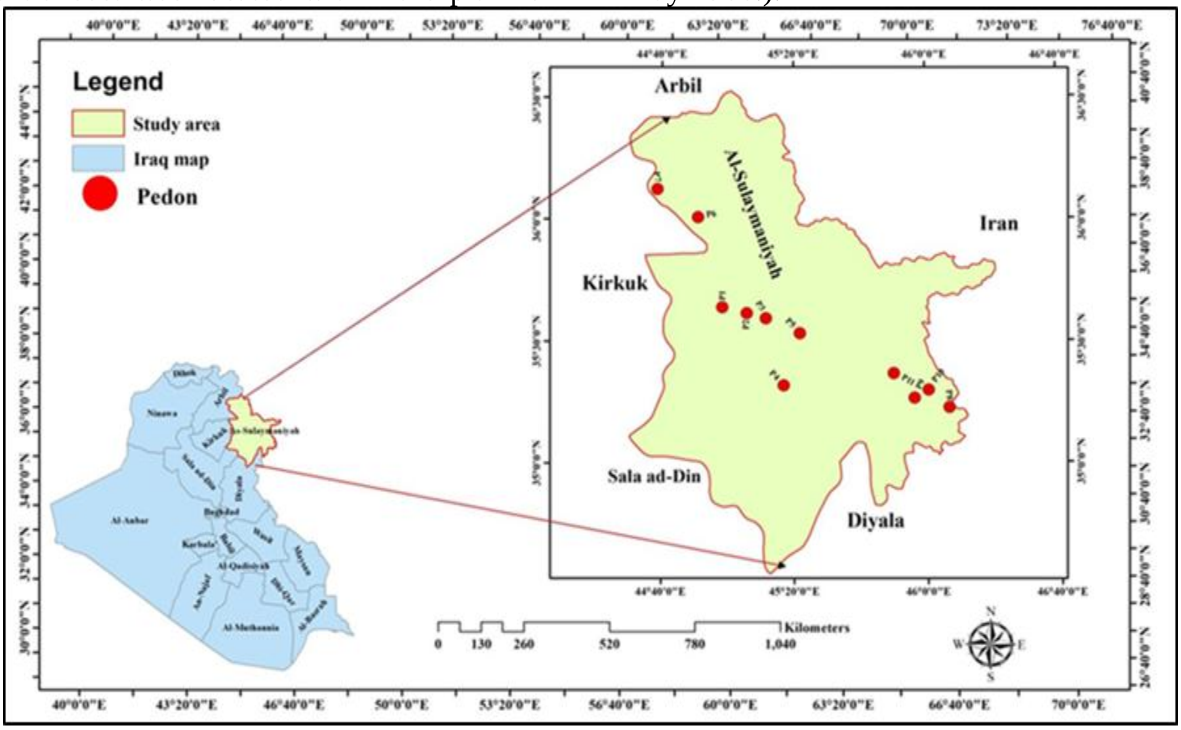

Fig. 1. Map of the study soil site locations

RESULTS AND DISCUSSION

Soil formation and morphological properties: Soils in the studied area exhibit variations with respect to particle size distribution, colour, top soil thickness, and transformation of soil components (Table 1). In the first transect (Bazian, Tinal, and Taslujah) which developed on the Marl and Limestone, results showed that there is a clear changes in particle size distribution, colour, and top soil thickness of two pedons (Bazian and Taslujah) which located on either side and high elevations of the transect, with elevation (988 and 1020 m above the sea level)

