Iraqi Journal of Agricultural Sciences –2026:57(4):1080-1092
P-ISSN: 0075- 0530 /E-ISSN: 2410-0862
DOI: https://doi.org/10.36103/fv07mx53

USING INFRARED SPECTROSCOPY IN CHARACTERIZATION OF CLAY MINERALS IN SOME IRAQI SOILS NORTH AND SOUTHE AL- HANDIA DAM

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ABSTRACT

Four soil pedons along the Euphrates river were chosen, two of them were north of Al-Handia Dam (Jurf Al-nasr and Um-Aruk), when the other two pedons (Al-Tubar village and Almishkhab) were chosen south of Dam, in order to study the impact of the location of Al-Handia Dam on the distribution and characteristics of clay minerals in Euphrates river sediments. Infrared technique has been used to diagnosis and characterized the clay minerals in studied soils. Results showed the dominance of chlorite, mica and kaolinite minerals within sediments of Euphrates river north of Al-Hindiyah Dam, while montmorillonite and (M-S) interstratified minerals were dominant south of Dam. Also, results showed that the dam construction has affected the process of sorting and deposition of sediment particles in the Euphrates river, depending on the sizes of these particles and their specific gravities.

Key words: **corrosion, river sediments, sedimentary cycle.**

Received: 12/7/2024, **Accepted:** 23/10/2024, **Published:** 30/4/2026

INTRODUCTION

There are three factors of human activities that can reduce sedimentation within rivers. The first is changes in land use land cover within the upstream that reduce the supply of sediments to the river channels by trapping and storing them in upstream dams and reservoirs (Wohl, 2015). The second of these activities is increase sediment transport within the river channel by increasing the water supply to the channel. The third set of activities breaks the connection of channels with floodplains. The presence of dams can affect the river ecosystems in many ways, such as alteration of the natural flow cycle, modification of physical and biological features of the river channel and floodplain, and fragmentation of the river's continuity. Particle sizes of the sediments are the one of most important and essential physical and mineralogical properties in sedimentology. It is widely used to quantify sediments size, mineralogical composition, and texture, in order to understand the geochemical properties and sediment transport and sorting dynamics (Kher et al., 2006). In addition, in a wide area of research in sedimentology, it is extensively used as an indicator of hydrodynamic conditions. These particles can influence the clarity of the water in the river in both flood and normal conditions (Ramasamy et al., 2004). The changes in the particle size distribution of fluvial sediments are affected by soil redistribution. Grain size is the fundamental characteristic of river sediment in the determination of bed-load transport, deposition, and suspended sediment prediction, as it provides some of the essential information regarding the fundamental properties of sediments, such as physical characteristics in managing the morphology of channel and stream hydraulics (Madejova, 2003). The erosion and transportation of clay, silt and sand particles which causes to the enrichment of sediments. These particles are contain various minerals, some of which are primary minerals, and some of which are

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secondary minerals (clay minerals), all of them are distributed among the particles of these sediments according to their sizes (Al-Khalidi and Uws.2015). Studying river sediments and knowing their layers and mineral components gives us an important guide and indicator in evaluating what sediments contribute to add mineral elements, whether beneficial or polluting to the soil (Leeder, 2006). The study of sediments and the sequence of their layers is important in determining their texture and mineral content, as they give clues and indicators that help to understand and evaluate the contribution of these sediments to the supply of those soils with minerals and useful elements, which improve the composition and fertile content of the soil, or it may be harmful through its contribution to adding pollutants (Al-Ali, 2010.). The current study aims to investigate the variation in mineralogical properties of clay particles in the sediments of the Euphrates river north and south of Al-Handia Dam, and to study how the location of the dam affects the process of sorting, distributing, and sedimentation of these minerals north and south of dam.

MATERAILS AND METHODS

For the purpose of studying the impact of the location of Al-Handia Dam on the distribution and characteristics of clay minerals in Euphrates river sediments, four soil pedons along the Euphrates river were chosen, two of them were north of the Dam (Jurf Al-nasr and Um-Aruk), when the other two pedons (Al-Tubar village and Almishkhab) were chosen south of Dam. Soil samples were collected from two depths (A and C) and air dried, crashed, and passed through the sieve of 2 mm openings. A bulk sample of the soil clay (< 2 µm) particle size fractions was separated by sedimentation and used for mineralogical studies. The infrared spectra were recorded by Shimadzu-IR Affinity -1 spectrometer equipped with DTGS KBr detector. For each sample, the scan was measured in the 4000-400 cm^{-1} spectral range in the transmission mode with a resolution of 4 cm^{-1}. The KBr pressed-disc technique was used for preparing a solid sample for routine scanning of the spectra. Samples of approximately 2 and 0.5 mg were dispersed in 200 mg of KBr to record optimal spectra, according to the method of (Madejová, and Komadel, 2001).

