Relationship of some soil characteristics with the content of alluvial soils of heavy metals

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Abstract

A field study was carried out in the year 2021 to find out the pedogenic distribution of some heavy metals in the soil extending from the left of the Euphrates River to the Great Mussiab project, which represents the sediments of the Euphrates River, within the coordinates of longitude (44°.19 and 44°.48 east) and latitudes (32°.35 and 32°.48 north), Thirty sites were selected covering the surface layer of the study area and revealed the locations as auger hole for a depth of 0-30 cm. The soil particles and some properties were analyzed, as well as the estimation of the available elements of manganese, zinc, copper, lead, nickel and cadmium. The results indicated that all sites were characterized by the predominance of sand particle in the nearby sites of river and the dominance of the clay particle in the locations far from the river with the heterogeneous distribution of calcium carbonate and the degree of soil pH, while the organic matter was positively correlated with the clay particle.The pedogenic distribution of Mn , Cu, Pb and Cd correlated positively with organic matter and negatively with $CaCO_3$, Zn, Pb , and Ni were positively associated with clay particle.

Keyword: Pedogenic distribution, Heavy Metals, Alluvial Soil, Tigris River

Introduction

The soil content of the elements depends mainly on the parent rocks from which that soil is derived. As the proportions of heavy elements vary depending on the mother rocks. The content of basal igneous rocks of heavy elements is richer than that of sedimentary rocks as well as depends on the degree of weathering of the rocks that make up them, and that the concentrations of heavy elements vary according to the type of soil and the geographical area, and the reason for this difference is the role of the origin material and climatic conditions in the region, and this affects positively or vice versa on the readiness of Micro-elements and transformation processes of these elements in soil Sumner (2000). Iraqi soils in general suffer from a high degree of soil reaction and its high content of calcium carbonate and low organic matter, all of which affects the readiness of nutrients already present in the soil, as it is exposed to a series of reactions such as adsorption, sedimentation and stabilization, which reduces the readiness of these elements for the plant when added (Al-Naimi, 2011)

Soil elements and their distribution pattern in the soil vertically and horizontally are essential in recognizing the pidogenic state of the soil and knowing the degree of its development and the prevailing processes, due to its wide relationship with environmental influences. The surfaces of carbonate minerals. It was noted (1977, Jenne) that there is a high affinity for heavy elements (Cd, Cu, Fe, Mn, Ni, pb, Zn) with carbonate minerals, as noted by

Singh (and others, 1988) that the greatest part of the small elements was Associated with calcium carbonate, calcareous soil.

Saleh and Khalil, 2013, pointed in the study of the effect of separating (clay and silt) and carbonate minerals on the biological distribution of manganese extracted by different methods and in three locations in Nineveh Governorate, manganese extracted by DTPA method showed a significant correlation with clay and silt in Al-Fadiliya and Al-Hamdaniya areas, despite the high amount of extracted manganese. By the snowy acetic acid method, the pyridogenic distribution was different from one area to another, and there was a significant relationship with (mud and silt) in the Qara Tabeh area only, while the manganese extracted by DCB method showed a significant correlation with the mud and silt in the Hamdaniya area, as for the effect of carbonate minerals on the distribution The piezoogenicity of manganese in the study soils was clear and significant in the Hamdaniya site only.

Salih and Khalil, 2018 indicated in their study of 40 sites of surface Iraqi soils that there is a positive and significant relationship between the soil content of clay, organic matter, the degree of interaction and the element manganese, and the correlation coefficient was (R = 0.869), while the correlation coefficient was with soil salinity, calcium, magnesium and chlorine. It is (R = 0.520), and a negative correlation with calcium carbonate amounted to (R = -690), and the values of the correlation coefficient varied according to the different method of extracting manganese, and these indicators were used in determining mathematical functions to predict the values of the element in alluvial soils.

In his study of three sites in northern Iraq, Al-Khafaji, 2018 found that there is a discrepancy in the soil content of the elements (Zr, Zn, Pb, Cu, Ni, and Co) and for four depths of the soil and attributed this to the difference in the index of the degree of weathering of those soils and the variation in their content of Fine separated (silt and clay), calcium carbonate and organic matter with different significant degrees and correlation coefficients.

