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Diagnostics and Characterization of Micro morphological Features of some Soil Series in Baiji City, Central Iraq

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ABSTRACT

Three pedons were selected representing the soil series of the study area in Baiji city, which are Khadraniya, Al-Sharqat, and Manjour soils series, representing calcareous and gypsiferous soils, to diagnose some of micro-morphological Features in soil series horizons. Pedons were morphologically described, and disturbed and undisturbed soil samples were collected from each horizon. The presence of (calcic) and (gypsic) horizons has been diagnostic by morphological field results, ccumulation of lime and gypsum in soil matrix as vertical gypsic threads and beards and aggregates under gravel and gypsum crystals the size of coarse sand, as well as some lime and gypsum as nodules intertwined within soil structure units in soil horizons that reflects the influence of parent material and primary sedimentation sources .

The results of morphological characteristics are represented by the presence of gypsum crystals in distinct shapes, including lenticular, and spindle as Enhedral and subhedral, and the size of fine to coarse sand, as well as the granules that in filling pores, as well as the presence of pores in vughs and chamber, as well as the spongy and granular structure, as well as the presence of iron coating in the form Encases of gypsum crystals.

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INTRODUCTION

Agriculture development in any country necessitates a variety of factors, the most important of which are soil and water, as well as machinery, fertilizers, agricultural pesticides, and high-yield seeds. When the production elements become available, agricultural productivity will increase, as symmetry, collaboration, and integration between the production elements are required to achieve the highest levels of agricultural production, and increasing the agricultural land alone is not the solution.

As a natural resource, soil is one of the most important pillars of the agricultural environment, as the importance of documenting information and understanding the nature of its properties has emerged as one of the necessary requirements for the success and development of agricultural production in the country and around the world. (Dines et al., 2014),also, Knowing and studying the distribution of soil series is an important step toward identifying and treating their problems, determining the best ways to exploit them, and maintaining an appropriate economic policy for them, It is not possible to successfully manage soil and know their productive state unless soil surveys and characterization are carried out, and the precise morphological

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characteristics of the soil are studied to explain the present and future of the soil under the present climatic conditions suffer from drought and soil degradation of study area (Esmael, 2017). Soil micromorphology is one of the basic sub-disciplines in soil science (Macphail and Cruise, 2001) and is an important field on the agenda of researchers specializing in the study of soil pedology, as this field is currently receiving global attention in the field of scientific research. Each of the scientific and technical challenges regarding the concept of soil micromorphology in terms of its procedures, operational techniques, effects, and application in the field of soil science are unique. The modern scientific field is mainly concerned with studies of the morphological characteristics and appearances of soil under the microscope, which is a very important and necessary matter, especially in the evaluation of soil minerals, composition, and geomorphological processes of the soil (Sadiq, 2020). Stoops (2019) defines Micromorphological characteristics as the study of a sample of undisturbed soil samples with the help of modern microscopic techniques to identify the small and micro-sized properties of the soil and how they are formed and pedogenically formed. To an increasing extent, measuring components, characteristics, and membranes in unstimulated soils at the microscopic level (Sadiq, 2020). He also indicated the possibility of using accurate morphological studies to diagnose soil horizons in dry areas, as lime and gypsum coating are used in diagnosing gypsic and calcic horizons. Micromorphology applications are also an aid in the study of soil Genesis. It is not possible to know a true genetic explanation for pedological phenomena without the help of micromorphological studies.

When studying Gypsiferous Soils in Salah al-Din Governorate, Tikrit University soils, he showed the presence of some micro morphological forms, including intermittent clay films, whether around soil grains or on the internal or external surfaces of the interfacial pores, which is evidence of a state of pedogenic development for these soils, as well as the presence of lime and gypsum coating, which shows the movement of some soil components from top to bottom as a result of the activity of some pedogenic processes and their deposition in the Illuvaition horizons (Latef and Rasheed, 2012). Gypsum soils cover large tracts of land in center and north of the Iraqi sedimentary plain. Most of these lands suffer from multiple problems affecting their agricultural productivity. According to (Esmael 2017) the deterioration of soils is due to the high content of gypsum and salts and the low content of organic substances, which began to negatively affect its agricultural productivity, also, diagnosing and describing micromorphological features of soil structure is of importance in defining and explaining the interrelationships of soil characteristics with each other. Soil structure plays an important and influential role in soil management due to its direct and indirect influence on some pedological properties of soil, affecting plant growth and productivity, including the movement of water, nutrients, and air and the nature of root penetration into the Soil surface and sub surface within the genetic horizons of the soil. Muhaimeed et al (2012) mentions Soil structure has been identified as a very important physical characteristic in determining the series level in present soil classification and clarified the importance of structure the soil in the direct influence on the cultivation of the soil, and knowing soil micro structure, is important in explaining many of the relationships between water and plants with the soil. It is possible to know the present and future of the soil and how to manage it by micro morphological studying, as the presence of gypsum, lime, and salts in surface and subsurface horizons will inevitably affect the nature of root expansion and vital activity, as well as other soil characteristics (Hashemi et al, 2011). This study aims to document the genetic status of these soils, which is the truest reflection of their nature and productive state in the future, with the increasing conditions and factors of drought and the increase in the accumulation of gypsum content affected by the nature of the dry climate and the nature of the original material for these soils, such as the process of gypsum accumulation, the process of clogged pores, and accumulation of gypsum in the Soil Matrix as vertical and solid gypsum layers, which will affect the management of gypsum soils in the future. It is necessary to find smart solutions and modern technologies in irrigation and plowing operations to avoid the problem of deterioration of gypsum soils to achieve the most successful management of them; Therefore, the aim of the research is to study micromorphological features of gypsum and lime in

soil horizons and the largest and widest units of the soil series dominant in the region as well as the dominant microstructure.

MATERIAL AND METHODS

Study area

The study area is located within the administrative borders of Salah al-Din Governorate, in the district of Baiji between Longitude $34^{\circ} 51' 55''.76$, $34^{\circ} 53' 42''$ N and latitude $43^{\circ} 25' 48''$, $43^{\circ} 30' 36''$. The topography of the region is generally flat and interspersed with some valleys, such as Wadi Al-Sahel, Wadi Al-Gamal, and Wadi Al-Mustaslan fig 1. The physiography of the region varied widely, from river water deposits to the lands of the winding valleys to the lands of the lower valleys to the stony desert plains, whether it was nearly flat and undulating or undulating to the Mutawakil upper rivers. Makhol's high mountainous areas and revolving terrace mountain. These soils occur on undulating area at Al-Jazeera area. The region's soils are generally classified as Gypsiferous Soils, consisting of mixed sandy and alluvial materials with a few pebbles on their surfaces (as in a desert environment), Or calcareous soils clearly characterized by calcic horizon B with the variation of other soil characteristics and topographic wavy to slightly wavy. The topography of the flat land may allow the penetration of water through it to form relatively well-structured Calcic, Gypsic horizons(Salluom & Elyas,2002)

Office work

Three soil series were chosen to represent the region's largest and most representative soil series.

Soil series classified according to soil survey manual. The taxonomy of soil series is as follows (Salluom & Elyas,2002) :

First series is SHARGAT series

SHARGAT series is a member of coarse silty, mixed calcareous hyperthermic family of Calcic Gypsiorthids. Typically, SHARGAT soils have yellowish brown to brown (10YR) moderate medium and fine sub angular blocky to massive structure. Moderately to highly saline soils, loam to silt clay in texture alluvium deposit and affected by water erosion. The area is cultivated with wheat, barley but low production ,Undulating slope.