RESULTS AND DISCUSSIONS

Table 1 shows some chemical and physical properties of studied soils. Results indicated that the range of pH values was between (7.40 – 8.10), reflecting that the reaction of all pedons was around moderate alkali to nutral, due to effect of calcareous parent material of these soils. Also, results showed there was no specific pattern for pH values with depth in all studied pedons. Results of Electrical conductivity (EC) indicate that all studied soils were non-moderately saline, reflected by their values of EC (2.19 – 5.21 $dS.m^{-1}$). Results in Table 1 show that the amount of total $CaCO_3$ were ranged between (195.89 – 288.32 $g.kg^{-1}$). The high content of CaCO3 reflected a calcareous nature of studied soils. Results also, show that the amounts of total CaCO3 were increased in soil pedons, north of the Al-Handia Dam reflects the effect of the dam location on sorting and deposition of coarse particals of sediment transported by river. The values of cation exchange capacity (CEC) were ranged between (7.21 – 27.91 $Cmol.Kg^{1}$). In general, the results showed that the soils located in the north dam have a high values of CEC. These results suggest the effect of organic matter and clay content which both of them were deposited north of the dam were contributed to increases the CEC values of these soils. These results agree with (Al-Shimani, 2020), who studied the spatial variation of content and distribution of sediments minerals of Al- Gharraf river and found that both clay and organic matter were deposited in frount of the dam, and a high contribution of clay and organic matter in CEC of soil.

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Table 1. Some chemical properties of studied soils

Location	Horizon Depth - cm	pH	EC ds . m^{-1}	CEC Cmol C . kg^{-1}	T.$CaCO_3$ g . kg^{-1}
Jurf Al-nasr	0 – 30	7.90	3.74	27.91	288.32
	31 – 69	7.80	3.04	16.23	274.70
	70 +	7.70	3.27	18.05	272.09
Um-Aruk	0 – 48	8.10	5.21	15.28	258.22
	49 – 80	7.60	4.07	16.39	266.12
	81 +	7.70	4.24	16.01	201.18
Al-Tubar village	0 – 30	7.40	3.31	20.52	230.15
	31 – 58	7.90	3.57	21.16	198.77
	59 +	7.60	5.20	19.76	212.69
Almishkhab	0 - 33	7.70	2.53	9.89	247.18
	34 - 61	7.70	2.87	7.21	223.39
	62 - 90	7.50	2.19	10.02	195.89
	91 +	7.60	3.07	9.88	217.33

Infrared radiation diagnosis of clay fraction

Infrared technique has been used widely in mineralogical studies during infrared spectrum bands, to study and determine the type of clay minerals in soils. In the current study, we used (IR) technique as means of diagnosis the types of clay minerals, in addition to using it as confirmatory method for the results of mineralogical examinations obtained by X-ray method. In general the Figs (1-4) shows the correspondence of the absorption spectrum bands of (IR) inspections for clay fractions in all studied soils, with some difference in the values and intensity of bands, depending on the difference in the pedological conditions that surround each soil pedon, and the impact of transport, sorting, and sedimentation processes. which caused the difference in the type of internal cations within the interlayers of clay minerals. The diagnosis results in Fig (1a) is for clay sample from surface horizon (A) in Jurf Al-nasr soil pedon, show the presence of broad spectrum bands at 3741.65 cm^{-1} and 3614.35 cm^{-1}, and accompanied by the presence of a spectrum band at 651.89 cm^{-1}, which indicates the presence of chlorite mineral in this soil (Nayak and Singh, 2007). These results are in agreement with what (Al – Ftlawii, 2016) found through her study of some soils of Iraqi alluvial plain. while the appearance of band at 651.89 cm^{-1}, which is belong to the Mg_3 - $(OH)_6$ group indicated that the hydroxyl interlayer in Chlorite structure is Brucite layer (Trioctahedra) (Shahad, 2021). The results of diagnosis in Fig (1a) also, show the presence of spectrum bands at vibrations of 3614.35, 3417.63, 1027.99, 798.47, and 432.03 cm^{-1} which confirms existence of Mica minerals in clay fraction of surface horizon in Jurf Al-nasr pedon, while the variation of these bands in their intensity and values indicates the variety of the presence of Mica minerals in different stages of weathering in this soil (Al – Ftlawii, 2016). Also, the appearance of spectrum band at 432.03 cm^{-1}, confirmed to presence of trioctahedrail mica (Biotite) in this soil (Dixon et al., 1977). The results of diagnosis in Fig (1a) also, shows the appearance of spectrum bands at 3614.35, 817.76, 692.40, 522.67, 432.03 cm^{-1}. All these bands are confirm to presence (M-S) interstratified mineral in clay fraction of this horizon. One of the most prominent features of the interstratification state is the appearance of the shoulder at the left edge of the broad band at the range of 1110 cm^{-1}, which indicates a high percentage of smectite contribution (> 30%) in the structure of (M-S) interstratified mineral (Inoue, 1989). Also, Kaolinite has been diagnosed in clays of this horizon by appearance of spectrum bands at 3741.65, 1027.99, 777.26, 692.40, 522.67, 464.81, and 432.03 cm^{-1} Fig (1a) (Khang et al.,2026). The results of diagnosis in Fig (1b) were