Al-Ta’i and Al-Ta’i, 2018 studied the distribution of iron, manganese, zinc and copper in the developed and sedimentary soils from Iraq and the relationship of the pedogenic distribution and soil content of them with the distribution of calcium carbonate in the soil and they found that there is homogeneity in the distribution of iron with the depth of the soil (increasing the proportion of calcium carbonate), while the concentrations of calcium carbonate increased Manganese in the third depth of the studied soil models. As for the zinc and copper elements associated with the carbonate minerals, they did not show any homogeneous distribution with the depth of the soil.

Zubbar and Al-Rifai, 2019 found that the values of iron and total and ready manganese were affected by the type of sedimentary environment, and their values in desert soils were more than those in sedimentary soils. They also found that the movement of clay from surface horizons to deeper horizons affected its content of the two elements and in the total and ready forms The organic matter was also significantly associated with an increase in the soil iron and manganese content. The study aims to know the pedogenic distribution of some heavy soil metals and its relationship to some soil properties.

Materials and Methods

The study area is located in the province of Babylon and for the area extending from the left of the Euphrates River until the end of the Great Mussiab project and within the geographical coordinates between longitudes (44°.19 and 44°.48 east) and latitudes (32°.35 and 32°.48 north) (Fig. 1) and it is part of the sedimentation of the alluvial plain , which is known as the Iraqi alluvial plain (Abdul-Amir, 2016). 30 auger holes were selected representing the surface layer of the project, and using the GPS system with a UTM coordinate system, the location of the drilling was determined for the studied area, from which samples were extracted from the horizons and according to the Soil Survey Manual 1960, then the soil samples were dried, crushed and passed through a sieve with the diameter of its holes 2 mm for the purpose of measuring soil properties that represent some physical and chemical properties of soil, which included the volumetric distribution of soil particles by the method of density and soil interaction (pH) using a pH meter and electrical conductivity (ECe) in the extract of saturated soil paste using the Electrical Conductivity Bridge and the exchange capacity of positive ions (CEC)) using 1N ammonium acetate NH4OAc at (pH = 7.0) and soil content of calcium carbonate minerals ($CaCO_3$) using acid (HCl 1N) and scavenging of the remaining acid by NaOH (1N) and soil content of calcium sulfate minerals ($CaSO_4.2H_2O$) mediated by acetone precipitation and content Soil from organic matter (OM) by wet digestion method according to the methods mentioned in Jackson, 1958 and Black, 1965.

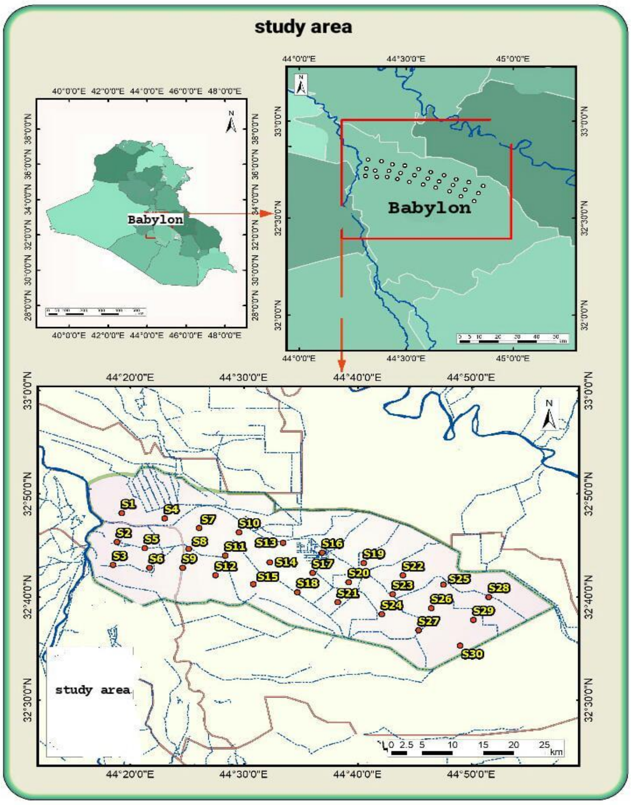

Fig.1 study area and soil sample location

Soil samples were digested with acid mixture ($HClO_4$: H_2SO_4: HF) (hydrofluoric: sulfuric: perchloric) respectively according to the method proposed by Jackson (1958) and described in Page (1982). The total content of cadmium, nickel, zinc, copper, lead and manganese in the digestion solution was estimated using the Atomic Absorption Spectrophotometer and according to the wavelength of each element.

