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STATUS OF CERTAIN MICRONUTRIENTS IN SOME WADIS SOILS OF ABU RUDEIS DISTRICT IN SOUTH SINAI, EGYPT

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ABSTRACT: Fifty one soil samples were collected from some wadis soil *i.e.*, (El Sheikh Soliman, Sidri, El-Arishia and Bodra) of Adu Rudeis district, which is lies between some mountain chains. These soil samples were collected to determined their physical and chemical properties and to assess their total and available contents of Fe, Mn, Zn and Cu in a fairly intanse sampling scheme. The results indicate that the texture class varies from sandy to sandy clay loam, The content of CaCO₃, organic matter, soil salinity and pH value varies from 12.4 to 579 g kg⁻¹, 6.7 to 30.2 g Kg⁻¹, 0.23 to 8.62 dSm⁻¹ and 7.6 to 9.3, respectively. The total Fe, Mn, Zn and Cu ranged from 1020 to 9000, 370 to 900, 190 to 500 and 90 to 280 mg kg⁻¹, respectively. Most wadis soils of Abu Rudeis district have their DTPA available Fe, Mn, Zn and Cu higher than the critical level *i.e.*, 4,1,1 and 0.2 mg kg⁻¹, respectively. The respective correlated coefficients, indicate that available Fe, Mn, Zn and Cu showed significant positively correlated with clay (%), (silt + clay)%, CaCO₃ content, pH and EC values and O.M content, except available conent of (Fe and Zn), (Mn), (Zn), (Mn) and (Fe and Zn) that showed significant negatively correlation with clay (%), CaCO₃, pH and O.M values, respectively.

Key words: Certain micronutrients, wadis soils, Abu Rudeis District, South Sinai .

INTRODUCTION

Generally, most desert soils are sandy in texture, poor in both organic matter and available nutrients content micronutrients have received increasing attention in recent years in Egypt. **Lindsay and Norvell (1978)** reported that plants requirement of microelements is very small, yet the yield and quality of many crops may by greatly improved by the application of some micronutrients if the available supply of soils is lower than critical levels. The range of these levels is a complex function of the specific nutrient, crop variety and an array of physical, chemical and mineralogical soil properties. **Viets and Lindsay (1973) and Lindsay and Norvell (1978)** developed the idea that the chemical forms of a given micronutrients are in dynamic equilibrium. As such, the active concentration of an element in the soil solution

is interrelated to other forms of the element, whether chemically sorbed on solid surfaces, or being a chemical constituent of these solids. On this basis, several soil testing procedures were developed, where by the available content of the micronutrient can be determined. **Hesterberg *et al.* (1993)** and **Willet and Bond (1995)**. Reported that more recently, environmentalists place some of these elements in the heavy metal list. Elements of this list pose on eminent hazard to man if present at high concentration in soils or water. In most cases, this high concentration is caused by widespread industrialization mining and addition of sludge without due consideration to environmental safety.

El-Falaky (1981) reported that the total Fe content of soils in the Nil Valley and Delta is about 5.8%, whereas soils of deserts contain about 1.3%. **Gaber (1979)** reported that the alluvial soils of Egypt contain at least twice as

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much total Mn compared with the sandy soils. The same trend was reported for Zn and Cu by **Kamk (1981) and Mohamed (1982)**.

Morgan (2013) and Chibuike and Obiore (2014) stated that contamination of soils by heavy metals, such as Cd, Ni, Zn, Pb and Cu has dramatically increased during the last few decades due to mining, smelting, manufacturing use of agricultural fertilizer and pesticides, municipal waste, traffic emission, and industrial effluents.

El Sawey (2008) studied the mineralogical content of Magharet El Maih sandstones west of Wadi, El Sahu in Um Bogma environs. He found that the main minerals are, atacamite, paraatacamite, mottramite, dravite, zircon, spessarinte, kaolinite, cassetrite, brass, graphite and native nickel. **Al-Sewailem *et al.* (2004)** investigated the distribution and accumulation of Fe, Mn, Zn and Cu throughout sandy soil columns amended with different rates of sewage sludge, they found that application of sludge enhances in the total amount of studied metals. **Salim *et al.*, (2002)** reported that total Fe, Mn, Zn and Cu in different Egyptian soils having various values that ranged from 1050 to 74400, 20 to 200, 5 to 74.9 and 5 to 84.4 mg kg⁻¹. **Tahoun *et al.* (1999)** stated that DTPA-extractable Fe, Mn, Zn and Cu in some soils of Abu Hammad ranged from 1.5 to 47.9, 1.3 to 51.6, 0.1 to 28.2 and 0.2 to 13.3 mg kg⁻¹, respectively. **Tolbah *et al.* (2002)** reported that the DTPA- extractable Fe, Mn, Zn and Cu in some of Egyptian soils ranged from 45 to 220, 3.5 to 85, 2 to 35 and 4 to 10 mg kg⁻¹, respectively. **Khalil *et al.* (2004)** found that the total Fe, Mn, Zn and Cu contents in soils of west El-Gidida region, El-Dakhla Oasis and the New Valley ranged from 2371 to 3531, 80.7 to 894, 1.5 to 132.3 and 1.2 to 38 mg kg⁻¹, respectively. Available Fe, Mn, Zn and Cu contents in the same soils ranged from 1.77 to 13.7, 0.62 to 53.8, 0.0 to 1.49 and 0.0 to 0.98 mg kg⁻¹, respectively.