Second series is AL- KHADRANIA series

AL- KHADRANIA series is a member of fine loamy,mixed,calcareous, Hyperthermic family of Calcic Gypsiorthids, Typically, AL- KHADRANIA soils have pale brown(10YR) and light yellowish brown in Ap horizon, brownish yellow to yellowish brown at B-horizon and C-horizon. Moderate medium sub angular blocky at Ap-horizon range to massive at B,C-horizon. Slightly to highly saline at some places. Sandy loam, silt loam, and loam in texture. These soils are deep soil in soil depth, developed in calcareous (Calcic and Gypsic horizon), fine coarse texture deposit, effected by water erosion . The area is cultivated with wheat, barley but low production Undulating slope.

Third series is AL-MANJOR series

AL-MANJOR series a member of coarse loamy, mixed, calcareous hyperthermic family of Gypsiorthids. Typically, Al- MANJOR soils have light yellowish brown to dark yellowish brown (10YR). Massive structure with slightly, moderately and highly saline soils. Loam to loamy sand in texture as alluvium and Aeolian deposit and affected by water and wind erosion. The area is cultivated with wheat, barley but low production ,Undulating slope.

Field work

Three pedons were excavated and described Morphological characteristics for each genetic horizon were documented such as soil color , depth , soil Texture, soil structure , soil consistence , Root distribution, boundary of soil horizon and accumulation of gypsum and lime . and according to Soil Science Division Staff, 2017 .

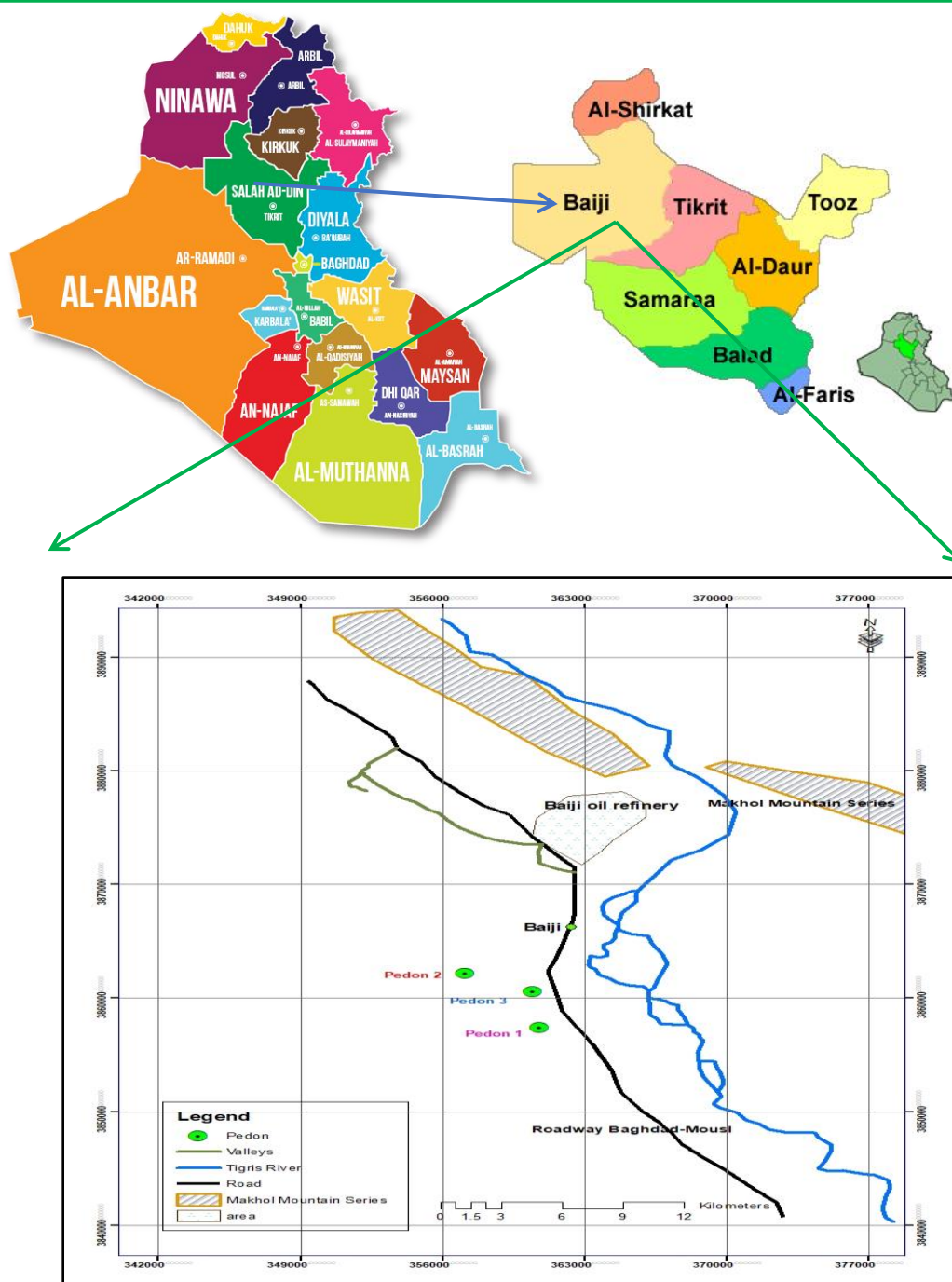


Figure (1): Location map of study area

Laboratory analysis

Soil samples were taken from each soil horizon to determine some physical and chemical properties. Particle size distribution analysis was determined by the international pipet method (Kilmer and Alexander, 1949). Bulk density (Black, 1965), Porosity calculated according the equation $(1 - \text{bulk density } p_b / \text{solid density } p_s) \times 100$ soil pH and the electrical conductivity of the soil was measured by making an extract water : soil (1:1), and using pH and Ec Meter and according to Richards (1954). The cation exchange capacity estimated according to savant, 1994. Total Calcium carbonate (calcium) determined by titration with sodium hydroxide (NaOH) (N1) and in the presence of phenolphthalein evidence, and as mentioned in Page et al., (1982). The organic matter was estimated by wet digestion method, according to the method (Black and Walkely) and mentioned in (Jackson, 1958). Soil samples were Prepared for micromorphology studying according to Stoops (1978).

RESULTS AND DISCUSSION

morphological properties of soil pedons studied

Table 1 shows a summary of morphological description of Soil profile of study area indicated the presence of surface diagnostic horizon (Ochric Epipedon), and subsurface diagnostic horizons (Gypsic Endopedon and Calcic Endopedon) as the soil was with a relatively high content of lime and gypsum in subsurface horizon of pedons in form of fine powder, crystalline and gypsum cones in form of beards as vertical and solid gypsum layers. It appeared through the morphological description of some soils, namely; Pedon1 and Pedon 2, the presence of some rock pieces, horizons of soil pedons within soil matrix unit of different sizes and This is as a result of effect The eastern side (Makhol mountain series) , which contributed to the formation of the region's soils, as the limestone rocks exposed in the deep valleys on both sides of series generally consist of limestone, gypsum and shale (AL-Ansari, 1972). soils of the study area contained genetic horizons A, B, and C, as the presence of horizon B represents a part of the soil, which represents the area of accumulation of colloidal substances transferred from the loss horizons A to the horizon B as a result of the activity of some genetic processes, including loss and alluvial, and the removal of gypsum and lime. (Soil Survey Staff, 1999). It appeared from the morphological description shown in Table 2 and Figure 2 and that the dominant wavelength (Hue) values for all soils in the study area were (10YR), as most soils in dry and semi-arid areas fall within this wave, and that the soil color of the Soil Series ranged from brown to red. There is a clear contrast in the intensity values (Value) and the degree of color saturation with its different degrees, gray and white (Chroma). Between 4 and 8, and the degree of saturation (Chroma) between 2-4, and accordingly, the color of the soils of the study sites ranged light yellowish gray 10YR6/4 and very pale brown 10YR8/2 in the dry condition, while in the wet condition it ranged between brown 10YR5/3 Yellowish brown 10YR5/6 .It was noted that some soils and in some genetic horizons were characterized by a white color (10YR8/3) and this is due to the high content of gypsum . This variation in horizon color is due to differences in the nature of the soil components of salts in some surface horizons of Soil Pedons of the study area, in addition to the lime and gypsum aggregates that were abundant in some subsurface horizons. (Esmael et al ., 2017).

