Caspian Journal of Environmental Sciences
Online ISSN: 1735-3866
Print ISSN: 1735-3033

Effects of climatic variation on weathering intensity for the mineral composition in some Iraqi soils

Salwa Hashim Khalaf Al Shamary[1]*, Abdul Baqi D.S. Al Maamouri[2], Sadeq Jaafar Hassan Dwenee[3]

1. Ministry of Higher Education and Scientific Research- Administrative and Financial Department, Iraq
2. College of Agriculture Engineering Sciences, University of Baghdad, Department of Soil Sciences and Water Resources, Iraq
3. Ministry of Science and Technology, Agricultural Research Center, Iraq

** Corresponding author's E-mail: salwaahashem3@gmail.com*

ABSTRACT

This study was conducted to find out the effect of variation in the nature of climatic conditions and physiographic location on the weathering intensity of the mineral composition in some Iraqi soils. Six different locations were selected within rainfall with intensity ranged between 100-1200 mm year^{-1}, located in the north, west, central and southern Iraq. These locations were represented by the governorates of Erbil and Sulaymaniyah, Salah al-Din, Wasit and Dhi Qar in the locations of Joman, Halabja, Al-Sharqat, Tikrit, Al-Suwaira project, and Hor Al-Jbayish respectively. The scanning electron microscope (SEM) was used to diagnose the most important morphological features of clay minerals. Moreover, the examination results of clays in northern Iraq showed the presence of mica minerals in their irregular lamellar shape with rough surfaces containing cracks. These features reflected the exposure of mica minerals to different stages of weathering intensity of the layers. It was also exposed to the edges weathering in some of its areas. Likewise, the surfaces of these minerals seemed to contain slab elongated particles of regular geometric shape and with curled edges belonging to other minerals that are considered as impurities within the composition of the original mineral during the formation process. Besides, a transformation of part of the mica minerals appeared towards the expanded minerals 1:2 most likely to be Smectite minerals. As for the clays of the western regions of Iraq, the mica mineral particles appeared with multiple morphological appearances within the weathering of layers and edges. The surfaces of those particles appeared rough with the presence of the layers splitting accompanied by peeling, which indicates the exposure of these minerals to layers weathering. Furthermore, the results of general examination of the particles showed the absence of sharp edges rather, and some of them had irregular edges as a result of breaking the metal flakes as they were subjected to physical weathering in conjunction with chemical weathering, in addition, the presence of a shift at the edges of the mica minerals towards the expanded Smectite minerals 1:2. The latter appeared in the form of a white cloud, in addition to the presence of mica minerals with the weathered edges, but it appeared in a limited way, which reflects the extent of the decrease in the effective weathering intensity in those areas. The particles of the Palygorskite mineral appeared in an elongated shape, which reflects the appropriateness of the environmental conditions in those areas to form it, as it is a gypsum soil in nature. In the case of the clays of the central regions of Iraq, mica minerals appeared in the form of unaffected surfaces and the edges of some of them weathered which may have been weathered by transport and sedimentation processes. On the other hand, at the source, the conditions of the sampling areas do not encourage the occurrence of weathering processes, since they are dry or semi-dry areas with little rain. Similarly, it may be caused by wind weathering. In addition, chlorite minerals appeared in a pseudo hexagonal form, while Smectite minerals in a white cloudy form. At the same time, the clays of the southern regions of Iraq - Hor Al-Jbayish showed that a large part of the surfaces of their minerals were irregular. However, the surfaces of the mica minerals contained holes of different sizes and that some of

Caspian Journal of Environmental Sciences, Vol. 20 No. 5 pp. 991-1001 Received: May 24, 2022 Revised: Sep. 05, 2022 Accepted: Nov. 13, 2022
DOI: 10.22124/CJES.2022.6053

Publisher: University of Guilan,

those mineral surfaces appeared in a spongy form. Moreover, the holes that had been observed on the surfaces of Mica minerals can be the result of the presence of impurities from fossilized plant. Otherwise, animal remains during the synthesis of the mineral, which left a hole after the process of its complete dissolution. Similarly, it may be the result of the mineral impurity in the presence of impurities of other minerals that may differ in their geological age and degree of resistance to weathering. In general, all these morphological features are a product of what these minerals are exposed to the weathering processes, whether they are water or wind in the source areas or during transport and deposition.

Keywords: Soil. Weathering Intensity, Rainfall, Electron Microscopy.
Article type: Research Article.

INTRODUCTION

Mineral studies of soils give detailed and accurate pictures about the stages of development and the overall conditions that they experience throughout different times, and to determine the extent of the readiness for nutrients in them. The mineral part in the soil consists of a large mixture of minerals, and after minerals are formed in the soil through its various sources, it becomes subject to various weathering factors, including mechanical or what is known as physical and chemical alike, depending on the type of conditions surrounding the mineral. The physical action works on cracking and disintegration of minerals, while the chemical action works on the decomposition of minerals and the formation of new minerals. Chemical processes may interfere with each other, such as oxidation, hydration and carbonation. Soil is one of the most important products of the various weathering processes and sculpting, and these weathering processes continue to work in the mother rocks until reaching the most stable state with its equilibrium under the influence of different climatic factors such as rain, wind and temperatures. Weathering is among the most important direct processes in affecting different soil minerals. Especially Silicate clays, as the proportions of participation by physical, chemical and biological influences in these weathering processes depend on environmental conditions such as the prevailing climate (intensity of rainfall, and temperatures). In desert environments that are characterized by drought, frigid and polar regions, physical weathering is dominant in the process of decomposition and fragmentation of the mother rocks, while chemical weathering is dominated by other conditions. Thus, the nature of the products formed within the scope of that weathering is determined (Naseef, 2013; Abu Shalbaya *et al.* 2019; Suleiman 2020). The detection and the investigation of the potential impact of climate on soils is an almost complex process, and progress in it is rather slow. It is also, full of complications accompanying the interactions between the various processes of soil formation. Generally, the formation of soils under the influence of many factors and interactions that take place among them such as the parent material, climate, topography and vegetation cover takes long periods of time. Besides, the nature and type of these interactions almost differ in different regions, meaning the physiographic location, which results in many, varied and different types of soils in the world. Soil formation and development may take hundreds or even thousands of years, and that changes in the climate and successive climatic cycles have direct and indirect effects on the emergence, formation and development of soils, their uses and management methods. After the development that took place and the use of scanning electron microscopy examinations, it was found that most of the components of clay minerals are of a crystalline nature. So, it has become necessary to study them and follow up all the changes that occur in their different properties with extreme accuracy to prevent them from deteriorating. Besides, the absence or presence of a certain mineral in the soil gives a huge amount of information and sufficient evidence about how these soils are formed, the degree of their development and the extent to which each factor contributes to their formation (Al-Jaf 2006; Khalil 2016). Al-Khafaji *et al.* (2017) indicated that the degree of development in soils is largely related to the weathering they are exposed to. In areas where rainy climates prevail, the chemical weathering process increases, which leads to the predominance of multi-layered clay minerals 1:2. On the other hand, in arid and semi-arid climates, where the lack of precipitation witnesses a limitation of chemical and biological weathering processes.