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respectively, comparing with the same characteristics of (Tinal) pedon, which located in the plain area (823 m above the sea level) at the middle of the distance between them. These changing reflects the obvious effect of soil erosion, through top soils have been transported from the high slope elevations (Bazian and Taslugah) sites to the low slope plain (Tinal) site, their accumulation leading to progressively darker, deeper and finer-textured soils with decrease in elevation (Tinal) pedon. Colour of soil in (Bazian and Taslugah) pedons is closely reflective of their parent materials (Marl and Limestone) with a colour of 7.5YR 5/4 Yellowish brown and 2.5 Y 4/4 Olive brown respectively, while the blackening progressively to make a maximum hue value of 7.5 YR 3/4 Dark brown on the lower elevation at plain area (Tinal) pedon. The clay content was increasing with translocation from high elevation sites (Bazian and Taslugah), to the plain area (Tinal) pedon. While the clay content of (Bazian) pedon, developed on the (Marl) parent material was considerably higher than that of (Taslugah) pedon, which has developed on (Limestone) parent material. In the second transect (Haibat sultan, Khalikan, Bakrih Joe, and Qara Dagh), which is considered the longest of the transects, and pedons of (Haibat sultan and Qara Dagh), are forms the highest ends at both sides of it. Whereas, the pedons of (Khalikan and Bakrih joe) are represent the plain area of this transect. As it seems that there is an effect from both sides of this transect on properties of the soils in the plain area, and this depending on the elevation, slope, and distance from the high end. Accordingly, we expected that the soil of (Bakrih joe) pedon (711 m above the sea level) is more affected by the characteristics of (Qara Dagh) site (1282 m above the sea level) due to the close distance between them, while the soil properties of (Khalikan pedon) (764 m above the sea level) are effected by characteristics of elevated site at (Haibat sultan) (820 m above the sea level) for the same reason above. It appears from the results of Tables 1. That the progressively darker, deeper and finer-textured soils with decrease in elevation (Bakrih joe) pedon, as it was noted that the dominant soil colour of (Qara Dagh) pedon, was ranged between 5Y 3/4 Dark radish brown to 10YR 2/2 very Dark brown, and the dominance of Brown colour in soil of this pedon may be associated with the high Fe oxide content, and closely reflective of its parent material (Red mudstone and Shale rocks). While the soil colour of (Bakrih joe) pedon looks darker and ranged between 7.5 YR 4/4 Dark brown to 10 YR 3/3 Dark brown. Also, results in Table 1 . showed that the amount of clay fraction was increased with decreasing in elevation, where the clay content within (Qara Dagh) pedon was ranging between (458.0 – 598.0 g kg^{-1}), while the clay content within (Bakrih joe) pedon was ranged between (615.0 – 688.0 g kg^{-1}). Through the results of Table 1 . It was noted that there is a similarity in soil colours of Haibat sultan and Khalikan pedons, which was ranged between 5YR 5/6 Yellowish red to 10 YR 3/4 Dark yellowish brown, which is a reflection of their parent material (Chart rocks) and also, confirms that they were formed from the same parent material (Yizhou and Grigorieva, 2023.).

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Table 1. The Color type and Particle Size distribution in studied soils