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represented to the (C) horizon of Jurf Al-nasr soil pedon, were showed the appearance of spectrum bands at 3614.35, 3566.14, 3402.20, 655.75 cm^{-1} which confirm to presence chlorite mineral in clay fraction of this horizon, also, the Palygorskite has been diagnosed by appearance of spectrum bands at 3614. 35 cm^{-1} in clay fraction of this horizon Fig (1b), As Frost et al., 2001 pointed out, that the broad band at 3614.35 cm^{-1} considered one of the distinctive bands of Palygorskite. These results are consistent with findings of (Al – Ftlawii, 2016) during her study on some Iraqi soils. Also, Mica minerals can detected in the clay sample of (C) horizon at Jurf Al-nasr pedon Fig (1b), through the appearance of bands of structural hydroxyl groups at 3614.35 cm^{-1}, band of Si-O stretching at 1026.06 cm^{-1}, deformation bands of Al-O-Si in-plane vibration at 798.47 cm^{-1}, and deformation bands Al-O-Si, Si-O-Si, respectively at 437.81 cm^{-1} (Dixon et al., 1977). Kaolinite has been diagnosed in clay fraction of this horizon by appearance of spectrum bands at 3672.21, 1026.06, 779.19, 462.88, and 437.81 cm^{-1} (Khang et al., 2016). The diagnosis results in Fig (2a) is for clay sample from surface horizon (A) in Um-Aruk soil pedon north of Al-Hindiyah Dam shows the presence of broad spectrum bands at 3687.85 cm^{-1}, and accompanied by the presence of a spectrum band at 655.75 cm^{-1}, which indicates the presence of chlorite mineral in this soil (Nayak and Singh. 2007). while the appearance of band at 655.75 cm^{-1}, which is belong to the Mg_3 - $(OH)_6$ group indicated that the hydroxyl interlayer in Chlorite structure is Brucite layer (Trioctahedra) (Ramasamy et al., 2004). Mica minerals also, can detected in the clay sample of this horizon Fig (2a), through the appearance of bands at 3417.63, 1024.13, 798.47, and 437.81 cm^{-1}. Also, the appearance of spectrum band at 437.81 cm^{-1}, confirmed to presence the trioctahedral mica in clay fraction of that horizon (Dixon et al., 1977). Also, Palygorskite has been diagnosed in clays of this horizon by appearance of spectrum bands at 3618.21 cm^{-1} Fig (2a), As Frost etal.,2001 pointed out, that the broad band at 3614. 35 cm^{-1} considered one of the distinctive bands of Palygorskite. These results are consistent with findings of (Al – Ftlawii, 2016) during her study on some Iraqi soils. The diagnosis results in Fig (2b) is for clay sample from (C) horizon in Um-Aruk soil pedon north of Al-Hindiyah Dam shows the presence of spectrum bands at 3618.21, 3564.21, 522.67, 466.74 cm^{-1}, and accompanied by the presence of a spectrum band at 655.75 cm^{-1}, which indicates the presence of chlorite mineral in this soil (Nayak and Singh. 2007). while the appearance of band at 655.75 cm^{-1}, which is belong to the Mg_3 - (OH)6 group indicated that the hydroxyl interlayer in Chlorite structure is Brucite layer (Trioctahedra) (Shahad, 2021). Mica minerals also, can detected in the clay sample of this horizon Fig (2b), through the appearance of bands at 3618.21, 1027.99, 798.47, and 432.03 cm^{-1}. Also, the appearance of spectrum band at 432.03 cm^{-1}, confirmed to presence the trioctahedral mica in clay fraction of that horizon (Dixon et al., 1977). Also, Palygorskite has been diagnosed in clays of this horizon by appearance of spectrum bands at 3618.21 cm^{-1} Fig (2b), As (Frost, et al., 2001) pointed out, that the broad band at 3614. 35 cm^{-1}, considered one of the distinctive bands of Palygorskite. These results are consistent with findings of (Al-Ftlawii, 2016) during her study on some Iraqi soils. Also, Kaolinite was diagnosed in clay fraction of this horizon by appearance of spectrum bands at 1027.99, 779.19, 466.74, and 432.03 cm^{-1} (Khang et al., 2016.). According to IR diagnosis results in Figs (1 and 2), the following clay minerals were identified in order of abundance: chlorite, mica, and kaolinite in the sediments north of Al-Hindiyah Dam, it appears that the dam construction has affected the process of sorting and deposition of sediment particles in the Euphrates river, depending on the sizes of these particles and their specific gravities. The chlorite, mica, and kaolinite clay minerals are characterized by their high specific gravity (3, 3.2, and 2.68) respectively. This may be attributed to the predominance of these minerals in the coarse clay particles (Chen et al., 2020) that are usually deposited in front of dam. These results are consistent with what

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(Fonseca et al., 2009.) obtained during their study of the effect of dam construction on clay minerals sedimentation.