Result and Discussion

1-Soil Characteristics

The results in Table 1 indicate that the content of sand particle ranged between 162.8 - 479.2 gm kg^{-1} and an average of 317.6 gm kg^{-1}, and the values of clay particle ranged between 149.3 - 445.1 gm kg^{-1} and an average of 280.9 gm kg^{-1}, while the silt content ranged from 321.5 - 462.1 gm kg^{-1} and an average of 401.5 gm kg^{-1} at a depth of 0 - 30 cm, the values of the pH ranged between 7.0 - 7.9 and an average of 7.4, and the electrical conductivity values ranged between 4.1 - 11.2 dsm^{-1} and an average of 7.1 dsm^{-1} The values of the soil exchange capacity ranged between 15.1-28.5 Cmole charge. kg^{-1} with an average charge of 21.6 Cmol. kg^{-1}, and the values of calcium carbonate in the soil ranged between 20.5-24.3%, with an average of 22.5%, the values of the gypsum content of the soil ranged between 0.06-0.14%, with an average of 0.08%, while the values of the soil organic matter content ranged between 0.56-1.36% and with an average 0.89%.

2-Heavy metals in soil

The results shown in Table 1 and Figure 2 show that the values of available manganese in the soil of the study area ranged between (0.413 - 1.985 mg kg^{-1}) in soil, with an average of (1.231 mg kg^{-1}). The Mn correlated positively with organic matter while correlated negatively with clay , calcium carbonate and soil pH.

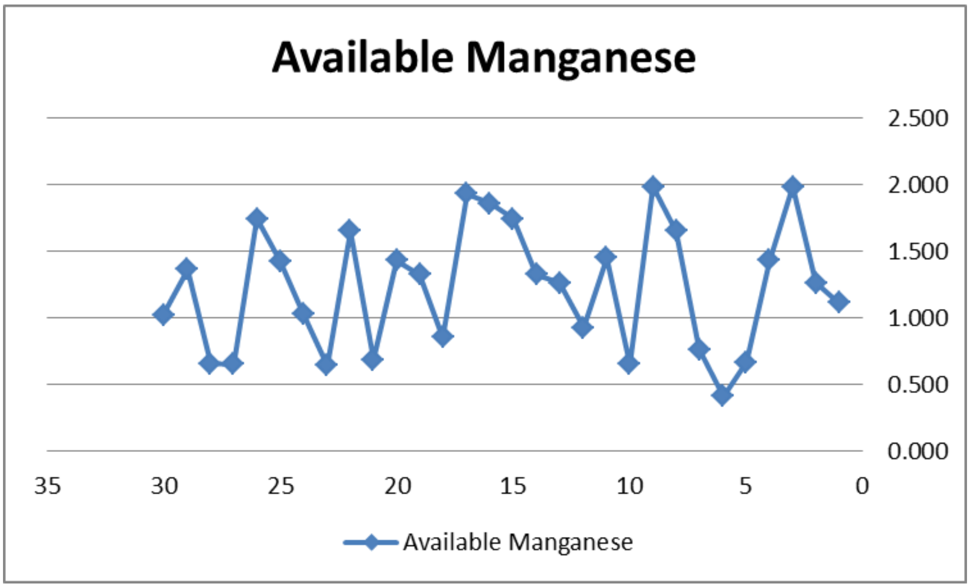

Fig. 2 available Mn in soil study area

The results shown in table 1 and Figure 3 show that the values of available Zinc in the soil of the study area ranged between (0.322 – 3.200 mg kg^{-1}) in soil, with an average of (1.848 mg kg^{-1}). The Zn correlated positively with clay particle and $CaCO_3$ while correlated negatively with organic matter and soil pH.