The climate factor has a great influence on the emergence and development of soils and their inheritance. However, the activity of different soil formation processes and the doubling the processes of loss, transformation, gain, weathering and removal of calcification are caused by an increase in the amount of rainfall that differ according to the physiographic location. This study was conducted for the purpose of identifying the variation effect in the nature of climatic conditions, in addition to the physiographic location on the effective weathering intensity on the mineral composition of the soil through different time periods and its uses as an indicator of the formation and development of soils.

MATERIALS AND METHODS

Soil models were collected for the period from 10/10/2020 to 22/11/2020 from different regions of Iraq, varying in the nature of climatic conditions and physiographic location. These samples located within rainfall of varying intensity, ranging between 100 - 1200 mm annually and for a depth of 0-30 cm, selected from the north, west, central and southern of Iraq. It were represented in each of the governorates of Erbil, Sulaymaniyah, Salah al-Din, Wasit and Dhi Qar in the locations of Joman, Halabja, Al-Sharqat, Tikrit, Al-Suwaira project, and Hor Al-Jbayish, respectively. Soil samples were taken and placed in plastic bags, and the information was written on them in an accurate and detailed manner for the purpose of conducting laboratory analyses. Table 1 shows some physical and chemical properties of the soil under study.

Physical analyses

Particle size distribution

The relative distribution of the different soil particle were estimated by the hydrometer method mentioned by Day (1965).

Chemical analysis

1. Soil reaction number (pH)

It was estimated in the saturated paste extract in a pH-meter device of type WTW according to its instruction (Richards 1954).

2. Electrical conductivity (EC_e)

It was estimated in the saturated paste extract using an EC-meter type WTW, according to its instruction (Richards 1954).

Table 1. Some physical and chemical properties of soil models.

	Location	**Rainfall mm**	**Horizon depth Cm**	**Relative distribution of soil particle (g kg^{-1})**			**Tissue class**	**pH saturated dough extract**	**ECe ds m^{-1}**
				Sand	**Silt**	**Clay**			
North	Joman	1000-1200	0-20	12.0	336.0	652.0	C	7.9	0.56
	Halabja	900-1000	0-38	112.0	212.0	676.0	C	7.6	1.06
West	Al-Sharqat	200-300	0-25	184.0	490.0	326.0	Si .C. L	7.9	2.88
	Tikrit	100-182	0-20	607.0	240.0	153.0	S. L	7.8	3.09
Central	Al-Suwaira project	100-150	0-28	36.0	212.0	752.0	C	8.1	56.1
Southern	Hor Al-Jbayish	Less than 100	0-25	40.0	476.0	484.0	Si. C	7.7	15.84

Separation and fragmentation

The sand was separated from the clay and silt by the Wet Sieving method using a sieve with a diameter of 50 µm, and then the clay was separated from the silt by sedimentation according to the Law Stocks, taking into account the temperature according to the method described by (Jackson 1979).

Examination of clay by scanning electron microscopy SEM

After the particles were separated from the silt and sand particles, they were taken and dried by air and became in the form of a dry powder prepared for examination. Part of it was dispersed on the stage of the scanning electron microscope (SEM) in order to study the Morphological features of clay minerals for selected models of the soil under study. The tests were carried out in the laboratories of Department of Physics, College of Science, Al-Nahrain University, Baghdad. The percentages of clay minerals in the samples were calculated after examination and diagnosis by measuring the area under curve in a semi-quantitative method, according to the method described by Gjems (1967) depending on the D - Spacing, which is a constant characteristic in minerals (Table 2).

Table 2. The degree of dominance of clay minerals in the soils examined.

Region	Governorate	Location	% For mineral				
			Mont.	**Chlo.**	**Kaol.**	**Paly**	**Mica**
North	Erbil	Joman	++++	++	++	+	++
	Sulaymaniyah	Halabja	++++	++	++	-	++
West	Salah al-Din	Al-Sharqat	+++	++	++	+	++
		Tikrit	++	++	++	++	++++
Central	Wasit	Wasit	+++	++	++	-	+++
Southern	Dhi Qar	Hor Al-Jbayish	++	++	++		++++

Dominant = 50-90% (++++), Major = 20-50% (+++), Minor = 5-20% (++), Trace < 5% (+); Mont = Smectite, Chl = Chlorite, Kao = Kaolinite, Mica = Mica, Paly = Palygorskite