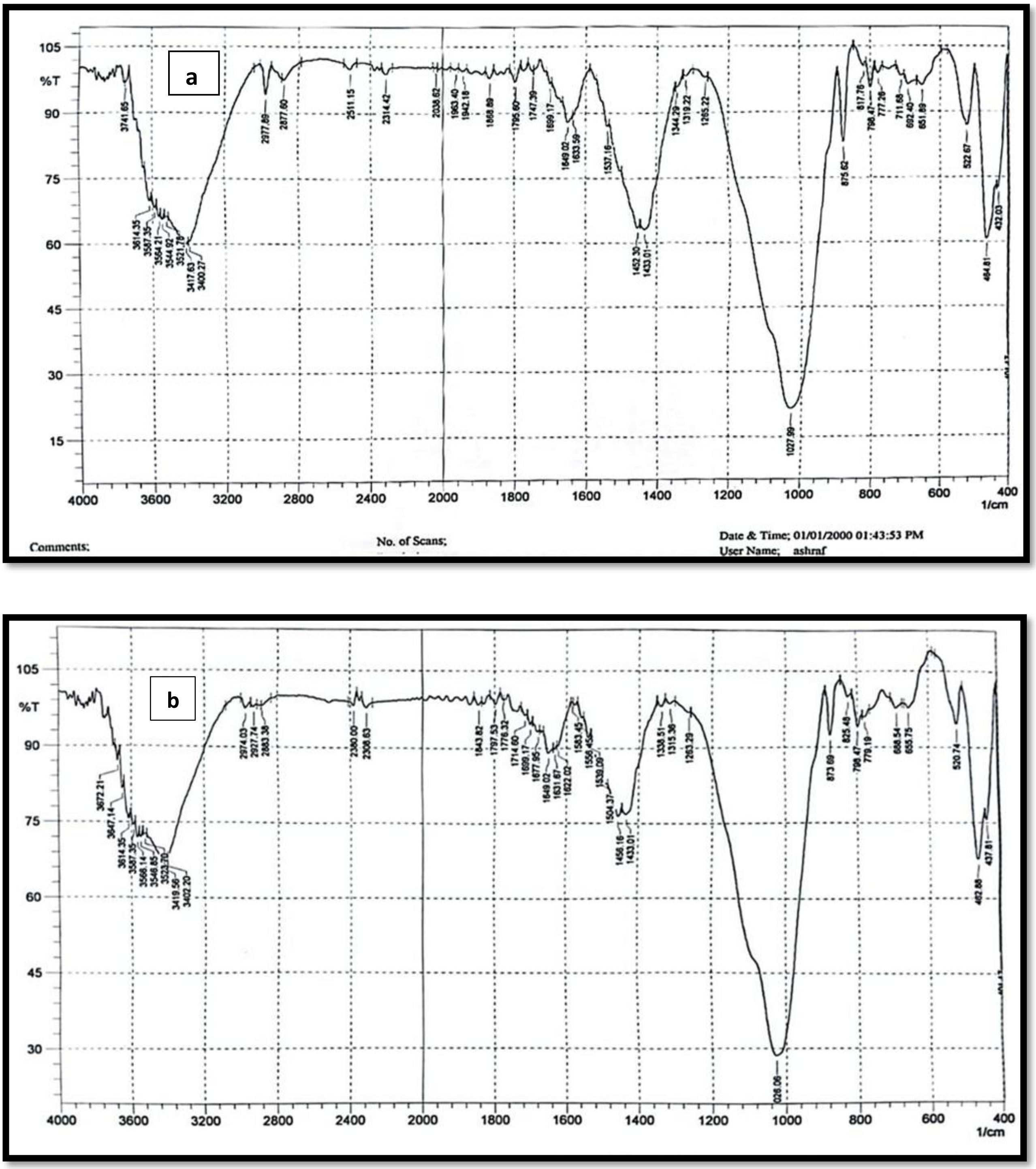

Fig. 1. Infrared absorption spectra of clay fraction at a. (A) horizon and b. (C) horizon of Jurf Al-nasr soil pedon

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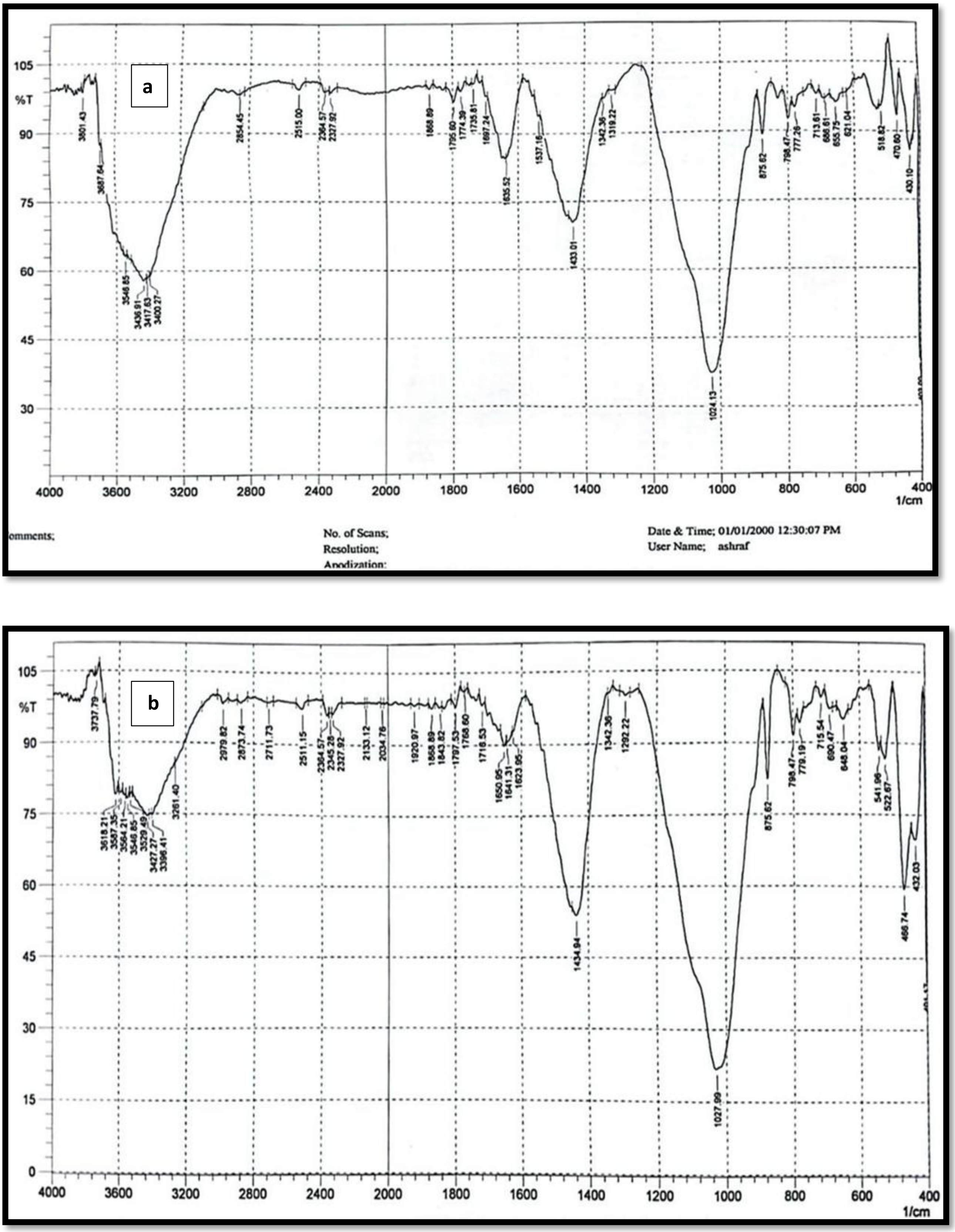