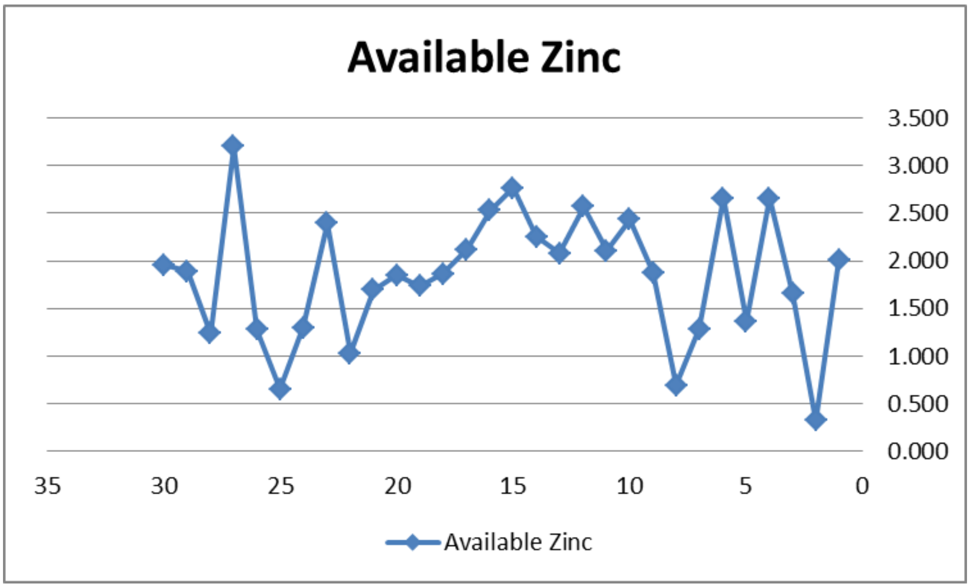

Fig. 3 available Zn in soil study area

The results shown in table1 and Figure 4 show that the values of available Copper in the soil of the study area ranged between (0.125 – 0.607 mg kg^{-1}) in soil, with an average of (0.330 mg kg^{-1}). The Cu correlated positively with organic matter while correlated negatively with clay , calcium carbonate and soil pH.

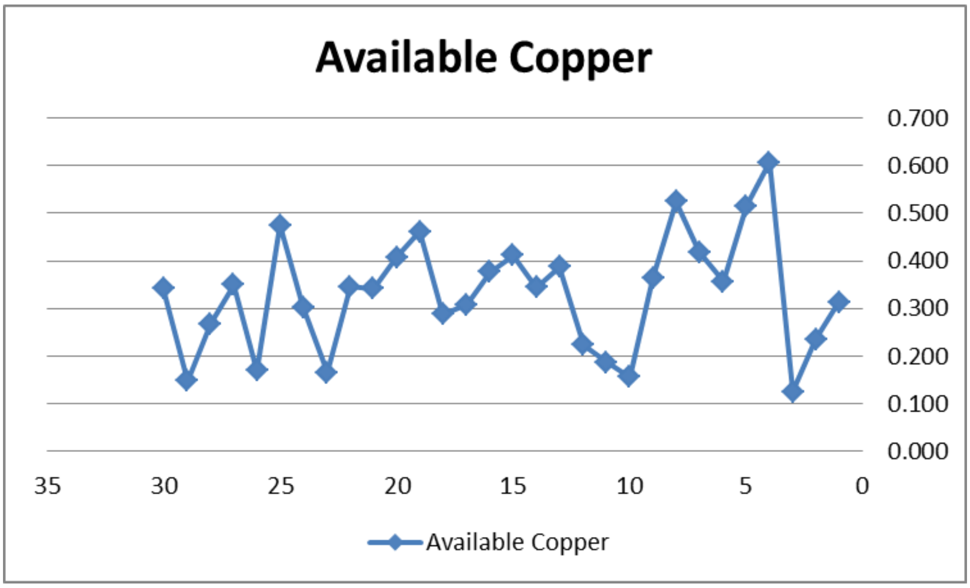

Fig. 4 available Cu in soil study area

The results shown in table1 and Figure 5 show that the values of available Lead in the soil of the study area ranged between (0.451 – 3.653 mg kg^{-1}) in soil, with an average of (2.501 mg kg^{-1}). The Pb correlated positively with organic matter , clay particle , and soil pH while correlated negatively $CaCO_3$.