The aim of this work is to study the spatial distribution pattern of total and available Fe, Mn, Zn and Cu in some wadis soils of Abu Rudeis district, South Sinai Governorate and to assess the abundance of micronutrients in terms of individual soil properties.

MATERIALS AND METHODS

The study area is located at the East of Abu Rudeis city on the coast of the Gulf of Suez, is referred to as South Sinai, Egypt (E,33° 11' 37") and (N,28° 55' 21").

Soil Sampling

Fifty one surface soil samples (0-40 cm) were collected from some wadis in Abu Rudeis district, which lies between mountain chains, South Sinai Governorate to implement this work (Figs. 1 and 2). The district was subdivided into four wadis (Fig. 2 and Table 1). The soil samples were air dried, crushed, passed through a 2.0 mm sieve and kept for subsequent analysis.

Soil Analysis

The Particle size distribution of the samples was carried out using the international pipette method (**Piper, 1950**). Organic matter content was determined by the Walkely-Black procedure as given by **Piper (1950)**. Calcium carbonate was determined by using the Collins calcimeter (**Jackson, 1958**). The pH values (1:2.5 suspension) and electrical conductivity of the saturated extract were determined using a pH meter and a conductivity salt bridge, respectively, as described by **Jackson (1958)**. The total Fe, Mn, Zn, and Cu were determined after fusion with mixture of concentrated HNO₃, HClO₄, and H₂SO₄ as given by **Hesse (1971)**. The available content of these micronutrients was extracted using 5x 10⁻³ N DTPA in 10⁻² M CaCl₂ and 10⁻¹ M triethanol amine (TEA) at pH 7.3, according to **Lindsay and Norvell (1978)**. In all cases, the elements were determined using an atomic absorption spectrometer.

RESULTS AND DISCUSSION

General Soil Properties

Table 1 shows the results of some selected physical and chemical analyses of the selected soil samples taken from the different wadis of Abu Rudeis district.

Soil texture

The soils vary in textural class between sandy clay loam and sandy loam.