Macro morphological features of Lime as nodules in AL- KHADRANIA series pedon 1 and accumulation of lime in soil profile and B_k horizon were observed in pedon 1 while not observed in SHARGAT and AL-MANJOR series pedon 2 and 3 respectively. Gypsum appears in form of friable or strong crystals beneath the gravel bodies. It was seen in all horizons soil Pedons for all series , rock pieces of gypsum vary in color from white to brown to dark brown and note of In soil profile appear dissolving threads or gypsum washing threads, which was identified and described in a series on a depth of gypsum horizons figure 2. The soil texture class ranged from the sandy to loam texture. Soil structure type was sub Angular blocky except for some Horizon where angular blocky and platy structure. The grade of soil structure, was weak for some surface horizons and was Weak and Medium and Strong for subsurface horizons, and the structure sizes (Class) ranged from very fine to medium to coarse for the surface horizons, as for the sub-surface horizons, their sizes ranged between medium and very coarse. This difference in the nature of soil structure is due to the nature of the sedimentation of the parent material and the presence of highly cohesive bonding materials such as gypsum and lime in the subsurface horizons and the state of deterioration experienced by the soils of the study sites.

Table 1 shows soil consistency varied in the soils study sites and it ranged for the surface horizons between slightly hard at the horizon A1 in P2 to hard and very hard for some subsurface horizons in the dry state, and between friable for some surface horizons and friable to firm for most subsurface horizons in the wet state .The difference of soil consistency properties is due to the difference in mineral components of soil particles in addition to the difference in organic matter content, lime and gypsum and the state of deterioration experienced by the soil. the boundaries between the surface horizons ranged between abrupt and clear in their degree of clarity and smooth in their topography. As for the subsurface horizons, the boundaries ranged from clear to gradual.

Table (1): Morphological properties of Soil profile for study area

Horizon	Depth(cm)	Color		Texture Classe*	Structure	Consistence		Root distribution	Boundary	Notes
		Dry	Moist			Dry	Moist			
Pedon 1										
A _p	0-10	10YR 6/4	10YR 5/4	L	1c.sbk	Sh	Fri	v.few.v.fine roots	Abrupt smooth boundary	
B _{ky1}	10-35	10YR 6/4	10YR 5/4	L	2vc.abk	h	Fi	v.few.v.fine roots	Clear smooth boundary	Accumulation of Lime in the soil matrix
B _{ky2}	35-70	10YR 7/3	10YR 5/3	SL	2c.sbk	h	Fi	-	Clear smooth boundary	Accumulation of Lime as nodules and gypsum in the soil matrix as vertical gypsic threads and beads
C _{ky1}	70-85	10YR 7/3	10 YR 5/4	L	2m.sbk	vh	Fi	-	Clear smooth boundary	Accumulation of Lime as spot and gypsum in the soil matrix
C _{ky2}	85-100 ⁺	10YR 7/4	10YR 5/3	LS	2m.sbk	Ext.h	v.fi	-	-	
Pedon 2										
A _p	0-12	10YR 7/3	10YR5/4	SL	2msbk	s.h	Fri	Many v.fine fibrous	Abrupt smooth boundary	Accumulation of Lime and gypsum
B _{y1}	12-30	10YR 8/3	10YR 7/3	L	2vesbk	s.h	Fri	Many v.fine fibrous	clear smooth boundary	Accumulation of Lime and gypsum in the soil matrix as vertical gypsic threads and beads
B _{y2}	30-66	10YR 8/3	10YR 7/3	L	2vesbk	h	fi	v.few.v.fine roots	Clear smooth boundary	Accumulation of gypsum as beads
B _{y3}	66-80	10YR 8/3	10YR 7/3	SL	1csbk	h	fi	-	gradual smooth boundary	Crystals of gypsum
C _{ky}	80-120 ⁺	10YR 8/4	10YR 7/4	LS	2csbk	v.h	fi	-		Crystals of gypsum
Pedon 3										
A _p	0-10	10YR 8/3	10YR 7/2	L	2mplaty	sh	fri	v.few.v.fine roots	Abrupt smooth boundary	Accumulation of Lime and gypsum
B _{y1}	10-20	10 YR 8/3	10 YR 7/2	L	1msbk	sh	fri	v.few.v.fine roots	clear smooth boundary	Accumulation of gypsum in the soil matrix as vertical gypsic threads and beads
B _{y2}	20-45	10YR 8/3	10YR 6/3	SL	2msbk	sh	fri	-	Clear smooth boundary	Accumulation of gypsum as powdery in the soil matrix
B _{y3}	45-70	10YR 8/3	10YR 6/3	SL	2vesbk	h	fi	-	Clear smooth boundary	Accumulation of gypsum as beads
C _{ky}	70-110 ⁺	10YR 8/2	10YR 6/2	LS	2vesbk	Vh	fi			Crystals of gypsum