RESULTS AND DISCUSSION

The scanning electron microscope (SEM) was used to diagnose the morphological features of the most important minerals in soil clays under study. The selected models were obtained according to the main objective of the current study. Those models were obtained from the sites that varied in the nature of their climatic conditions, rainfall and physiographic location, represented by the soils of Joman, Halabja, Al-Sharqat, Tikrit, Al-Suwaira project, and Hor Al-Jbayish as represented by each of the Figs. 1, 2, 3, 4, 5 and 6 respectively. Figs. 1a and 1b of the soil clays of the Joman location, Erbil Governorate - northern Iraq, which is located within a high rainfall of about 1000-1200 mm year^{-1} exhibited the mica minerals in their irregular lamellar shape. Furthermore, mica displayed the rough surfaces containing coarse crackle surface, which was represented in the Fig. 1a, as these features reflect the exposure of mica to different stages of layer weathering intensity. In addition to its exposure to edges weathering in some of its areas, as those edges appeared in a faint colour contrary to the original colour of the mica (Fig. 1b). These morphological features can be attributed to the influence of mica on the weather conditions surrounding their particles, such as an increase in the amount of rainfall at the sampling sites. This in turn led to affecting the mica and exposing it to weathering conditions directly and continuously, which affected its structural composition, resulting in mineral particles with irregular crystal structures and varying chemical composition. These results were identical to what was obtained in the present study by mineral analysing those clays through using X-rays, as the interstratified minerals in their regular types (chlorite-vermiculite) and irregular (mica-smectite) were detected. The appearance of those interstratified minerals in these clays with more than one diffraction indicates the exposure of mica minerals to varying degrees of weathering intensity. These results were identical to the results of many studies conducted on the soils of the northern regions of Iraq (Al-Jaf 2006; Muhammad 2007). So that, these pictures confirmed the appearance succession of faded and dark-coloured areas on the surfaces of mica. It also proved that this succession in appearance can be due to the influence of the mineral surfaces by varying degrees of weathering processes. These results are consistent with what was stated by Islam et al. (2002) that mica show varying degrees of resistance to weathering, as some areas of their surfaces are weathered. Conversely, other areas resist weathering, which leads to the emergence of areas called evacuation and dislocation areas as well as areas of cracking and cracking, while other areas on the surface remain unaffected by these weathering processes.

The results of SEM (Figs. 2a and 2b) showed the soil model of the Halabja Site, Sulaymaniyah Governorate, Northern Iraq, located within a high rainfall. Its intensity ranged between 900 and 1000 mm year^{-1}. Besides, the morphological features of the mica minerals were similar to those features of mica particles within the clays of Joman Site, Erbil Governorate. The surfaces of these particles appeared in coarse shapes interspersed with parts of the mineral surfaces with varying degrees of weathering intensity, which reflects the extent to which these surfaces are affected and exposed to the weathering (Fig. 2a). The results also showed that the surfaces of these minerals contained lath-shape elongated particles with a regular geometric shape and with curled edges (Fig. 2a), since their presence can be interpreted as belonging to other minerals that were considered as impurities within the composition of the original mineral during the formation process. Weaver (2013) showed that the structural composition of mica can contain impurities from other minerals, the most important of which are quartz, beryl, tourmaline, and granite, that are resistant to weathering.

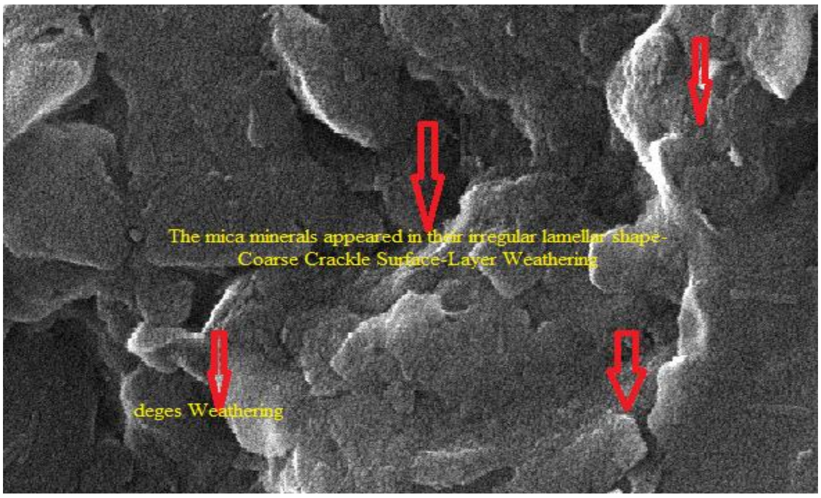

Fig. 1a. The soil clays of Joman site - Erbil governorate - northern Iraq. The mica appeared in their irregular lamellar shape, and appeared with coarse crackle surface.

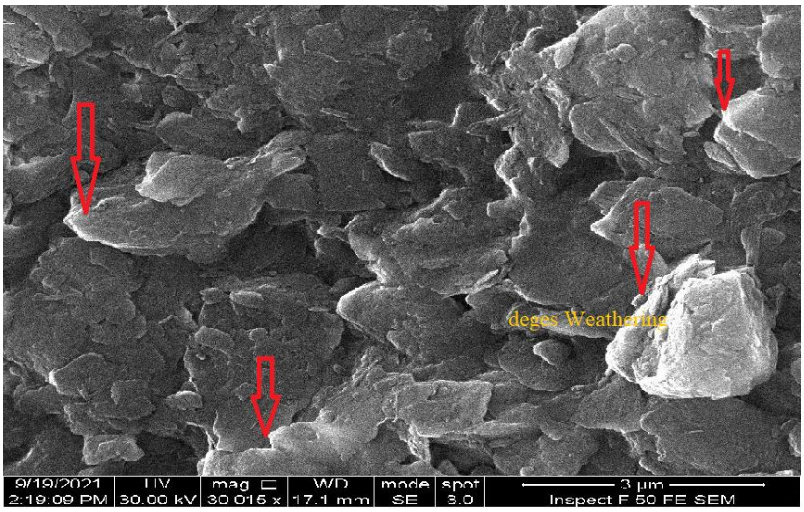

Fig. 1b. Mica subjected to edge weathering in models of Juman soils, Erbil Governorate, Northern Iraq.