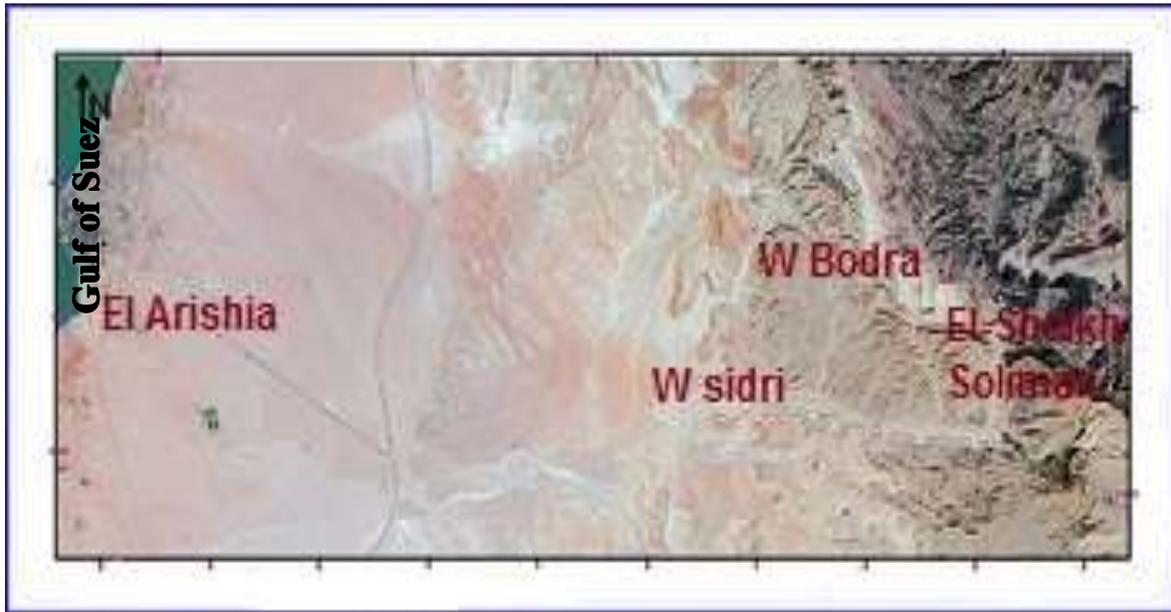


Fig. 1. Google map of the study area

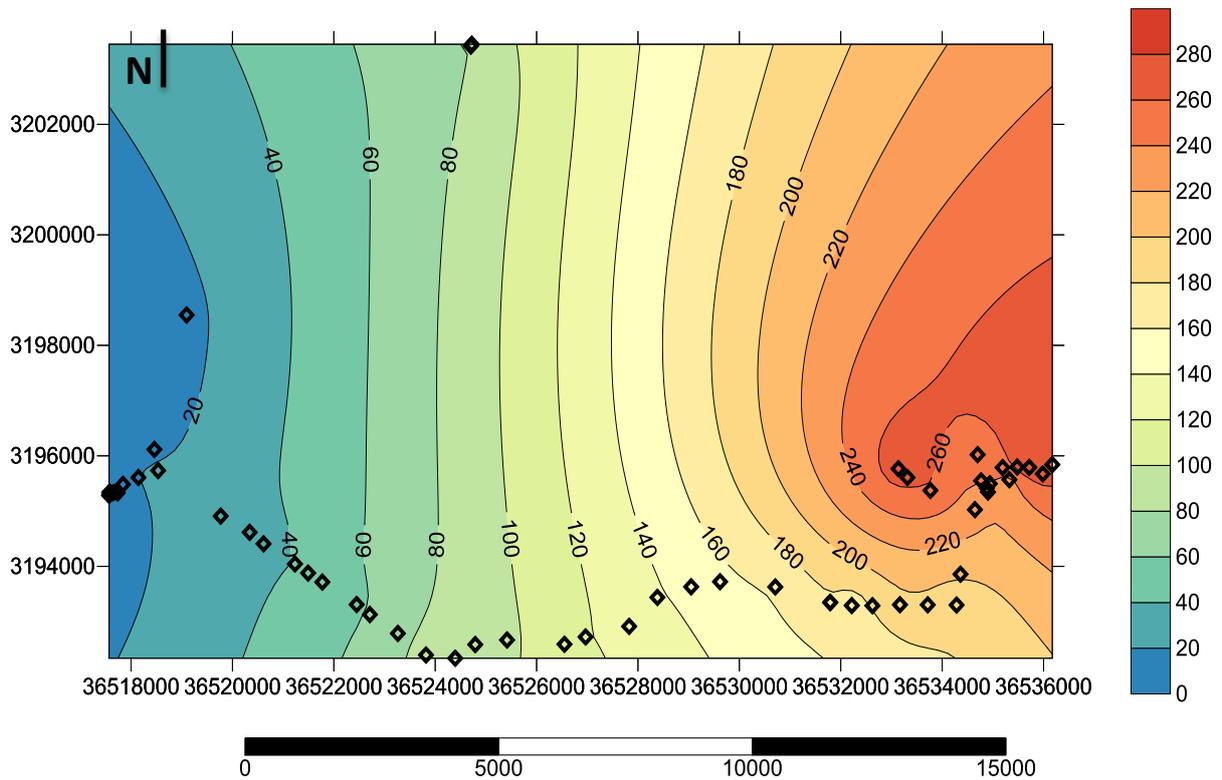


Fig. 2. Topographic contour map showing the distribution of the selected samples in the area of study