location	Horizon	Depth(cm)	Color (Moist)	Sand	Silt	Clay	Tex
					gm kg^{-1}		
Bazian	A_1	0-20	Dark brown 7.5 YR 3/2	63.0	216.0	721.0	C
	B_t	20-40	yellowish brown 7.5 YR 5/4	59.0	251.0	690.0	C
	C_k	40-60	Brownish yellow 7.5 YR 6/6	64.0	248.0	688.0	C
Tinal	Ap	0-25	Dark brown 7.5 YR 3/4	69.0	272.0	654.0	C
	C_{k1}	25-50	Dark brown 7.5 YR 3/4	60.0	339.0	601.0	C
	C_{k2}	50-75	Dark brown 7.5 YR 3/4	78.0	247.0	675.0	C
	C_{k3}	75-100	Dark brown 7.5 YR 4/4	83.0	362.0	555.0	C
Taslujah	A_1	0-40	Olive brown 2.5 Y 4/4	550.0	246.0	204.0	SCL
	C_{k1}	40-75	Olive brown 2.5 Y 4/4	515.0	242.0	243.0	SCL
	C_{k2}	75-110	Very Dark garish brown 2.5 Y 4/2	467.0	151.0	382.0	SC
	C_{k3}	110-140	Olive 5 Y 5/4	591.0	225.0	184.0	SL
	C_{k4}	140-155	Dark brown 7.5 YR 4/3	574.0	258.0	168.0	SL
Qara Dagh	A_1	0-20	Dark radish brown 5 Y 3/4	175.0	346.0	479.0	C
	B_{t1}	20-45	Dark brown 7.5 YR 4/4	184.0	358.0	458.0	C
	B_{t2}	45-70	Yellowish red 5 YR 5/6	168.0	327.0	505.0	C
	C_k	70-100	Very Dark brown 10 YR 2/2	150.0	252.0	598.0	C
Bakrah Joe	Ap	0-20	Dark brown10YR 3/3	45.0	336.0	619.0	C
	C_{k1}	20-45	Yellowish brown 10 YR 3/4	37.0	294.0	633.0	C
	C_{k2}	45-75	Dark brown 7.5 YR 4/4	75.0	237.0	688.0	C
	C_{k3}	75-95	Dark brown 7.5 YR 4/4	62.0	305.0	633.0	C
	C_{k4}	95-120	Dark Yellowish brown 10 YR 4/4	61.8	217.0	615.0	C
Khalikan	A_1	0-25	Light red 5 YR 5/6	195.0	367.0	438.0	C
	A_2	25-60	Yellowish red 5 YR 5/6	209.0	309.0	482.0	C
	B_t	60-95	Dark Yellowish brown 10 YR 4/6	226.0	300.0	474.0	C
	C	95-145	Dark Yellowish brown 10 YR 4/6	215.0	369.0	416.0	C
Haibat Sultan	A_1	0-20	Yellowish brown 10 YR 5/8	140.0	291.0	569.0	C
	A_2	20-40	Dark Yellowish brown 10 YR 3/6	120.0	359.0	516.0	C
	B_{t1}	40-80	Dark Yellowish brown 10 YR 3/6	134.5	304.5	561.0	C
	B_{t2}	80-120	Dark Yellowish brown 10 YR 4/4	119.0	240.0	641.0	C
	C_k	120-140	Dark Yellowish brown 10 YR 3/4	134.0	262.0	604.0	C
Horamann	A_1	0-25	Dark brown 7.5 YR 4/4	220.0	298.0	482.0	C
	A_2	25-45	Strone brown 7.5 YR 5/6	215.0	332.0	453.0	C
	B_t	45-95	Brownish Yellow 10 YR 6/6	275.0	316.0	409.0	C
	C_k	95-120	Brownish Yellow 7.5 YR 7/8	249.0	289.5	461.5	C
Khurmal	Ap	0-20	Dark reddish brown 5 YR 2.5/2	58.0	363.0	579.0	C
	B_{t1}	20-40	Dark reddish brown 5 YR 3/2	67.0	231.0	702.0	C
	B_{t2}	40-70	Reddish Yellow 7.5 YR 6/6	77.0	289.0	633.0	C
	C_{k1}	70-95	Reddish Yellow 7.5 YR 6/6	68.0	275.0	657.0	C
	C_{k2}	95-120	Light yellowish brown 2.5 Y 6/4	62.0	242.0	696.0	C
Sirwan	Ap	0-20	Very dark garish brown 2.5YR 3/2	54.0	398.0	548.0	C
	B_{t1}	20-65	Dark yellowish brown 10 YR 4/6	50.0	387.5	562.5	C
	B_{t2}	65-85	Brown 7.5 YR 5/4	47.0	314.0	639.0	C
	C_k	85-110	Yellowish brown 10 YR 5/4	41.0	364.0	595.0	C
Syed Sadiq	Ap	0-25	Reddish Yellow 7.5 YR 6/6	46.0	381.0	573.0	C
	B_{t1}	25-50	Reddish Yellow 7.5 YR 6/6	59.0	333.0	608.0	C
	B_{t2}	50-75	Brown Yellow 10 YR 6/6	41.0	397.0	562.0	C
	C_{k1}	75-95	Yellowish brown 10 YR 6/6	45.0	328.0	627.0	C
	C_{k1}	95-120	Yellow brown 10 YR 5/8	58.0	357.0	585.0	C

In the third transect (Hormann, Khurmal, Sirwan, and Syed Sadiq), The results of Table 1 show that brown color prevails in all soil pedons of this transect, which ranged between 2.5 YR 3/2 – 10 YR 5/8 (very dark garish brown – yellow brown). The predominance of brown color of these soils is due to the influence of parent materials (Red Mudstone and Basalt-Olivine) of high elevated sites (Qara Dagh and Hormann) located on both sides of this transect, which characterized by their high iron content. Brihanta et al., 2024 pointed out that one of the reasons for the appearance of the brown color of soil is due to parent rocks, which most of it are Basalt rocks with a high content of Fe-oxides. While (Eren *et al.*, 2014), found that Red Mudstone contributes greatly to the development of brown color of soil.