The aforementioned author also indicated that the most famous of these minerals are quartz, describing its morphological features, so that, its particles are present within the structural composition of mica as impurities in the form of Lath-Shape plates and that they penetrate the Inter-Penetrating. Also, the edges of its particles are similar to sutured boundaries. In the light of the results obtained by Weaver (2013), likely, the appearance of these elongated plates on the surfaces of mica in the soil clay model of the Halabja Site belongs to quartz. The edges of its minutes are twisted and in the form of elongated plates, penetrating the crystal structure of mica (Fig. 2a). Fig. 2b showed that there is a shift of a large part of the mica particles towards the expanded minerals 1:2, and most likely towards the group of Smectite minerals.

The white mass appearing at the top of Fig. 2b) illustrates this transformation as being similar in its morphological features to those of Smectite during SEM examination described by Dixon *et al.* (1977) about mica and its weathering followed by transformation into interstratified minerals. The results of the SEM examination of the soil samples of Halabja Site, Sulaymaniyah Governorate showed consistency with the results of the X-ray examinations of these clays. These Figs. illustrated the presence of many diffractions representing the interstratified minerals, whether they were regular or irregular, which indicates the effectiveness and impact of weathering processes on particles of mica in these areas. It is mainly attributed to the high amount of rainfalls in these areas. These results were in agreement with what was found by Al-Jaf (2006) during a study on the formation of the interstratified mineral in the Sulaymaniyah Governorate. Likewise, the results showed that the quantity and intensity of the rainfalls played a leading role in influencing the particles.

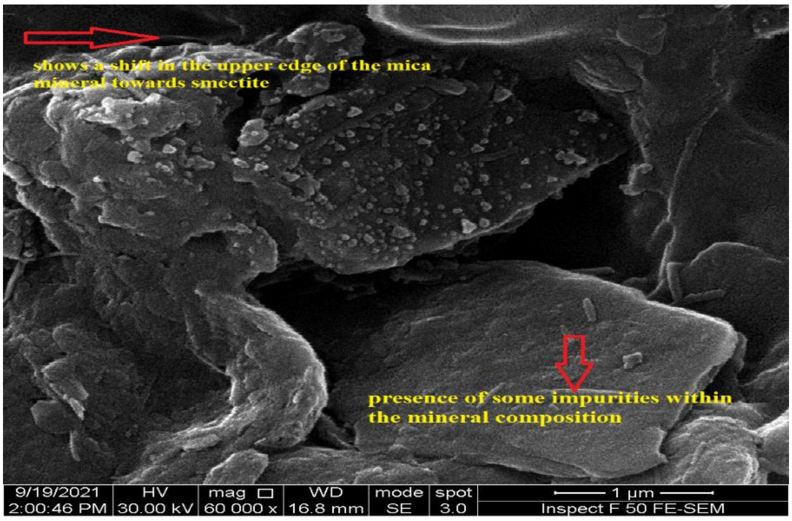

Fig. 2a. Illustrating a shift in the upper edge of the mica towards smectite and the presence of some impurities within the mineral composition in soil samples of Halabja Site, Sulaymaniyah Governorate, Northern Iraq.

As for the areas of Sharqat - Salah al-Din, Western Iraq, the results of SEM in Figs. C, b, and 3a showed the appearance of mica particles with multiple morphological features within the weathering of the layers and edges of those minerals. The Fig. 3a shows the mica, as the surfaces of these particles appeared rough with the presence of splitting of the layers accompanied by the exfoliation of these layers, which indicates the exposure of these minerals to the layers weathering.

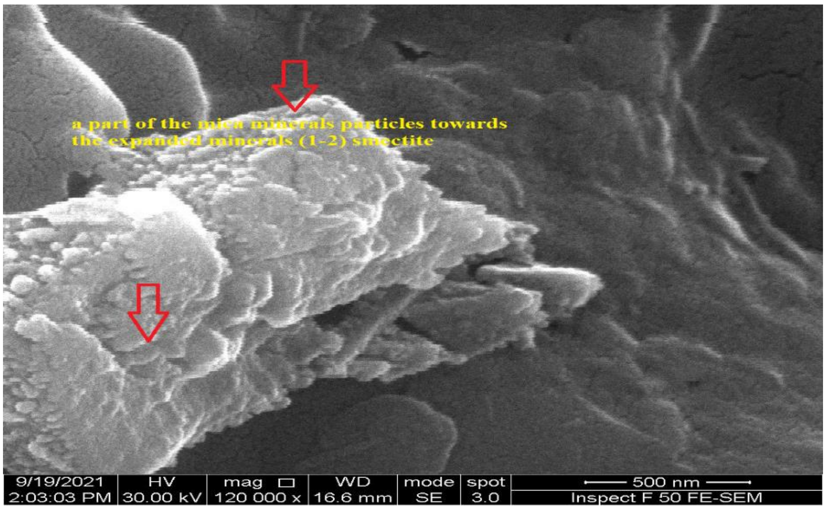

Fig. 2b. Shows the shift of a part of the mica particles towards the expanded minerals (1-2) smectite in soil samples of Halabja Site, Sulaymaniyah Governorate, Northern Iraq.