Fig. 2. Infrared absorption spectra of clay fraction at a. (A) horizon and b. (C) horizon of Um-Aruk soil pedon

The diagnosis results in Fig (3a) is for clay sample from surface horizon (A) in Al-Tubar village soil pedon, south of Dam show, that the band at around 3415.70 cm^{-1} is the stretching vibration of interlayer water molecule and at 1633.59 cm^{-1} is the bending

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vibration. While the band at around 1029.92 cm^{-1} is the stretching vibration of Si-O-Si, and the band at 466.74 cm^{-1} is the bending vibration of Si-O-Si. The weak band at 520.74 cm^{-1} is bending vibration of Si-O-Al, All these bands are confirm to presence Montmorillonite in clay fraction of this horizon (Li et al.,2014.). Also, Fig (3a) show the presence of broad spectrum bands at 3616.28, 3564.21, 520.74, and 466.74 cm^{-1}, which indicates the presence of chlorite mineral in this soil (Nayak and Singh 2007). These results also, are in agreement with what (Al – Ftlawii, 2016) found through her study of some soils of Iraqi alluvial plain. while the increase in the intensity of the frequency band 466.74 cm^{-1} compared to the intensity of the 520.74 cm^{-1} band confirms the presence of Mg_3 - $(OH)_6$ layer and indicated that the hydroxyl interlayer in Chlorite structure is Brucite (Trioctahedra) (Shahad, 2021). The results of diagnosis in Fig (3a) also, show the presence of spectrum bands at vibrations of 3616.28, 3415.70, 1020.92, 798.47, and 437.81 cm^{-1} which confirms existence of Mica minerals in clay fraction of surface horizon in Al-Tubar village pedon, while the variation of these bands in their intensity and values indicates the variety of the presence of Mica minerals in different stages of weathering in this soil (Al-Ftlawii, 2016). Also, the appearance of spectrum band at 437.81 cm^{-1}, confirmed to presence of trioctahedral mica (Biotite) in this soil. while, Kaolinite was diagnosed in clay fraction of this horizon by appearance of spectrum bands at 1029.92, 798.47, 466.74, and 437.81 cm^{-1} (Kher et al., 2006). The results of diagnosis in Fig (3a) also, shows the appearance of spectrum bands at 3616.28, 690.47, 520.74, and 437.81 cm^{-1}, which confirms the presence of (M-S) interstratified mineral in clay fraction of this horizon. One of the most prominent features of the interstratification state is the appearance of the shoulder at the left edge of the broad band at the range of 1029 - 1110 cm^{-1}, which indicates a high percentage of smectite contribution (> 30%) in the structure of (M-S) interstratified mineral (Inoue, 1989). The diagnosis results in Fig (3b) is for clay sample from (C) horizon in Al-Tubar village soil pedon, show, that the band at around 3419.56 cm^{-1} is the stretching vibration of interlayer water molecule and at 1633.59 cm^{-1} is the bending vibration. While the band at around 1031.85 cm^{-1} is the stretching vibration of Si-O-Si, and the band at 468.67 cm^{-1} is the bending vibration of Si-O-Si. The weak band at 522.67 cm^{-1} is bending vibration of Si-O-Al, All these bands are confirm to presence Montmorillonite in clay fraction of this horizon (Li et al.,2014). Also, Fig (3b) show the presence of broad spectrum bands at 3614.35, 3562.28, 522.67, and 468.67 cm^{-1}, which indicates the presence of chlorite mineral in this soil (Nayak and Singh 2007). These results also, are in agreement with what (Al – Ftlawii, 2016) found through her study of some soils of Iraqi alluvial plain. while the increase in the intensity of the frequency band 468.67 cm^{-1} compared to the intensity of the 522.67 cm^{-1} band confirms the presence of Mg_3 - $(OH)_6$ layer and indicated that the hydroxyl interlayer in Chlorite structure is Brucite (Trioctahedra) (Shahad, 2021). The results of diagnosis in Fig (3b) also, show the presence of spectrum bands at vibrations of 3614.35, 3419.56, 1031.85, 798.47, and 432.03 cm^{-1} which confirms existence of Mica minerals in clay fraction of (C) horizon in Al-Tubar village pedon, while the variation of these bands in their intensity and values indicates the variety of the presence of Mica minerals in different stages of weathering in this soil (Al-Ftlawii, 2016). Also, the appearance of spectrum band at 432.03 cm^{-1}, confirmed to presence of trioctahedral mica (Biotite) in this soil (Dixon et al., 1977). Also, Kaolinite was diagnosed in clay fraction of this horizon by appearance of spectrum bands at 1031.85, 798.47, 468.67, and 432.03 cm^{-1}, (Khang et al., 2016). The results of diagnosis in Fig (3b) also, shows the appearance of spectrum bands at 3614.35, 690.47, 522.67, and 432.03 cm^{-1}, which confirms the presence of (M-S) interstratified mineral in clay fraction of this horizon. One of the most prominent features of the interstratification state is the appearance of the shoulder at the left edge of the broad band at the range of 1031 - 1110 cm^{-1}, which indicates a high percentage of