* L= Loam, SL= Sand Loam LS= Loamy sand

** 1 = Weak 2 = Moderate sbk = Sub angular block m = medium c = coarse , v.c= very coarse

*** s = Slight , h = Hard , Ext.h= Extremely hard, fri = Friable fi = Firm v.fi = very friable , v.h= very hard

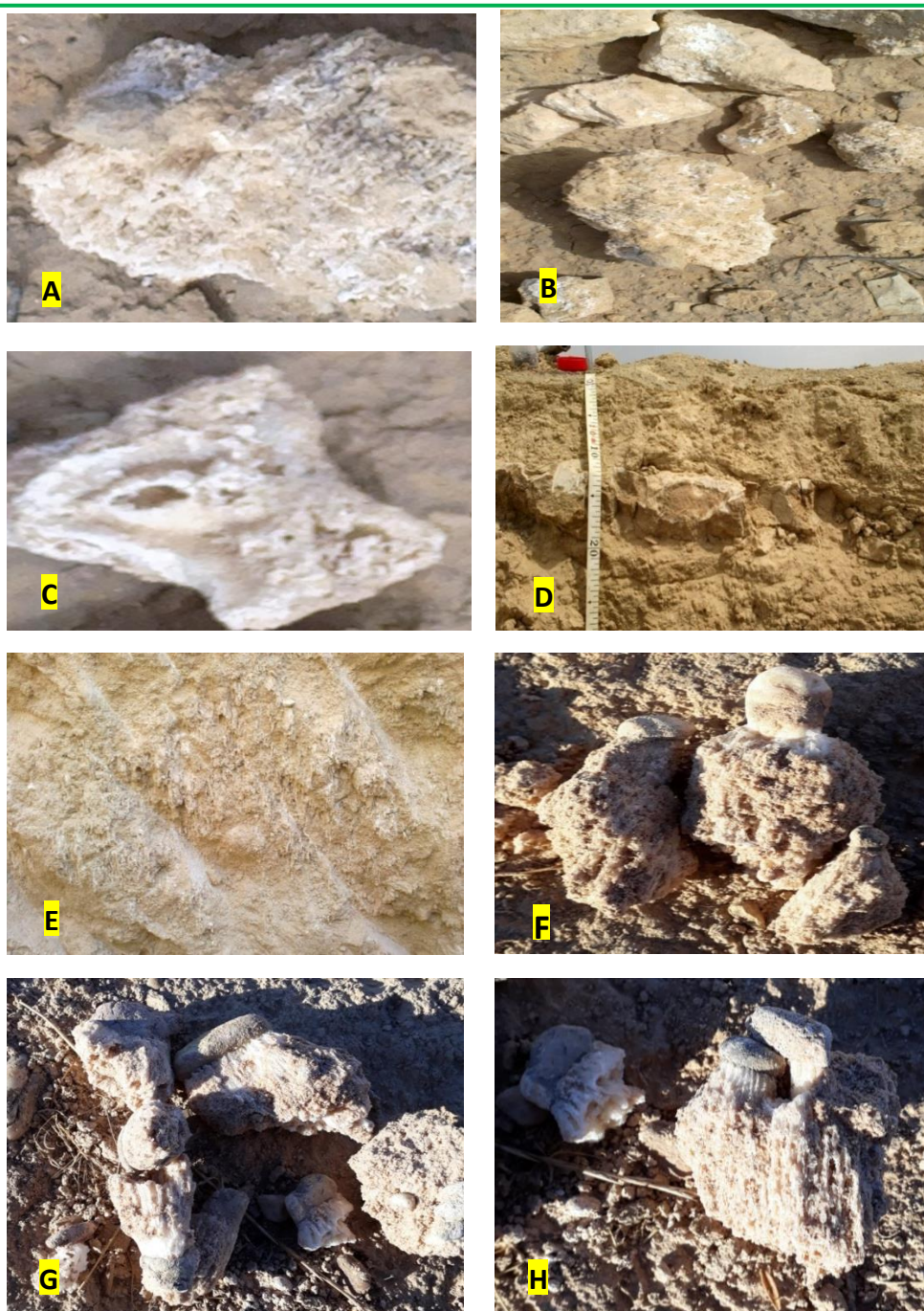


Figure (2): Macro morphological Features in field (in soil profile) as nodules of carbonate and gypsum (picture A,B,C) and cemented layer of gypsum rock pieces (picture D) and Accumulation of gypsum in soil matrix as vertical gypsic threads and accumulation gypsum under the gravel bodies in the form of fragile or strong crystals and Accumulation of gypsum in soil matrix as vertical gypsic threads beards (picture F,G,H). and some gypsum stones that were found overlapping with the soil composition units. As well as gypsum rock pieces, which appear in white to semi-transparent or brown color and in different shapes and showing traces of gypsum melting in them, which were seen in the soil pedon , Gypsum crystals are collected under and on the side edges of gravel bodies in the form of a sedimentary layer or in the form of coarse crystals intertwined with the soil materials

Physicochemical properties

The results of the soil partial size distribution of the studied soil badass (Table 2) showed the predominance of sand content at all horizons, which is mainly due to the effect of the mother material rich in sand, in addition to increase in the soil content of gypsum and carbonate minerals that increase the degree of coarseness of the soil. Sand content in pedon 2 in SHARGAT Soil Series than pedon 1 in AL- KHADRANIA Soil Series and pedon 3 in AL-MANJOR Soil Series, Sand content in pedon 2 range from (418 to 800) gkg^{-1} , while it ranges from (351 to 674) gkg^{-1} and from

(440 to 840) gkg^{-1} in pedon 1 and pedon 3 respectively. Silt content in pedon 3 AL-MANJOR Soil Series than pedon 1 AL- KHADRANIA Soil Series and pedon 2 SHARGAT Soil Series, silt content in pedon 3 range from (100 to 418) gkg^{-1} , while it ranges from (176 to 399) gkg^{-1} and from (150 to 290) gkg^{-1} in pedon 1 and pedon 2 respectively. Clay content in all soil pedons was lower according to sand and silt content, This confirms the effects of the nature of the dry climate and its direct impact on the weakness of the pedogenic processes related to the movement of soil colloids, especially clay, from one part to another in the soil pedons. Bulk density in general, rang from (1.37 to 1.66) mg.m^{-1} and Soil Porosity rang (37 to 48.30) %. High values of bulk density were observed in soil gypsum horizons; The reason may be due to crystallization of gypsum inside pores, which leads to increase bulk density in soil horizons that a high content of gypsum and this results agree with (salim,2001) and (Esmael et al.,2017).

Chemical properties Table 3 indicate that all Soils Pedons are slightly alkaline with pH ranged from 7.12 in A horizon in pedon 1 to 7.73 in B_{y3} horizon of pedon 3 and Ec values was higher in some soil pedons especially in pedon 2, It ranges from (2.20 to 15.71) dsm^{-1} . In general all pedons slightly to moderately salinity and the cause of that may be due several reasons, including the influence of the climate factor and the quality of irrigation water.

Organic Matter content decrease with depth in all studied Soil Pedons. It ranges from (4.10 to 1.3) gkg^{-1} in pedon 1 and from (6.2 to 1.0) gkg^{-1} in Pedon 3 while in Pedon 2 ranges from (10 to 0.6) gkg^{-1} . As for the reason for the decrease in the values of the cation exchange capacity for all Soils pedons of the study area, it may be due to the low content of clay and organic matter (Al-Barzanji,1986). The reason may also be due to the presence of the mineral palygorskites, as Eswaran and Barzanji (1974) stated that limestone and gypsum soils with a basic reaction close to 7.9 and a rainfall amount of 100–400 mm/year represent the best conditions for the formation of this mineral, which is characterized by a low exchange capacity ranging between 3–15 $\text{cmol.charge.kg}^{-1}$ (Barzanji, 1973). It was mentioned Barzanji (1973) that the palygorskites mineral constitutes 55% of the total clay minerals, while it constitutes 79% of the total clay minerals in the lower gypsum horizons, and as a result, leads to a decrease in the values of the cation exchange capacity of the gypsum horizons, although sometimes contain a higher amount of clay than the surface horizons. The reason for the decrease in the cation exchange capacity in all pedons may also be due to the high content of calcium carbonate(Van Bladel et al., 1975) They stated that there is an inverse relationship between the content of calcium carbonate and the cation exchange capacity, as carbonate minerals, especially calcium carbonate, negatively affect the cation exchange capacity values.. The cation exchange capacity in the soil is great as it works to encapsulate the clay and silt particles, which are of great importance in the exchange capacity, and thus it works to reduce the specific surface area of these separators and thus reduce the values of the cationic exchange capacity. This is agreement with Al- Adami (2006) as it is inversely proportional to the soil content of gypsum according to what was indicated by (Garman and Hesse 1975); because the increase in lime and gypsum is at the expense of other soil components such as organic matter and clay. And because the soils of the study area contain high percentages of gypsum, especially in some subsurface horizons, it led as a result to reducing the exchange capacity values, which decreased with depth.