The results of general examination of the mica in Fig. 3a also exhibited that there were no sharp edges, but a shape of steps like, and some of them had irregular edges. Moreover, the apparent gradual shape of edges is the result of the Flaks Broken. It is most likely that these particles were subjected to physical- in conjunction with chemical-weathering. Mica is one of the minerals that is characterized by the fact that its flakes are thin and flexible, which are in the form of laminate layers arranged one above the other and when broken, its edges appear as irregular scattered steps (Jackson 1964; Scott & Smith 1967). In general, these results were identical to what was obtained by Al-Shaikhly (2000) who worked the relationship of the mica morphological features in potassium forms for soils of some areas of the Iraqi alluvial plain. The results of the examination in Figs. C and 3b showed a shift at the edges of the mica towards the expanded smectite minerals 1:2. The latter appeared in the form of a white cloud at those edges, transforming the mineral into an interstratified mineral (mica-smectite). These results were identical to what was obtained in the X-ray diffraction tests on the clay models of these soils, which exhibited the presence of the interstratified mineral (mica-smectite). In addition, the examination results in Fig. 3C illustrates the presence of Palygorskite, whose particles appeared in an elongated needle-like shape. This was confirmed by the results of X-Ray in the clay models of these soils.

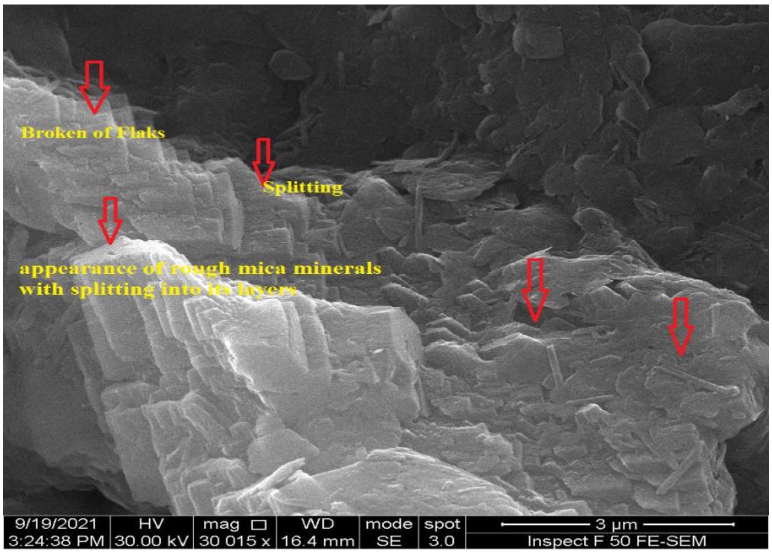

Fig. 3a. The appearance of rough mica with splitting into its layers and blunt edges in the form of steps in the clays of Al-Sharqat, Salah Al-Din Site, Western Iraq.

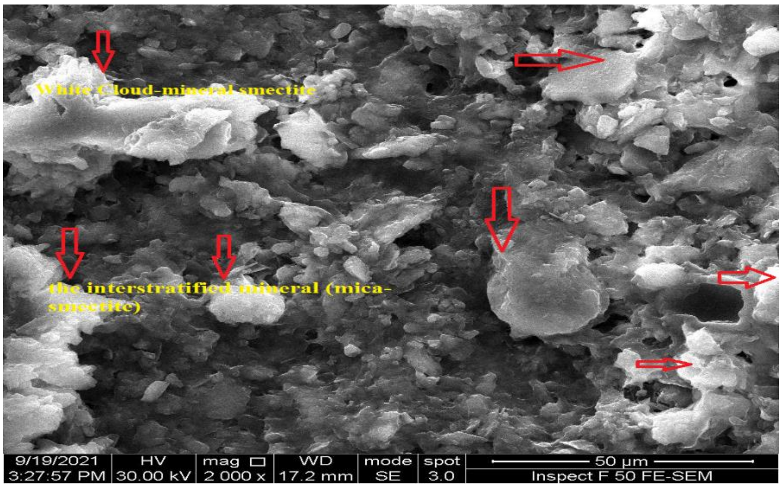

Fig. 3b. Exhibiting a shift at the edges of the mica towards the expanded smectite minerals 2:1 with the appearance of the interstratified mineral (mica-smectite) in the clays of the Shirqat site, Salah Al-Din, Western Iraq.

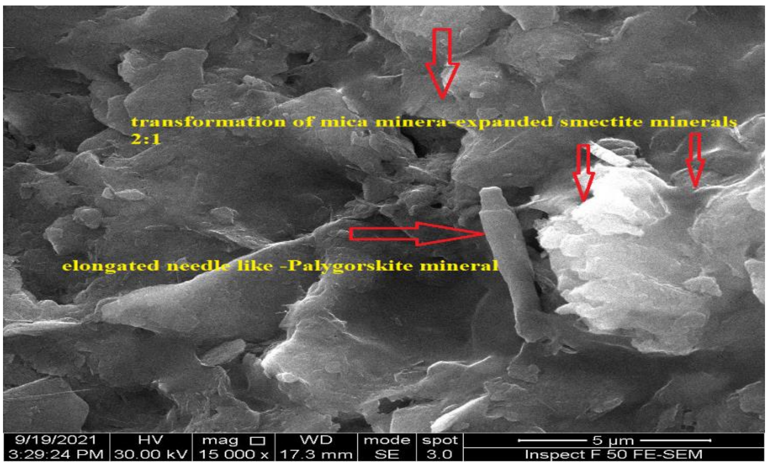

Fig. 3C. Displays the transformation of mica in the direction of the expanded smectite minerals 1:2 with the appearance of the Palygorskite in soil samples of Al-Sharqat Site, Salah aL-Din, Western Iraq.