Iron oxides distribution In Studied Soil

Results of Table 2. Showed that there is a difference in the amount and distribution of free iron oxides between the studied pedons, and even within one pedon. These differences can be attributed to the effect of the difference in the parent materials, topography, and the intensity of weathering. The index values of free iron oxides obtained from selective dissolution analysis confirmed these differences clearly. The range values of (Fe_o) were between (0.37-1.98 g kg^{-1}) and it seems that these values were rather low and constitute low percentages of the total content values (Fe_T) of free iron oxides in these soils, and indicate that

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iron oxides appears mainly in crystalline form. It was noted from the results of Table 2. that the distribution of (Fe_o), which represents the most exposed form of free iron oxides to the leaching process and moving with other soil components, such as clay particles and organic matter and Carbonate Mineral . In the first transect (Bazian, Tinal, and Taslujah), results in Table 2. Showed that in (Bazian and Taslujah) pedons, which located on the two elevated ends of this transect, were recorded a low values of Fe_o, while the soil pedon of plain area (Tinal) was recorded a high values of Fe_o , and exceeded the recorded values in elevated sites (Bazian and Taslujah).

Table 2. The amount and distribution of Iron Oxides in Studied Soil

Horizon	Depth (cm)	Fe_T g.kg^{-1}	Fe_O	Fe_d	Fe_O/Fe_d	Fe_d/Fe_T	(Fed-FeO)*100/Fed
				Bazian Pedon			
A_1	0-20	5.32	0.40	4.92	0.08	0.92	91.87
B_t	20-40	5.02	0.88	4.14	0.21	0.81	78.74
C_k	40-60	5.21	0.45	4.76	0.09	0.91	90.55
				Tinal Pedon			
Ap	0-25	4.60	1.51	3.09	0.49	0.67	51.13
C_{k1}	25-50	4.41	1.73	2.68	0.65	0.60	35.45
C_{k2}	50-75	4.42	1.89	2.53	0.75	0.57	25.30
C_{k3}	75-100	4.48	1.98	2.50	0.79	0.55	20.80
				Taslujah Pedon			
A_1	0-40	1.54	0.69	0.85	0.81	0.55	18.82
C_{k1}	40-75	1.83	0.75	1.08	0.69	0.59	30.56
C_{k2}	75-110	1.84	0.50	.341	0.37	0.72	62.69
C_{k3}	110-140	1.50	0.37	1.13	0.33	0.75	67.26
C_{k4}	140-155	2.53	0.59	1.94	0.30	0.76	69.59
				Qara Dagh Pedon			
A_1	0-20	5.62	1.72	3.90	0.44	0.69	55.90
B_{t1}	20-45	5.68	1.62	4.06	0.40	0.71	60.10
B_{t2}	45-70	5.64	1.82	3.82	0.48	0.67	52.36
C_k	70-100	5.74	1.57	4.17	0.38	0.72	62.35
				Bakrih Joe Pedon			
Ap	0-20	4.80	0.95	3.85	0.25	0.80	75.32
C_{k1}	20-45	4.94	0.73	4.21	0.17	0.85	82.66
C_{k2}	45-75	4.62	0.57	4.05	0.14	0.87	85.93
C_{k3}	75-95	5.02	0.65	4.37	0.15	0.87	85.13
C_{k4}	95-120	5.16	0.64	4.52	0.14	0.88	85.84
				Khalikan Pedon			
A_1	0-25	3.40	0.57	2.83	0.20	0.83	79.86
A_2	25-60	4.75	0.40	4.35	0.09	0.91	90.80
Bt	60-95	4.92	0.71	4.21	0.17	0.85	83.14
C	95-145	3.10	0.56	2.54	0.22	0.81	77.95
				Haibat Sultan Pedon			
A_1	0-20	6.01	1.03	4.98	0.21	0.82	79.32
A_2	20-40	4.60	1.06	3.54	0.30	0.76	70.06
B_{t1}	40-80	5.34	1.59	3.75	0.42	0.70	57.60
B_{t2}	80-120	5.44	1.62	3.82	0.43	0.67	57.59
C_k	120-140	5.00	1.31	3.69	0.36	0.73	64.50
				Horamann Pedon			
A_1	0-25	5.04	0.95	4.09	0.23	0.81	76.77
A_2	25-45	3.70	0.65	3.05	0.21	0.82	78.69
B_t	45-95	4.33	0.86	3.47	0.25	0.80	75.22
C_k	95-120	5.13	0.41	4.72	0.08	0.92	91.31
				Khurmal Pedon			
Ap	0-20	5.00	0.95	4.05	0.23	0.81	76.54
B_{t1}	20-40	4.33	0.85	3.48	0.24	0.80	75.57
B_{t2}	40-70	4.34	0.85	3.49	0.24	0.80	75.64
C_{k1}	70-95	4.58	0.53	4.05	0.13	0.88	86.91
C_{k2}	95-120	5.25	0.63	4.62	0.14	0.88	86.36
				Sirwan Pedon			
Ap	0-20	2.95	0.89	2.06	0.43	0.69	56.80
B_{t1}	20-65	3.20	0.77	2.43	0.32	0.75	68.31
B_{t2}	65-85	3.50	0.75	2.75	0.27	0.78	72.73
C_k	85-110	3.34	0.82	2.52	0.33	0.75	67.46
				Syed Sadiq Pedon			
Ap	0-25	5.09	0.88	4.21	0.21	0.82	79.10
B_{t1}	25-50	4.30	0.74	3.56	0.21	0.80	79.21
B_{t2}	50-75	3.90	0.60	3.3	0.18	0.84	81.82
C_{k1}	75-95	4.25	0.80	3.45	0.23	0.81	76.81
C_{k1}	95-120	2.53	1.01	1.52	0.66	0.60	33.55