The total carbon content of most of the pedons represents the sites of soils Table 2 ranged between 82 and 413.90 gkg^{-1} for the surface horizons and 110 to 470 g.kg^{-1} for the subsurface horizons, as it was generally high in all pedons, and this was noted through the morphological description, as aggregates and patches of lime were found visible for some Soil horizons, and this is due to the influence of the soils of the study area by the original sedimentation sources resulting from the Makhoul hills series that bordered the study area from the east, and which contributed to Soil formation of this area, as the limestone rocks exposed in the valleys (AL-Ansari, 1972), Calcic horizon observed in AL- KHADRANIA series in Pedon 1. The region's soils have calcic horizons and calcareous soils that increase in depth. This is agreement with the morphological distribution of carbonate assemblies, which confirms the presence of processes of dissolution, transport, and sedimentation from surface horizons to subsurface horizons, forming horizon B. That is, despite the

harshness of the current conditions and the possibility of climate change from the current reality during the formation period, increasing the activity of decalcification processes in the A₁ surface horizons, calcification processes in the subsurface horizons, and the formation of the B horizon.

The percentages of gypsum shown in Table 2 ranged between 63 to 130 gkg⁻¹ for the surface horizons and ranges from 93 to 580 gkg⁻¹ in the subsurface horizons. It is noted through these results that all the soil Pedons had a high content of gypsum in the surface and subsurface horizons, while the percentage of gypsum increased in the subsurface horizons, in accordance with what was observed during the morphological description of the studied Pedons in the form of fine powder and crystalline forms. The results shows that the highest content of gypsum was in the pedon 3 in AL-MANJOR Series and Pedon 2 in SHARGAT Series and these results are in agreement with the field observations and morphological documentation in the soil profile and within the diagnosed gypsum horizons the nature of the original material, and the nature of the original sediments resulting from the Makhoul mountains near the study area, which borders it from the east, contributed to the formation of the soils study area. Gypsum is present in region's soil, gypsum in various forms, the most important of which is primary gypsum, which arises as a result of geological processes and the receding of the sea and lakes containing salt water in the middle Miocene and as a result of the evaporation of this water and an increase in the concentration of dissolved salts due to the deposition of gypsum CaSO₄.2H₂O and rivers CaSO₄ and halite NaCl, There is also rocky layers of formations called Bay Hassan that are difficult to penetrate with helical auger or ordinary drilling tools. Secondary gypsum, which arose as a result of soil formation processes, moves from areas containing gypsum rocks in the form of dissolved in groundwater to areas currently affected by its deposits again Recrystallization.

Micromorphology properties

The study of thin section of soil horizon shown in the figures (3,4,5,6) reflects the existence of a state of pedogenesis in the nature of micro shapes of gypsum crystals, of which lenticular, spindle, and granular in different sizes were diagnosed, ranging from small silt size and very fine sand to large, coarse, or very coarse sand. This is according to the evolutionary pedogenic state of the soil and the effect of the primary sedimentation sources in the selected soil series, which was reflected in the growth of gypsum assemblies with time and thus affected by the activity of the processes of dissolution and sedimentation in succession and the resulting clear impact on the crystalline state of those assemblies, as the images show complete and almost complete crystals in the diagnostic horizons. Surface and subsurface with the diagnosis of some cracks in the surfaces of crystalline faces, which indicates the predominance of physical weathering, that results agreements with (Rasheed and Latef 2014), or they are in form of sheaths parallel to the walls of the pores from inside and oriented parallel to them and sometimes in an oblique, and with sizes distributed between the silt to the very fine sand depending on the size of the crystallized pores. Latef and rasheed (2012) mentioned the differences in the crystal shape that have It is also attributed to the difference in the location of the soil sample within the horizon and its distance from the source of gypsum, water quality, flow velocity, and soil characteristics. Gypsum crystals are collected under and on the side edges of the gravel bodies in the form of a precipitated layer or in the form of coarse crystals intertwined within the soil materials, which are identified and described on the horizon of soil pedon of soil series. Lenticular or spindle-shaped gypsum crystals, complete, semi-complete and incomplete, prismatic and in different directions. Gypsum crystals also appear in a form corrosion and breakage as a result of the activity of the weathering process they were exposed to. The gypsum crystals that cover the pores appear from the inside and are oriented parallel to their walls mostly and sometimes at an angle .fig 5 . Soil plasma materials are deposited in the form of gypsum salt films on the surfaces of walls or on the outer surfaces of pores or in the form of salt films of calcium carbonate that's results agreement with

The predominant microstructure for most surface and subsurface diagnostic horizons was of a complex type, consisting mainly of granular and spongy structures, as well as sub-angular blocky structures (Figures 5,6)), with an abundance and diversity of micro-shapes of the interstitial pores in

Table (2): Physical and Chemical properties of Soil profile for study area

Soil Series	Pedons	Depth (cm)	Soil particle size distribution (PSD) gkg ⁻¹			Texture class	Bulk density Mg m ⁻³	Porosity %	pH 1:1	Ec dsm ⁻¹	O.M gkg ⁻¹	CEC cmol _c /kg	CaCO ₃ g.kg ⁻¹	GYPSUM g.kg ⁻¹
			Sand	Silt	Clay									
AL-KHADRRANIA	P ₁													
	A _p	0-10	351	399	250	L	1.46	44.90	7.12	7.57	4.10	9.00	413.90	130
	B _{ky1}	10-35	364	396	240	L	1.52	42.64	7.14	6.27	2.7	7.00	441.00	270
	B _{ky2}	35-70	520	280	200	SL	1.64	38.11	7.33	2.56	2.00	7.56	344.4	389
	C _{ky1}	70-85	460	300	240	L	1.58	40.37	7.36	2.66	1.7	6.56	240.00	400
	C _{ky2}	85-100+	674	176	150	SL	1.66	37.35	7.35	2.55	1.3	4.75	230.60	417
SHARGAT	P ₂													
	A _p	0-12	441	418	141	SL	1.50	43.39	7.26	15.71	10.1	12.00	82	63
	B _{yl}	12-30	648	288	64	L	1.37	48.30	7.28	15.53	8.3	1087	110	93
	B _{y2}	30-66	680	250	70	L	1.40	46.60	7.38	8.85	5.1	8.82	339	281
	B _{y3}	66-80	650	290	60	SL	1.59	40.00	7.45	5.23	1.3	7.80	420	470
	C _{ky}	80-120+	800	150	50	LS	1.60	39.43	7.32	4.45	1.0	4.00	470	465
AL-MANJOR	P ₃													
	A _p	0-10	450	400	150	L	1.44	45.66	7.40	11.55	6.2	10.10	209	103
	B _{yl}	10-20	440	418	142	L	1.51	43.01	7.41	5.24	5.1	9.00	225	200
	B _{y2}	20-45	650	290	60	SL	1.49	43.58	7.54	3.02	4.1	8.77	200	230
	B _{y3}	45-70	695	224	81	SL	1.55	41.50	7.73	2.92	2.4	6.70	240	526
	C _{ky}	70-110+	840	100	60	LS	1.66	37.16	7.34	2.20	1.0	4.00	385	580

these horizons. which was between the tubular and vesicular with the presence of grains of different types of minerals such as quartz and gypsum.