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smectite contribution (>30%) in the structure of (M-S) interstratified mineral (Inoue, 1989). The diagnosis results in Fig (4a) is for clay sample from surface horizon (A) in Almishkhab soil pedon south Dam, show that the band at around 3429.20 cm^{-1} is the stretching vibration of interlayer water molecule and at 1645.17 cm^{-1} is the bending vibration. While the band at around 1029.92 cm^{-1} is the stretching vibration of Si-O-Si, and the band at 464.81 cm^{-1} is the bending vibration of Si-O-Si. The weak band at 518.82 cm^{-1} is bending vibration of Si-O-Al, All these bands are confirm to presence Montmorillonite in clay fraction of this horizon (Li et al., 2014). These results are in agreement with what (Al-Ftlawii, 2016) found through their study of some soils of Iraqi alluvial plain. The results of diagnosis in Fig (4a) also, show the presence of spectrum bands at vibrations of 3614.35, 3429.20, 1029.92, 798.47, and 441.87 cm^{-1} which confirms existence of Mica minerals in clay fraction of surface horizon in Jurf Al-nasr pedon, while the variation of these bands in their intensity and values indicates the variety of the presence of Mica minerals in different stages of weathering in this soil (Al-Ftlawii, 2016). Also, the appearance of spectrum band at 441.87 cm^{-1}, confirmed to presence of trioctahedral mica (Biotite) in this soil (Dixon et al., 1977). The results of diagnosis in Fig (4a) also, shows the appearance of spectrum bands at 3614.35, 688.54, 518.82, and 441.87 cm^{-1}, which confirms the presence of (M-S) interstratified mineral in clay fraction of this horizon. One of the most prominent features of the interstratification state is the appearance of the shoulder at the left edge of the broad band at the range of 1029 - 1110 cm^{-1}, which indicates a high percentage of smectite contribution (> 30%) in the structure of (M-S) interstratified mineral (Inoue, 1989). The diagnosis results in Fig (4b) is for clay sample from (C) horizon in Almishkhab soil pedon south Dam, show that the band at around 3431.13 cm^{-1} is the stretching vibration of interlayer water molecule and at 1616.24 cm^{-1} is the bending vibration. While the band at 464.81 cm^{-1} is the bending vibration of Si-O-Si. The weak band at 520.74 cm^{-1} is bending vibration of Si-O-Al, All these bands are confirm to presence Montmorillonite in clay fraction of this horizon (Madejová and Komadel.2001). These results are in agreement with what (Al-Ftlawii, 2016) found through her study of some soils of Iraqi alluvial plain. The results of diagnosis in Fig (4b) also, show the presence of spectrum bands at vibrations of 3649.07, 3431.13, 1041.49, 798.47, and 418.52 cm^{-1} which confirms existence of Mica minerals in clay fraction of this horizon, while the variation of these bands in their intensity and values indicates the variety of the presence of Mica minerals in different stages of weathering in this soil (Al-Ftlawii, 2016). Also, the appearance of spectrum band at 418.52 cm^{-1}, confirmed to presence of trioctahedral mica (Biotite) in this soil (Dixon et al., 1977). The results of diagnosis in Fig (4b) also, shows the appearance of spectrum bands at 3648.07, 688.54, 520.74, and 464.81 cm^{-1}, which confirms the presence of (M-S) interstratified mineral in clay fraction of this horizon (Inoue, 1989). Generally, the IR diagnosis results in Figs. (3 and 4), showed the following clay minerals were identified in order of abundance: montmorillonite, and (mica-smectite) interstratified mineral in the sediments south of Al-Hindiyah Dam, which reflect the extent of the effect of dam construction on the process of sorting and deposition of sediment particles in the Euphrates river, depending on the sizes of these particles and their specific gravities. The montmorillonite, and (mica-smectite) clay minerals are characterized by their low specific gravity (2.01 and 2.3) respectively (. Totten et al., 2002). This may be attributed to the predominance of these minerals in the fine clay particles (Al-Shimani, 2020) that are usually deposited behind of dam. These results are consistent with what (Fonseca et al., 2009.) obtained during their study of the effect of dam construction on clay minerals sedimentation.