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This trend of Fe_o distribution in soil pedons of this transect can be attributed to the effect of weathering process on the parent materials of elevated sites at the ends of this transect (Bazian and Taslujah), which causes to liberated Fe from iron-bearing minerals, despite the low content of those minerals in parent materials (Marl and Limestone) of those sites, which led to moving of Fe by leaching process and then accumulated it in plain area (Tinal) pedon. In the second transect (Haibat sultan, Khalikan, Bakrih joe, and Qara Dagh), the distribution of Fe_o within the soil pedons of this transect was quite different from its distribution in soil pedons of the first transect, where the results of Table 2. Showed that the values of Fe_o were increased in the soil pedons at elevated sites (Haibat sultan and Qara Dagh), and decreased in soil pedons of plain area (Khalikan and Bakrih joe), which reflected that the distribution of Fe_o values in this transect was opposite to their distribution in the first transect, despite the similarity in ambient conditions of the two transects, such as amounts of rain, weathering, and leaching processes. This distribution of Fe_o can be attributed to the effect of parent materials of elevated sites in the second transect (Haibat sultan and Qara Dagh), which are rich by Fe (Chart and Shale–Red mudstone), respectively while, the effect of weathering processes on these parent materials and accompanied by the leaching process can led to moving of Fe from elevated sites towards the plain area, with keeping the values of Fe_o high in elevated sites. In the third transect (Hormann, Khurmal, Sirwan, and Syed Sadiq), the distribution of Fe_o within the soil pedons of this transect was irregularly distributed and fluctuated between increasing and decreasing in all soil pedons of this transect. This fluctuation in Fe_o values in the soil pedons of this transect can attributed to the fact that the pedon sites of this transect are under the effect of weathering of two types of parent materials. The first effect is from the east, resulting from the weathering of the parent material of Qara Dagh heights (Shale – Red mudstone), while the second effect is from the north results from weathering of parent material of Hormann heights (Basalt - Olivine). This mixing in the diversity of the parent materials led to variation in the distribution of forms of Iron oxides in the soil pedons of this transect (McKeague and Day, 1966). In general results in Table 2 showed that the lowest values of Fe_o (0.41-0.95 g kg^{-1}) was in Horman Pedon which developed on (Basalt – Olivine), indicating that the Fe oxides in this soil have the highest degree of crystallinity (McKeague and Day,1966). Results of Table 2. Showed that the range values of (Fe_d) were between (0.85-4.98 g kg^{-1}) in all studied pedons. Also, results show that the Fe_d values were higher than Fe_o and were lower than Fe_T values. Moreover, results showed there are differences in values of Fe_d between the pedons, this may be due to many causes, such as location, topography, weathering intensity in each transect, and type of parent material. In the first transect, it was observed that the Fe_d values were higher in (Bazian pedon) compared to the other pedons (Taslujah and Tinal) (Fig. 2), this is attributed to the parent material (Marl) of that Pedon, which contains high percentage of iron oxides (Awadh and Al-Owaidi, 2021). Also, values of Fe_d were decreased as the topography decreased. This is due to the difference in the type of parent materials in the elevated sites at both ends of this transect (Bazian and Taslujah), which particulary affects the content of iron oxides in the plain area (Tinal pedon), especially the (Taslujah heights) which have higher elevation than (Bazian highlands), and his parent material (Limestone) contains a low percentage of iron oxides. In the second transect (Haibat sultan, Khalikan, Bakrih joe, and Qara Dagh), It was noted from the results of Table 2. And Fig 2. That the soil of (Qara Dagh) pedon contained the highest values of Fe_o (1.57-1.82 g kg^{-1}), accompanied by highest values of Fe_T (5.62-5.74 g kg^{-1}) and Feo/Fe_d ratio (0.38-0.48), compared to the soils of this transect. These results can be interpreted in two ways. The first is that Fe oxides in this soil have the lowest degree of crystallinity, and the second is its high Fe content, because it developed on (Shale – Red mudstone), which contains high percentage of iron oxides In the third transect (Hormann, Khurmal, Sirwan, and Syed Sadiq), it appears from the results of