The presence of these microscopic shapes and structures represented by calcians in the subsurface diagnostic gain horizons of pedon gives evidence of the activity and succession of decalcification processes in the surface horizons, which led to the dissolution and transfer of carbonate minerals, and then the activity of calcification processes that lead to the accumulation and accumulation of minerals Carbonates in the subsurface diagnostic gain horizons and the formation of the calcic horizon, as they provide the conditions and requirements for this horizon contained in terms of the weight and volume ratios of the assemblies (Muhaimed et al.,2017).

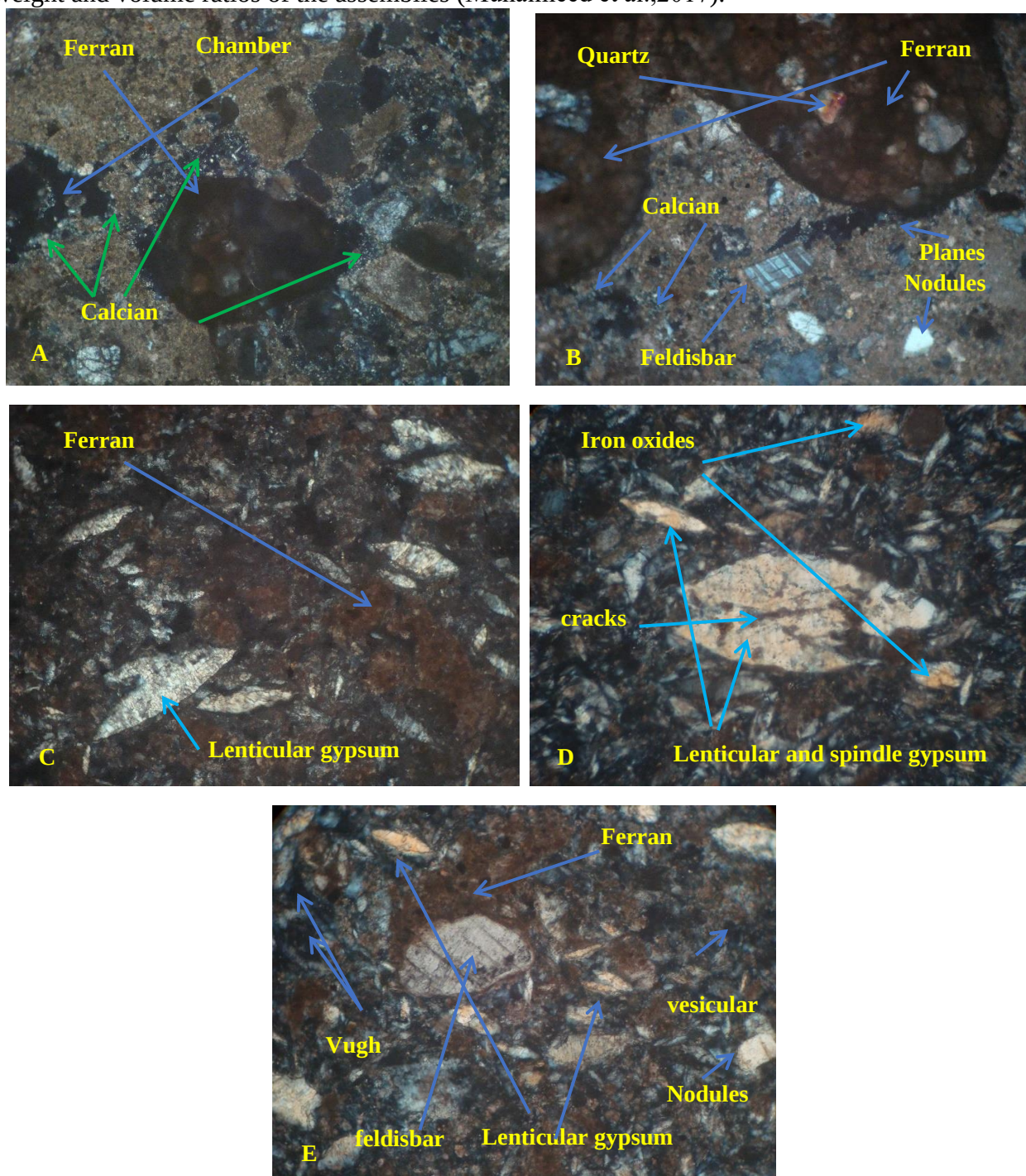


Figure (3): Picture A; infilling calcium carbonate as clacian coated on P1Ap horizon and pores type of chamber and ferran ; Picture B; Quartz and feldisbar and calcitan and ferran and planes channel pores and nodules of carbonate on P1By1 , picture C; ferran and Lenticular gypsum on P1B1, picture D; Iron oxides coated of Lenticular gypsum on P1By2 , picture E; feldisbar and pores type of vughs and vesicular and ferran and nodules of gypsum and lenticular gypsum crystals on P1By2