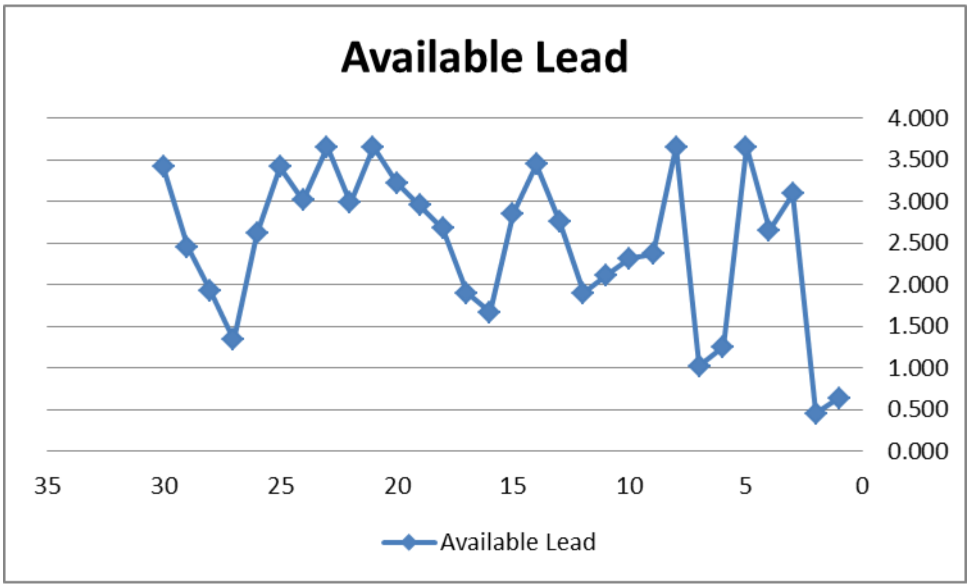

Fig. 5 available Pb in soil study area

The results shown in table1 and Figure 6 show that the values of available Nickle in the soil of the study area ranged between (0.069 – 0.621 mg kg^{-1}) in soil, with an average of (0.288 mg kg^{-1}). The Ni correlated positively with clay particle and $CaCO_3$ while correlated negatively with organic matter and soil pH.

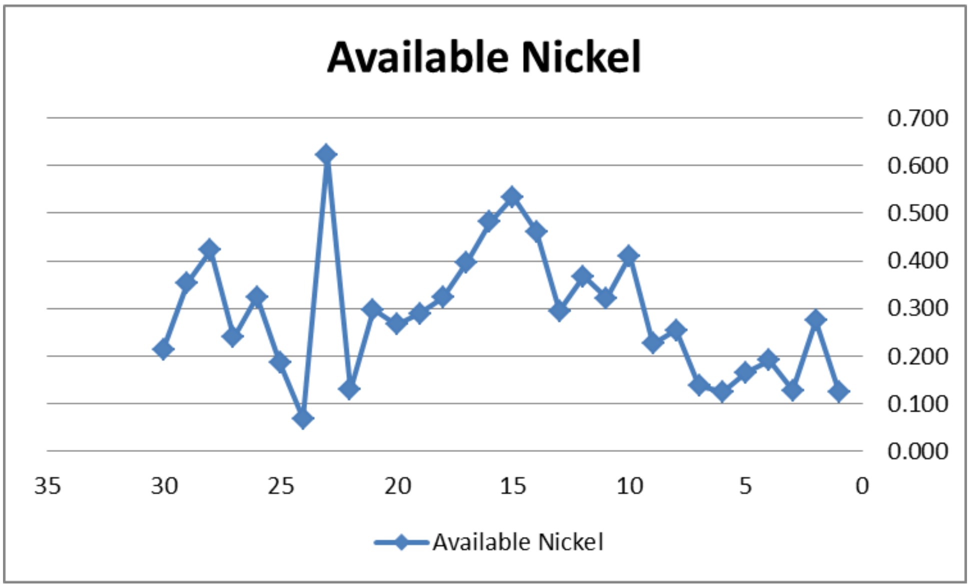

Fig. 6 available Ni in soil study area

The results shown in table1. and Figure 7 show that the values of available Cadmium in the soil of the study area ranged between (0.015 – 0.254 mg kg^{-1}) in soil, with an average of

(0.065 mg kg^{-1}). The Cd correlated positively with organic matter and soil pH while correlated negatively with clay and calcium carbonate.