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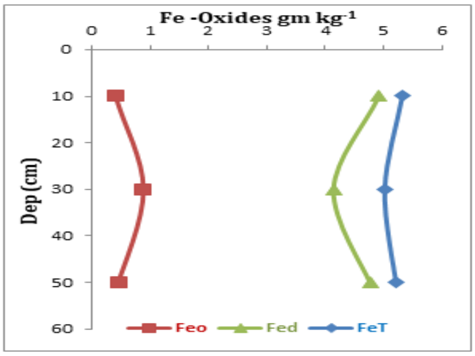
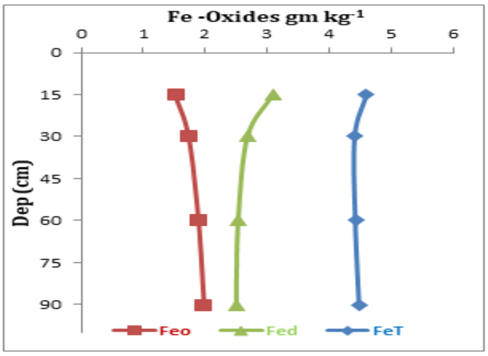
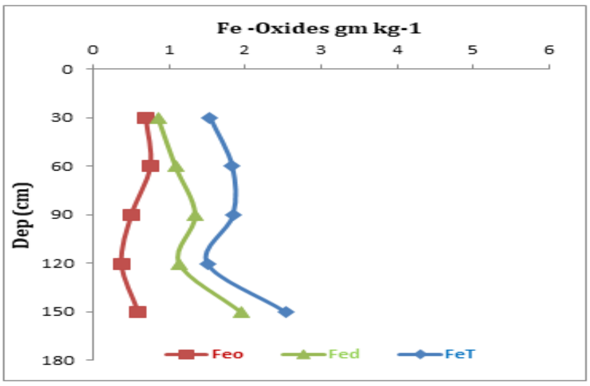
Table 2 and Fig. 2 that the pedon sites of this transect are subjected under two different effects of parent materials, the first is come from the north, represented by the parent material (Basalt - Olivine) of (Hormann heights), which affects the overall mineralogical and chemical properties of the soils of this transect. While the second effect comes from the parent materials (Shale – Red mudstone) of (Qara Dagh heights), which affects the soil properties of (Sirwan, and Syed Sadiq) pedons. In general, the variation in weathering products of parent materials for those heights and transported by leaching processes then distributed within horizons of these soils, will led to variation in the properties and distribution of Iron oxides in these soils. The Fe_o/Fe_d ratio has been calculated (Table 2), in order to find out the degree of crystallization and weathering in studied soil pedons. (Tunçay and Dengizb,2020.) considered that the Fe_o/Fe_d ratio is provide an approach of relative proportion of ferrihydrite, or degree of crystallization and weathering in soil. In the present study, The Fe_o/Fe_d ratio range between 0.08 - 0.81 g Kg^{-1} but was more than 0.10 g Kg^{-1} which suggested by Tuncay and Dengiz (2022) in most cases, and suggesting a prevalence of amorphous forms of iron in these soils. Fe_d/Fe_T is another important indicator of the degree of weathering in soils. Fe_T or total iron, refers to the percentage of Fe_2O_3 and is given in Table 2. It was observed that the Fe_T values for all pedons varied between (1.50 - 6.01 g Kg^{-1}). While the Fe_d/Fe_T ratio was ranged between (0.55 – 0.92), and the highest Fe_d/Fe_T ratios were increased in the soil pedons at elevated sites located at the ends of the three transect, indicating the greater amount of weathering. On the other hand, the highest weathering ratios were found in Hormann pedon formed on (Basaltic) parent material. The proportion $(Fe_d\text{-}Fe_o) \times 100/Fe_d$ shows the degree of crystallization of iron oxides in soil. It was ranged between 18.82-91.87. This ratio was found to be high in soil pedons at plain areas of each transect, indicating that the majority of Fe was in an amorphous or poorly crystalline form.