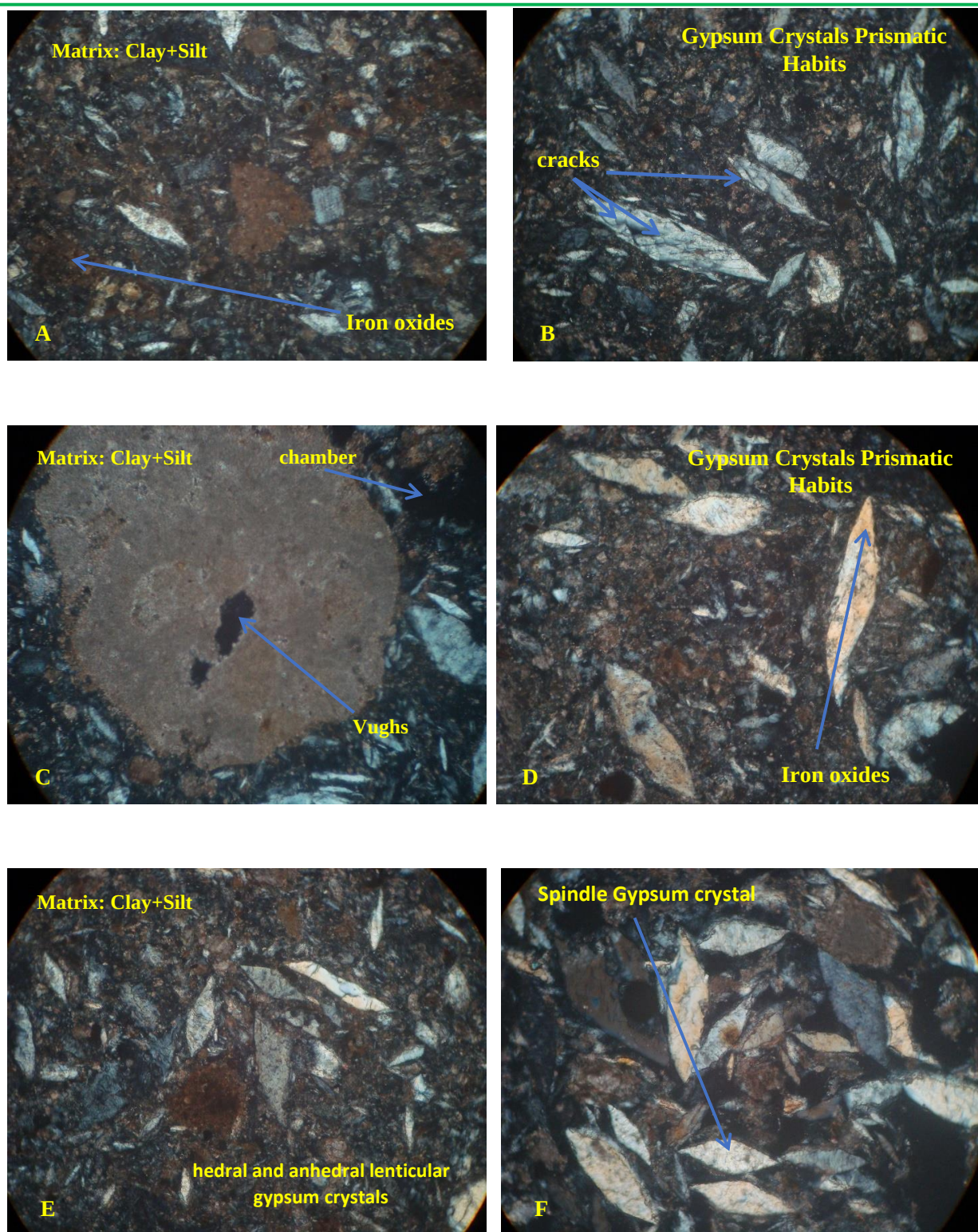


Figure (4): picture A; silt and clay in soil matrix and chamber channel of pores type and vughs and hedral and anhedral lenticular gypsum crystals and Iron oxides on p2Ap, picture B; Gypsum Crystals Prismatic Habits and Cracks caused by the effect of physical weathering , picture C; silt and clay in soil matrix and vughs of pores type and chamber channel and anhedral lenticular gypsum crystalson P2By1, picture D; Gypsum Crystals Prismatic Habits and spindle gypsum crystal the size of coarse sand on P2By1, picture E; silt and clay in soil matrix and hedral and anhedral lenticular gypsum crystals, picture F; spindle gypsum crystal the size of coarse sand on P1By2

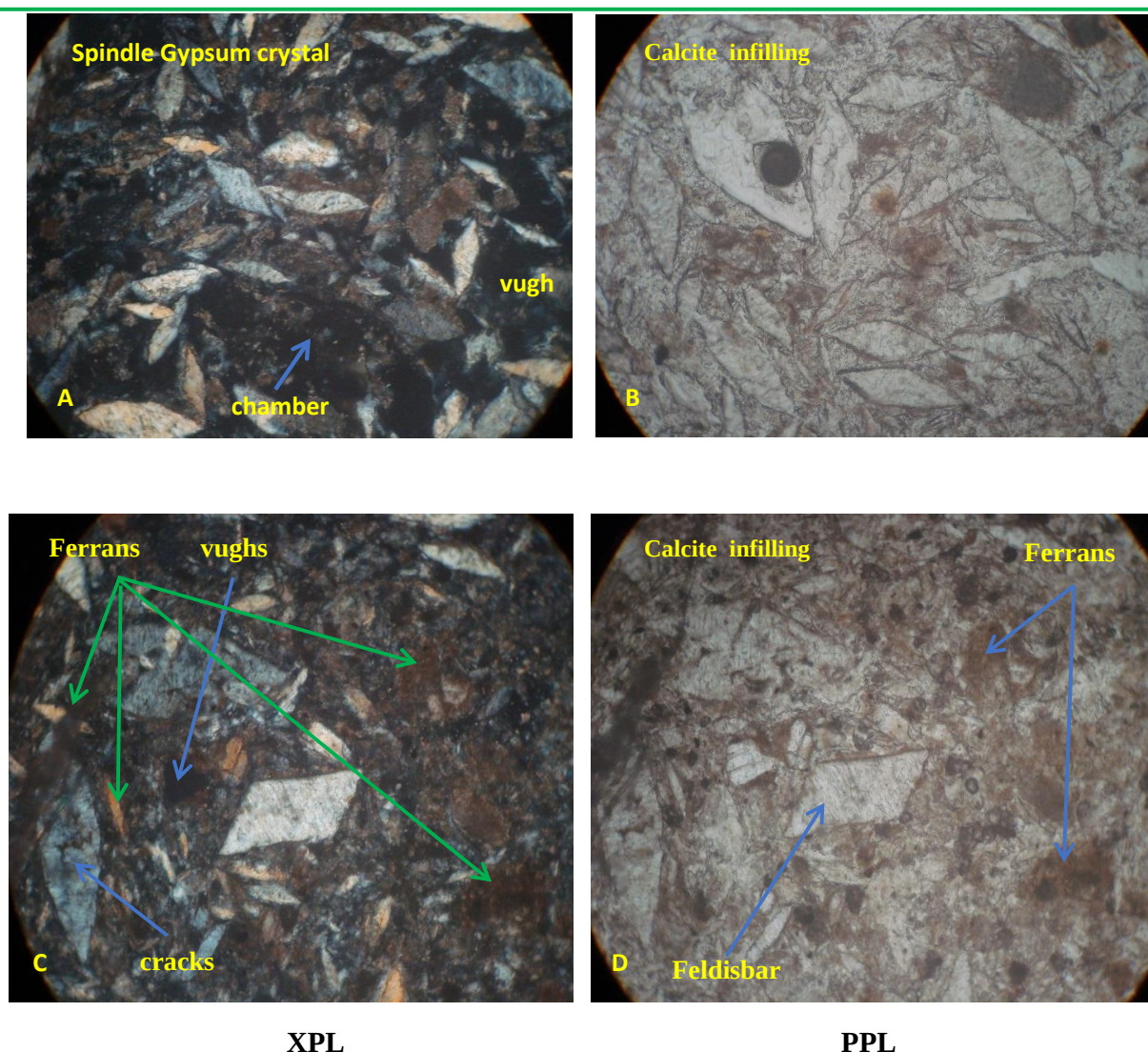


Figure (5): picture A; spindle gypsum crystal the size of coarse sand on P2By3 and chamber channel , picture B; Calcite infilling soil horizon plasma materials are deposited in the form of calcareous salt films and gypsum salt films inside the pores or on the outer surfaces of pores on P1By2, picture C; Cracks on the surface of the spindle gypsum crystals and vughs pores and ferran. Picture D; Calcite infilling soil horizon plasma materials are deposited in the form of calcareous salt films and gypsum salt films inside the pores or on the outer surfaces of pores on P2By3

Figures 3,4,5,6 shows iron oxides on the surfaces of gypsum crystals in the surface horizon of the soils pedons and this may explain the role of iron oxides on the coating of gypsum borate and impeding its movement or reducing its solubility and thus directly affecting the Soil properties. The picture also shows black grooves on the surface of gypsum crystals, which may be the result of the effects of dissolution of gypsum by limited rain water at successive intervals, or by irrigation water or physical weathering of temperature variations and that's results agreement with Rashid(2017) and Kamal and Rashid (2020).

Some pedogenic structures that reflect the effect of the activity of some pedogenic processes responsible for their formation were also diagnosed, as Soluans films were diagnosed in the form of crystallized salts of calcium carbonate as clacians and calcium sulfate as gypsans in some horizons with a high content of lime and gypsum, and they are either in the form of a fine powder in the form of calcareous saline membranes coated with that surface. The pores are of the type of vesicles the surfaces in the form of fine particles of lime or gypsum or both, these membranes are found either on of the peds or inside or outside the interfacial pores (Figures 3 , 5,6).