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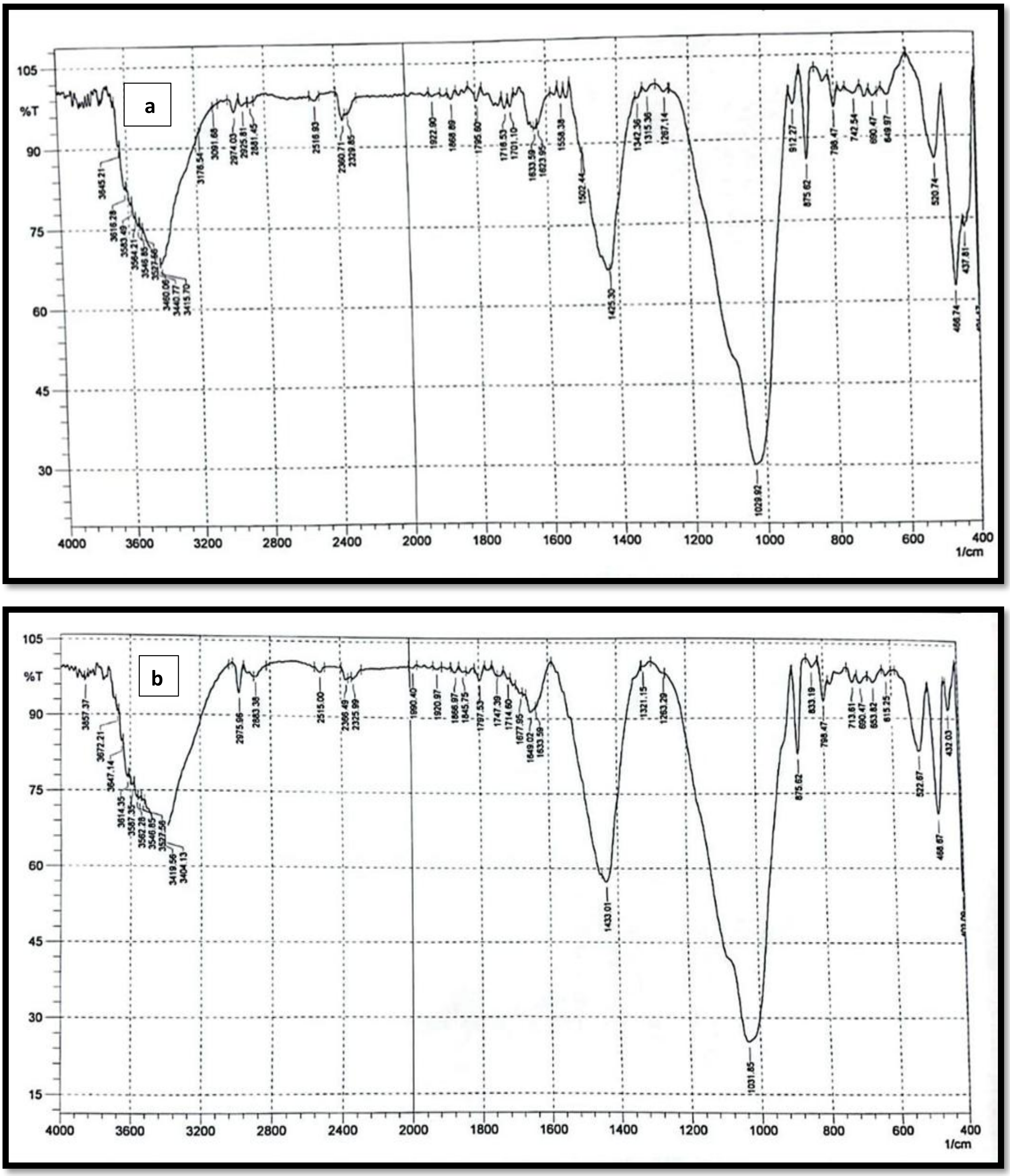

Fig. 3. Infrared absorption spectra of clay fraction at a. (A) horizon and b. (C) horizon of Al-Tubar village soil pedon