Bazin Pedon



Tinal Pedon



Taslujah Pedon

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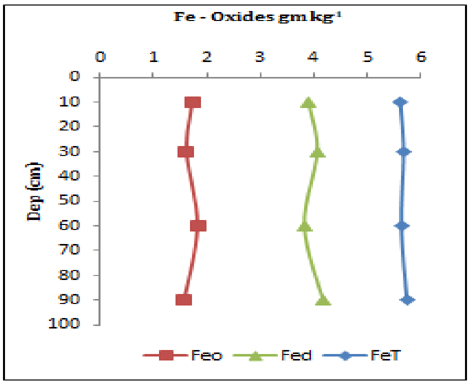
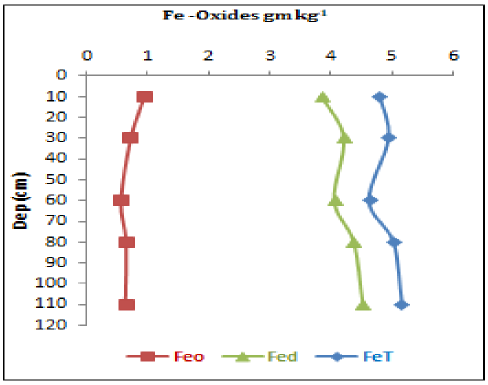
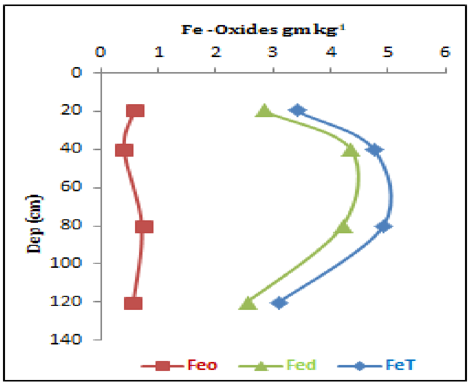