Figs. 4a and b illustrates the presence of mica in the soil samples of the Tikrit-Salah al-Din Site, Western Iraq with unaffected surfaces or edges. Fig. 4a depicts the absence of cracks and no splitting or exfoliation of the layers, which indicates that the weathering of the mica layers does not exist. No differentiation was observed in the colour of the edge from the surfaces colour of these mineral particles, which reflects the absence of any edges weathering as well. Scott & Smith (1967) revealed that the mica particles contain cracks in their surfaces, in which the layer's weathering prevails, and the boundaries of their edges cannot be distinguished from the surface areas. These morphological features of mica minerals within the clay models examined Fig. 4a reflect the overall environmental conditions prevailing in the sampling areas, which affect mica. However, the decline in the annual rainfall in Tikrit was directly reflected in the reduction of weathering of these minerals and thus affected its morphological features. Fig. 4a also shows the presence of Palygorskite, whose particles appeared in an elongated needle-like shape, reflecting the suitability of the environmental conditions in those areas to be formed. Al-Obaidi (2008) reported that the availability of appropriate environmental conditions in the soil areas of Salah al-Din Governorate-western Iraq helps the formation and presence of Palygorskite as it is a gypsum soil in nature. Fig. 4b also illustrates the presence of chlorite, which appeared in the form of a pseudohexagonal, and montmorillonite in the form of white clouds, in addition to the presence of mica with a weathered edge. However, these minerals appeared in a limited way, reflecting the low weathering intensity in these areas, and perhaps it is limited to wind weathering only. Furthermore, these results were consistent with what was obtained during examining the Tikrit, Salah Al-Din soil models by X-Ray, since these results showed the presence of mica, chlorite, and smectite.

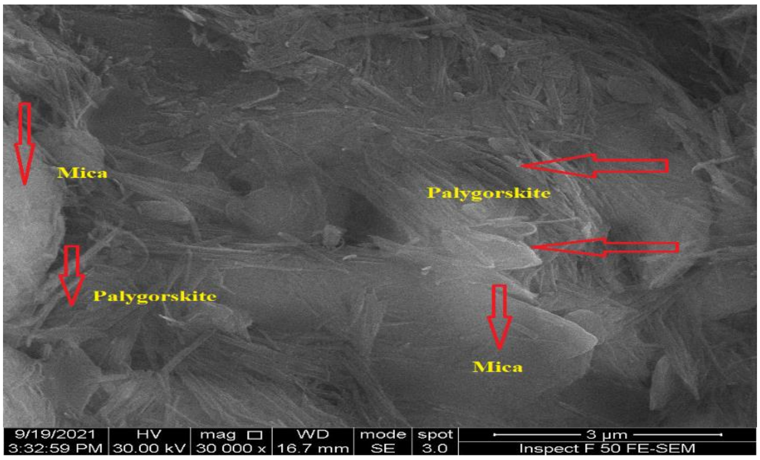

Fig. 4a. The Palygorskite and Mica in clay models, Tikrit, Salah Al-Din,Western Iraq.

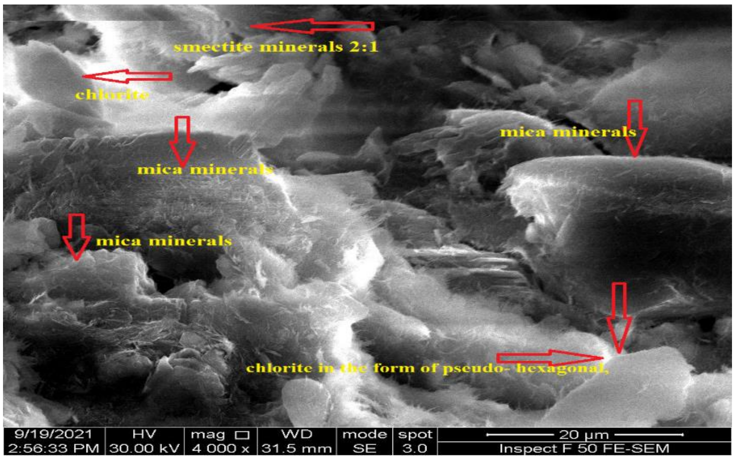

Fig. 4b. Exhibiting all of the mica, chlorite in the form of pseudo- hexagonal, and the smectite minerals 2:1 expanding in the form of white clouds in the soil clays of Tikrit, Salah al-Din Site, Western Iraq.

Figs. 5a and 5b captured from the soil samples of the Al-Suwaira Project Site, Wasit Governorate, Central Iraq showed the presence of mica, chlorite, and smectite, and the interstratified mineral (chlorite-smectite). Mica appeared in the form of unaffected surfaces and the edges of some of them are weathered (Fig. 5a) and may have been weathered by transport and deposition processes or at the source. In addition, the conditions of the sampling areas do not encourage the occurrence of weathering processes, since they are arid or semi-arid regions with little rainfall and high temperatures during summer or may be caused by wind weathering. However, Figs. 5a and 5b also depicted the presence of chlorite minerals, whose particles appeared in a pseudohexagonal shape, with the presence of smectite, which appeared in a white cloudy form, accompanied by the interstratified mineral (chlorite-smectite). These results were identical with the results of the X-ray diffraction tests for these clays, as they exhibited the presence of all these minerals. This is in agreement with the results of Al-Shammari (2020) on some soil samples obtained from Wasit and Maysan governorates. The mica appeared in different degrees of weathering intensity and transferred towards the expanded 2:1 smectite, along with the hexagonal-shaped chlorite with unaffected edges and also one of them was round.

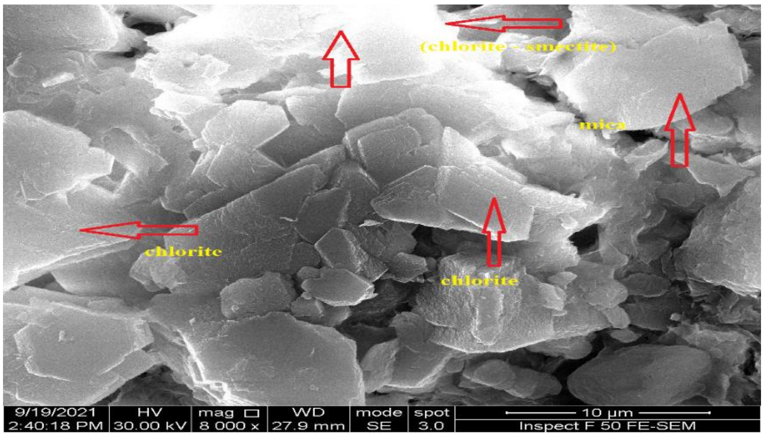

Fig. 5a. The mica with unaffected edges, chlorite in the form of pseudohexagonal, smectite and the interstratified mineral (chlorite - smectite) in soil clays of Al-Suwaira Project Site, Wasit Governorate, Central Iraq.