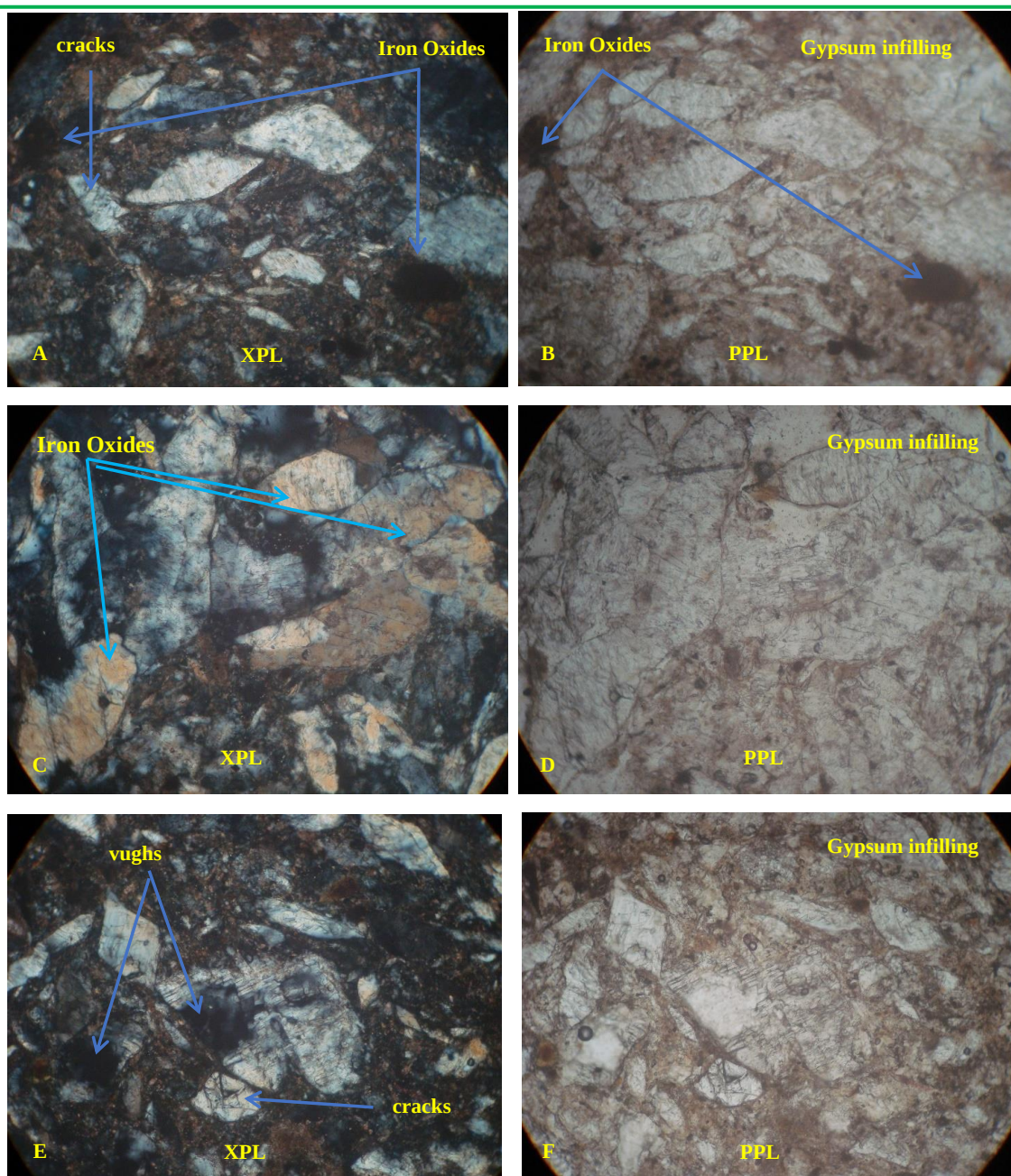


Figure (6): picture A; spindle gypsum crystal the size of coarse sand on P3By1 and Iron Oxides , picture B; Gypsum infilling soil horizon plasma materials are deposited in the form of gypsum salt films inside the pores or on the outer surfaces of pores on P3By1, picture C; Iron Oxides on the surface of the spindle gypsum crystals and vughs on P2By2. Picture D; Gypsum infilling soil horizon plasma materials are deposited in the form of gypsum salt films inside the pores or on the outer surfaces of pores on P3By2 , picture E; cracks and vughs and hedral and anhedral lenticular gypsum crystals , picture F; Gypsum infilling soil horizon plasma materials are deposited in the form of gypsum salt films inside the pores or on the outer surfaces of pores on P3By3.

Several Micro morphological studies have shown that the presence of the covers in some surface and subsurface diagnostic horizons for soil pedons represented by aggregates of gypsum, lime or iron oxides that are covered with soil pores or fill those pores, which confirms the occurrence of weathering and transfer of gypsum or lime from the surface horizon towards the horizon below. The surface area leads to the formation of Illuviation horizon (B), and this was confirmed by the changes that occurred in soil survey guide (Soil Survey Staff, 2014), in which it was mentioned that the Illuviation horizon can be formed as a result of the movement of some components of the soil from top to bottom, including gypsum materials, limestone and other salts (Jabbar and Jubier, 2017).

CONCLUSION

Results of the field morphological description and microscopic studies, as well as the results of laboratory analyzes confirmed existence of Gypsic and Calcic horizon, which confirms influence of soil by original sedimentation sources resulting from the Makhoul mountains series, which affected the Soil formation of study area. This was confirmed by nature of presence of gypsum crystals in their various forms and the pore-filling crystals on the one hand and on the other hand encapsulating the pores of soil, which confirms the occurrence of the process of transferring and illuviation gypsum and lime salts , in addition of physical weathering effects as well as the presence of iron oxides coated for gypsum crystals , while the Soil structure common is spongy and granular structure.

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تشخيص وتوصيف الخصائص المورفولوجية الدقيقة لبعض سلاسل التربة في مدينة بيجي وسط العراق

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الخلاصة

تم اختيار ثلاثة بدونات ممثلة لسلاسل تربة منطقة الدراسة في مدينة بيجي وهي سلسلة تربة خضرانية وشرقاط ومنجور ، والتي تمثل الترب الكلسية والجبسية ، لتشخيص بعض الصفات المورفولوجية الدقيقة في أفق سلاسل التربة. تم وصف البيدون مورفولوجياً ، وجمعت عينات التربة المثارة وغير مثارة من كل أفق. من خلال النتائج الحقلية المورفولوجية شخص وجود الأفق (الكلسية) و (الجبسية) ، وكذلك تراكم الكلس والجبس في سلاسل التربة كخيوط جبسية عمودية ولحي وتجمعات بشكل بلورات تحت الحصى وجبس بحجم الرمل الخشن وكذلك بعض الكلس والجبس كعقد ضمن وحدات تركيب التربة في أفق التربة والتي تعكس تأثير المواد الأم ومصادر الترسيب الأولية. وتتمثل نتائج الخصائص المورفولوجية الدقيقة في وجود بلورات الجبس بأشكال مميزة ، بما في ذلك العدسي ، والمغزلي مثل Enhdral و subh طويلة السطوح ، وبحجم الرمل الناعم إلى الخشن ، وكذلك حبيبات مألوفة للمسام ، والتركيب الإسفنجي والحبيبي وكذلك وجود أكاسيد حديد مغلقة لبلورات الجبس.

الكلمات المفتاحية:

مسح التربة، وراثية التربة ، حبيبات (دقائق) الجبس المغزلية ، حبيبات الجبس البلورية ، أغشية الجبس ، أغشية الكلس .