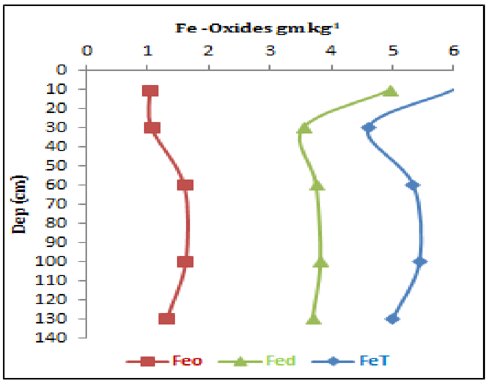
Qara Dagh pedon



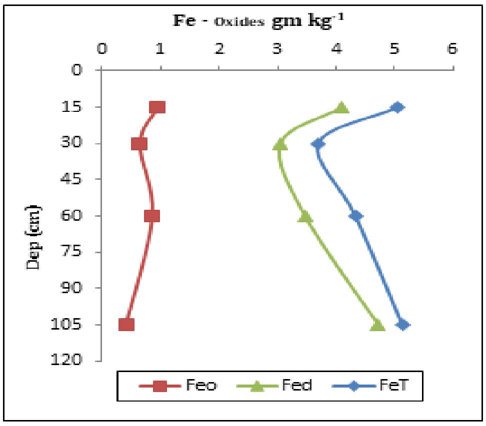
Bakrih Joe pedon



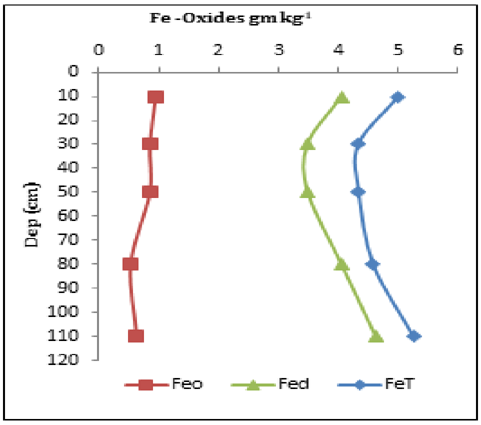
Khalikan pedon



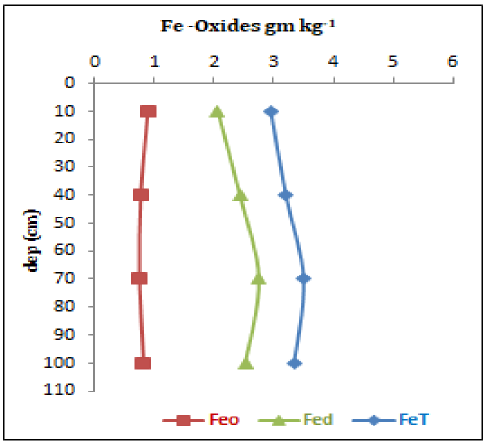
Haibat Sultan pedon



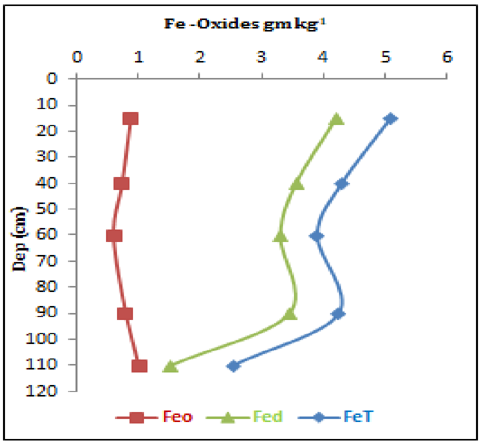
Hormann pedon



Khurmal pedon



Sirwan pedon



Syed Sadiq pedon

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CONCLUSIONS

The study in Sulaymaniyah governorate examined soils across three plains to assess the influence of parent material and topography on iron oxide distribution. Results indicated that both parent rock type and landscape position affect the amount and distribution of free iron oxides, with basalt and red mudstone soils showing higher content and darker color, while limestone soils had lower content and lighter color. Additionally, topography influenced the movement and deposition of weathering products from elevated areas to plains.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

DECLARATION OF FUND

The authors declare that they have not receivedafund.

AUTHOR/S DECLARATION

We confirm that all Figures and Tables in the manuscript are original to us. Additionally, any Figures and images that do not belong to us have been incorporated with the required permissions for re-publication, which are included with the manuscript.- Author/s signature on Ethical Approval Statement

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تأثير أختلاف مادة الأصل والطوبوغرافية في حالة وتوزيع أكاسيد الحديد في بعض ترب محافظة السليمانية / العراق

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المستخلص

إختيرت ثلاثة خطوط دراسية ضمن محافظة السليمانية. إذ يقع الاول في سهل بازيان والثاني في سهل السليمانية والثالث في سهل شهرزور. لدراسة تأثير مواد الاصل والطوبوغرافية في حالة وتوزيع أكاسيد الحديد في تلك الترب. بينت النتائج إن لمادة اصل الترب أثرا واضح في خصائص وتوزيع أكاسيد الحديد وإن محتوى تلك الاكاسيد كان متغايرا في ترب الدراسة ومرتبطا بمحتواها في مواد أصل تلك الترب ، إذ أمتازت الترب المتطورة عن صخور البازلت وأحجار الطين الاحمر أرتفاع محتوى أكاسيد الحديد فيها وبلونها البني– الداكن، في حين أنخفضت نسب أكاسيد الحديد في الترب المتطورة عن الصخور الكلسية والتي أمتازت باللون البني المصفر. كما أثر الموقع الطوبوغرافي في نقل نواتج تجوية صخورالاصل من المناطق المرتفعة وترسيبها عند المناطق السهلية.

الكلمات المفتاحية: غير المتبلورة، التبلور، الترسيب، النقل.