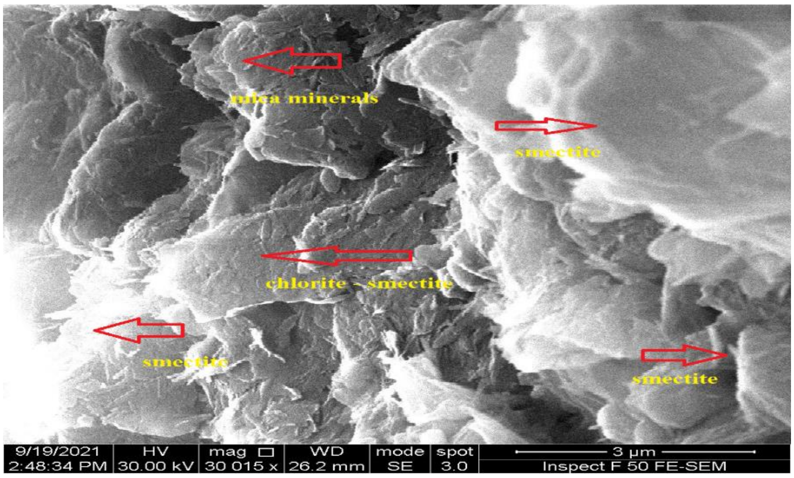

Fig. 5b. The shapes of mica and smectite in the form of a white cloud and the interstratified mineral (chlorite - smectite) in the soil clays of the Al-Suwaira Project Site, Wasit Governorate, Central Iraq.

Figs. 6a and 6b captured from the Hor Al-Jbayish soil model, Dhi Qar Governorate, Southern Iraq exhibited that a large part of the mineral surfaces was irregular, while the surfaces of mica contained "holes" of different sizes, and that some of the surfaces of these minerals appeared in a spongy form. All of these morphological features are a product of the weathering processes to which these minerals are exposed, whether water or wind at the source areas or during transport and sedimentation. The marsh areas are characterized by being wet environments with calm water currents, or they may have occurred as a result of the continuous processes of inundation and receding water that take place in the marsh areas. Therefore, it is difficult to determine which of these conditions were the ones that controlled the weathering processes of minerals in these areas. Since the morphological features of these minerals reflect both the physical weathering conditions (the appearance of the edges of the minerals sharply) and sometimes the chemical weathering conditions (some of the mineral edges are blurred). Also, the holes observed on the surfaces of mica can be caused by the presence of impurities from fossilized plant or animal remains during the synthesis of the mineral, which leaves a void after the process of its complete dissolution (Gilkers 1979), or it may be resulted from the impurity of the mineral with the presence of impurities from other minerals that differ in their geological age and the degree of their resistance to weathering (Eswaran *et al.* 1976). These results were consistent with those obtained by Al-Sheikhly (2000), since it was found that the surfaces of mica contained holes that differ in their sizes and are deep with edges along the vertical path through the mineral, while examining the relationship of the morphological features of mica in potassium images of some Iraqi alluvial plain soils. Fig. 6b depicts the presence of both chlorite and smectite, in addition to the presence of the interstratified mineral (chlorite - smectite).

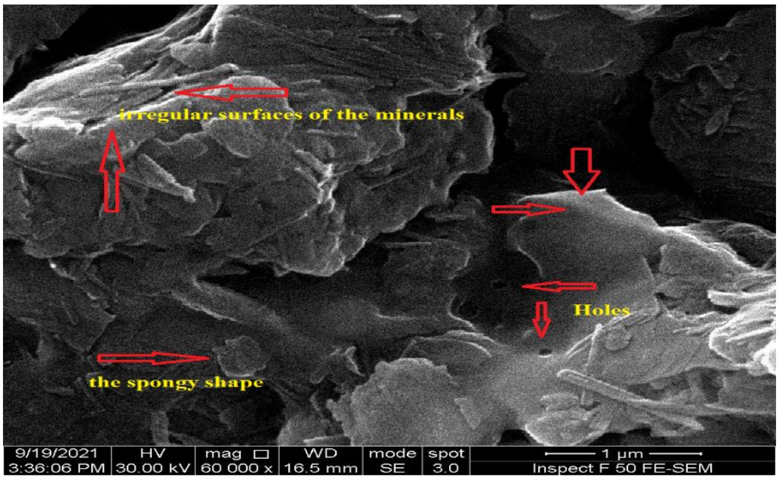

Fig. 6a. The appearance of holes of different sizes and deep in mica, as well as the irregular surfaces of the minerals and the spongy shape of the soil samples of Hor Al-Jbayish Site, Dhi Qar Governorate, southern Iraq.

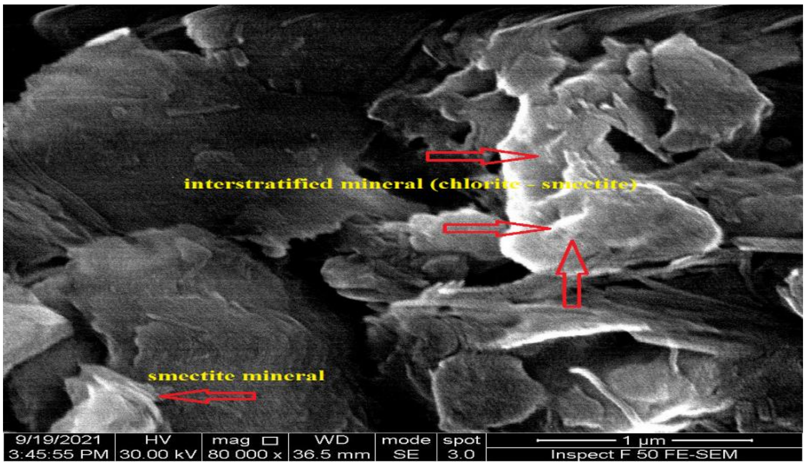

Fig. 6b. The interstratified mineral (chlorite - smectite) and smectite in the soil samples of Hor Al-Jbayish Site, Dhi Qar Governorate, Southern Iraq.