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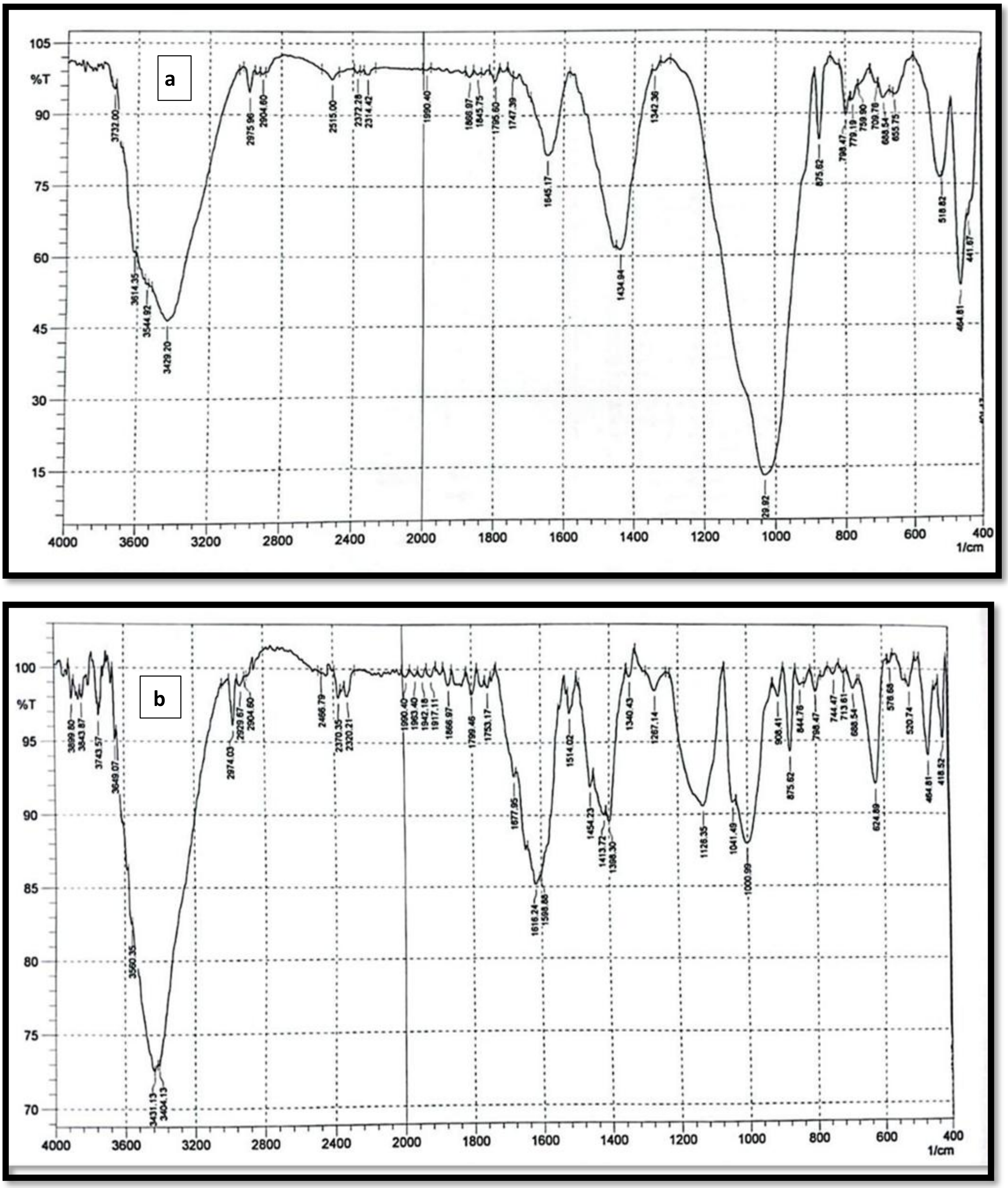

Fig. 4. Infrared absorption spectra of clay fraction at a. (A) horizon and b. (C) horizon of Almishkhab soil pedon

CONCLUSION

The study revealed a clear variation in clay mineral distribution along the Euphrates River, with chlorite, mica, and kaolinite dominating north of Al-Hindiyah Dam, while montmorillonite and mixed-layer minerals prevailed south of the dam. This indicates that the dam significantly influences sediment sorting and deposition processes based on particle size and density

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

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DECLARATION OF FUND

The authors declare that they have not received a fund.

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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Iraqi Journal of Agricultural Sciences –2026:57(4):1080-1092
P-ISSN: 0075- 0530 /E-ISSN: 2410-0862
DOI:

إستعمال الاشعة تحت الحمراء في توصيف المعادن الطينية في بعض الترب العراقية شمال وجنوب سدة الهندية

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المستخلص

أختيرت أربعة بيدونات لترب تقع على أمتداد نهر الفرات أثنان منها تقع شمال سدة الهندية متمثلة ببيدوني (جرف النصر و أم عروك) وأثنان جنوب سدة الهندية متمثلة ببيدوني (قرية الطبر والمشخاب) لدراسة تأثير موقع سدة الهندية في توزيع وخصائص المعادن الطينية. أستخدمت تقنية الاشعة تحت الحمراء في تشخيص المعادن الطينية في تلك الترب. بينت النتائج سيادة كل من معادن الكلورايت والمايكا والكاؤولينايت ضمن ترسبات نهر الفرات شمال سدة الهندية. في حين كانت السيادة لمعادن المونتمورلونايت والمعدن المستطبق (مايكا– سمكتايت) جنوب السد. ومثلما بينت النتائج فأن موقع السد قد أثر في عمليات الفرز والترسيب لدقائق ترسبات النهر إعتمادا على حجوم تلك الدقائق واوزانها النوعية.

الكلمات المفتاحية: الدورة الترسيبية، الحت، الترسبات النهرية.

*** جزء من اطروحة الدكتوراه للباحث الأول.**