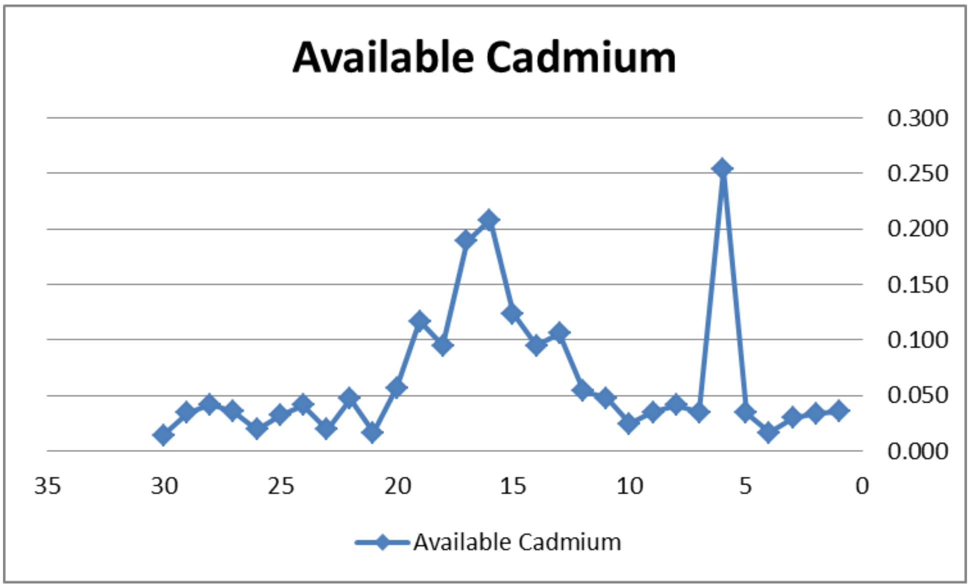

Fig. 7 available Cd in soil study area

Refrences

1. **Abdul Amir, Hamid Kazem** (2016). Biological analysis and statistical constants of the map of soil units in the Great Musayyib Project / Babil Governorate. Karbala Journal of Agricultural Sciences, 4(4): 203-217.
2. **Al-Khafaji, Qahtan Darwish Issa** 2018. A study of the distribution of some microelements under different climatic conditions in selected soils from northern Iraq. Kirkuk Journal of Agricultural Sciences, Volume (9), Number (3): 56-69.
3. **Al-Nuaimi, Saad Allah Najm Abdullah,** . 2011. Principles of Plant Nutrition, translated. Ministry of Higher Education and Scientific Research. University of Al Mosul .
4. **Al-Taie, Adel Mawloud Saleh and Ahmed Samir Ghanem Al-Taei**, 2018. Distribution of some microelements associated with calcium carbonate in some selected soil grades in Nineveh and Dohuk governorates. Mesopotamia Agriculture Journal, 46(2): 82-91.
5. **Black ,C.A.(ed.).** (1965) .Methods of soil analysis . Agron .Mono.9 , Part 2 . Amer .Soc. Agron ,Madison ,Wisconsin
6. **Jackson, M.L.** 1958. Soil Chemical Analysis. Prentice-Hall. INC. Englwood cliffs. N.Y.
7. **Jenne، E، A.، (1977).** Trace Element Sorption By Sediment And Soils-Sites And Processes،In Molybdenum In The Environment، Vol. 2، Chappell، W. R. and Petersen، K. K.، eds.،Marcel Dekker، New York، 555.
8. **Page , A.L. ; R.H . Miller and D.R. Keeney** . 1982. Methods of soil analysis . part 2 . 2nd ed . A S A Inc. Madison Wisconsin . U.S.A.
9. **Saleh, Adel Mahmoud and Muhammad Taher Saeed Khalil** (2013). The effect of separating (clay, silt) and carbonate minerals on the biological distribution of manganese extracted by different methods. Al-Rafidain Agriculture Journal, 41(1): 134-144.
10. **Saleh, Adel Mahmoud and Muhammad Taher Saeed Khalil** (2017). Using statistical approaches to study the combined effect of some chemical and physical properties of soils on the pedogenic distribution of manganese in some soils of Nineveh Governorate. Al-Rafidain Agriculture Journal, 45(4): 107-114.
11. **Singh, J.P., Karwasra, S.P.S.,M. Singh**, (1988). Distribution and forms of copper, iron, manganese, and zinc in calcareous soils of India. Soil Science. 146, 359–366.

12. **Soil Survey Staff, (1993)**. Soil Survey manual U.S.D.A.-SCS. Agric. Hand book 18. Washington , DC: U.S. Government printing Office.
13. **Sumner M.E. (ed).** (2000). Handbook of Soil Science ،Taylor and Francis ،Boca Raton ،FL
14. **Zabar, Omar Karim Obaid and Muthanna Khalil Ibrahim Al-Rifai**, 2019. Calculation of the crystallization index for iron and manganese under two different depositional environments. The Iraqi Journal of Desert Studies, 9(1): 50-56.

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