CONCLUSION

Through the results of the scanning electron microscope (SEM) examinations, a clear discrepancy was found in the morphological features of the mica and chlorite particles, and a part of the mica particles was transformed in some soils towards the expanded minerals 2:1. It is likely that smectite is similar to it in appearance and to varying degrees almost according to regions, as a result of its exposure to varying degrees of weathering intensity due to the different nature of climatic conditions and physiographic location. In addition, the presence of Palygorskite in the soils of Salah al-Din Governorate, Western Iraq reflects the suitability of environmental conditions for its formation in those areas being soils of a gypsum nature.

REFERENCES

Al-Sheikhly, RAL 2000. Relationship of the morphological features of mica minerals in potassium forms for some alluvial plain soils. MSc. Dissertation, College of Agriculture, University of Baghdad.

Abu -Shelbaya, MAD, Muhammad, AWS, Al-D, M, Al-Azim, MA & Husain MSM 2019 Land composition. Minia University, The Egyptian Arabic Republic.

Jaff, BO & Mohammed, A 2006, The nature of formation and presence of interstratified minerals and the factors affecting them in some Iraqi soils. PhD Dissertation, College of Agriculture, University of Baghdad, Iraq.

Al-Khafaji, QDI 2017, Study of the distribution of some microelements under different climatic conditions in selected soils from northern Iraq. *Kirkuk University Journal of Agricultural Sciences*, 9: 92-99.

Al-Shammari, AHD 2020, The effect of sedimentation sources on the content and properties of clay separated and mineral composition of some soils in Wasit and Maysan governorates. PhD Dissertation, Faculty of Agricultural Engineering Sciences, Department of Soil and Water Resources Sciences. Baghdad University, Iraq.

Al-Obaidi, BSO 2008, The nature of the presence of Palygorskite mineral in some Iraqi gypsum soils. PhD thesis. College of Agriculture. Baghdad University, Iraq.

Suleiman, HS, Omar AR & Kabba, R 2020, Study of the mineral composition of some soils of the Syrian island. The Arab Journal of Science and Research Publication. *Journal of Agricultural, Environmental and Veterinary Sciences*, 4(26-52): 807-818.

Khalil, EMI 2016, Fundamentals of Environmental Geology. College of Science. Zagazig University. The Egyptian Arabic Republic. Deposit number 11430.

Nassif, NS 2014, Changing the natural characteristics of the soil and groundwater of the landfill sites in the city of Baghdad. MSc. Dissertation, College of Education, Mustansiriya University, Iraq.

Day, PR 1965, Particle fractionation and particle-size analysis. In CA, Black *et al.* (eds.), Methods of soil analysis, Agronomy No. 9: 545-567. American Society of Agronomy, Madison, WI, USA.

Dixon, JB, Weed, SB, Kittrick, JA Milford, MH & White, JL 1977, Minerals in soil environments. Book. Published by Soil Science of America. Madison, Wisconsin, USA.

Eswaran, H, Rrich, PF Kimbie, JM, Beinroth, FA, Padmanabhan, E & Moncharoen, P 1976, Global carbon sinks, In: R, Lal, JM, Kimble, & BA Stewart (Eds.), Global climate change and pedogenic carbonates, CRC/Lewis Preww, Boca Ration, Florida, pp. 15-26.

Gilkers, RJ & Suddhiprakarn, A 1979, Biotite alteration in deeply weathering Granite: Morphological, mineralogical, and chemical properties. *Clays and Clay Minerals,* 27: 349-360.

Gjems, O 1967, Studies on clay minerals formation in soil profiles in Scandinavia. *Norke Skogfars Qksvesen,* 18: 305-315 (In Danish).

Islam, M, Stuart, R, Risto, A & Vesa, P 2002, Mineralogical changes during intense chemical weathering of sedimentary rocks in Bangladesh. *Journal of Asian Earth Sciences*, 20: 889-901.

Jackson, ML 1979, Soil chemical analysis. Advanced Course. 2nd Ed. Printed by the author, University of Wisconsin, Madison, Wisconsin.

Jackson, ML 1964, Chemical composition of soils. Inf. E-Bear (Ed.), Chemistry of the soil, Van No Strand Reinhold Co, New York, USA.

Muhammad, DAR 2007, The interaction between organic matter and smectite in some Iraqi soils of different agricultural land use. PhD Dissertation, College of Agriculture, University of Sulaimani, Iraq.

Richards, LA 1954, Diagnosis and improvement of saline and alkali soils. USDA Handbook No.60, Indian Edition, Prinlar for Oxford and IBH Publishing Co., New Delhi, India.

Scott, AD & Smith SJ 1967, Visible changes in marco mica particles that occur with potassium.

Weaver, CE 2013, Shale-slate metamorphism in southern Appalachians. Book, School of Geophysical Sciences. Georgia Institute of Technology, Atlanta, GA30332, USA.

Bibliographic information of this paper for citing:

Al Shamary, S, H, K, D.S. Al Maamouri, A, B, Hassan Dwenee, S, J 2022, Effects of climatic variation on weathering intensity for the mineral composition in some Iraqi soils. Caspian Journal of Environmental Sciences, 20: 991-1001.