Table 1. Some Physical and Chemical properties of the investigated soils

Location	Sample No.	Particle size distribution, %			Textural class	CaCO ₃ , g kg ⁻¹	pH* 1:2.5	EC,** dSm ⁻¹	O.M, g kg ⁻¹
		Sand	Silt	Clay					
Wadi ElSheikh Soliman	1	76	8	16	Sandy loam	33	8.4	0.6.6	6.7
	2	82	6	12	Loam sandy	49.6	8.4	0.530	6.7
	3	80	8	12	Loam sandy	53.7	7.8	0.595	6.7
	4	82	8	10	Loma sandy	53.7	8.0	0.600	26.8
	5	78	6	16	Sandy loam	62	8.4	0.524	6.7
	6	82	8	10	Loam sandy	41.3	8.5	0.390	6.7
	7	78	8	14	Sandy loam	70.3	8.6	0.330	13.4
	8	76	10	14	Sandy loam	74.4	8.5	0.440	20.0
	9	80	6	14	Loam sandy	70.3	8.6	0.304	13.4
	10	84	6	10	Loam sandy	57.9	8.7	0.304	23.5
	11	53	12	30	Sandy clay loam	119	8.6	0.703	20.0
	12	74	6	20	Sandy loam	49.6	8.6	0.250	23.5
	13	60	14	26	Sandy clay loam	45.5	8.7	2.298	23.5
	14	72	6	22	Sandy clay loam	53.7	8.6	0.308	26.8
	15	74	6	20	Sandy loam	66.1	8.7	0.233	26.8
	16	74	6	20	Sandy loam	82.7	8.5	0.615	23.5
	17	60	16	24	Sandy clay loam	53.7	8.5	0.398	30.2
	18	72	8	20	Sandy clay loam	186	8.2	0.888	26.8
	19	70	6	24	Sandy clay loam	111	8.5	0.509	30.2
Wadi Sidri	20	68	8	24	Sandy clay loam	57.9	8.4	0.466	30.2
	21	62	14	24	Sandy clay loam	49.6	8.7	0.270	26.8
	22	72	8	20	Sandy loam	82.7	8.7	0.278	26.8
	23	68	10	22	Sandy clay loam	78.5	8.8	0.316	23.5
	24	62	10	20	Sandy loam	99.2	8.7	0.314	26.3
	25	72	12	16	Sandy loam	99.2	8.6	0.377	30.2
	26	74	8	18	Sandy loam	103	8.8	0.322	6.7
	27	68	12	20	Sandy loam	107	8.6	0.350	6.7
	28	66	12	22	Sandy clay loam	128	8.3	1.210	6.7
	29	68	8	24	Sandy clay loam	148	8.5	1.620	20.0
	30	70	10	20	Sandy clay loam	103	8.4	0.900	13.4

*Soil suspension 1:2.5 **Soil water paste

Table 1. Cont.

Location	Sample No.	Particle size distribution, %			Textural class	CaCO ₃ , g kg ⁻¹	pH* 1:2.5	EC,** dSm ⁻¹	O.M, g kg ⁻¹
		Sand	Silt	Clay					
Wadi EL-Arishia	31	78	8	14	Sandy loam	126	8.4	2.66	20.0
	32	76	10	14	Sandy loam	128	8.4	0.92	28.5
	33	70	12	18	Sandy loam	115	8.6	0.56	28.5
	34	74	8	18	Sandy loam	186	8.1	3.08	28.5
	35	76	8	16	Sandy loam	144	8.5	0.73	26.5
	36	76	10	18	Sandy loam	95.1	8.3	4.25	23.5
	37	68	12	20	Sandy loam	140	8.2	2.22	20.0
	38	70	10	20	Sandy loam	103	8.2	2.97	6.7
	39	76	10	14	Sandy loam	91.0	8.3	3.62	23.5
	40	68	14	18	Sandy loam	103	8.9	6.19	20.0
	41	74	10	16	Sandy loam	115	8.0	4.89	23.5
	42	76	10	14	Sandy loam	397	8.3	3.64	26.8
	43	74	8	18	Sandy loam	570	8.4	5.40	30.2
	44	80	8	12	Sandy loam	579	8.3	5.24	26.8
	45	72	10	18	Sandy loam	512	8.5	4.72	26.8
	46	68	12	20	Sandy loam	479	8.4	6.60	23.5
	47	70	12	18	Sandy loam	554	8.6	8.62	23.5
	48	74	10	16	Sandy loam	49.6	9.0	0.756	20.0
Wadi Bodra	49	78	8	14	Sandy loam	16.5	8.8	0.438	20.0
	50	776	10	14	Sandy loam	12.4	8.4	0.430	23.5
	51	72	12	16	Sandy loam	12.4	9.3	0.404	20.0

*Soil suspension 1:2.5 **Soil water paste

CaCO₃ content

The calcium carbonate content of these soils plays a great role in their formation and consequently in their physicochemical characteristics. The total CaCO₃ content ranges between 33.0 and 119.0 g kg⁻¹ in Wadi El Sheikh Soliman, 45.5 and 186.0 g kg⁻¹ in Wadi Sidri, 91.0 and 579.0 g kg⁻¹ in Wadi El-Arishia and 12.4 and 49.6 (g kg⁻¹) in Wadi Bodra. The greatest CaCO₃ content was found in Wadi El-

Arishia due to near this Wadi area from Suez the Gulf, while the lowest one was found in Wadi Bodra.

Soil pH

The studied soils are generally weakly to strongly alkaline in reaction, as indicated by their pH values which varied between 7.8 to 8.7 in Wadi El-Sheikh Soliman, 8.2 to 8.8 in Wadi Sidri, 8.1 to 8.9 in Wadi El-Arishia and 7.6 to 9.3 in Wadi Bodra.

Soil salinity

The most soils under study are non-saline to extremely saline, as indicated by ECe values which range from 0.30 to 0.70 dSm⁻¹ in Wadi El Sheikh Soliman Soils, 0.23 to 1.62 dSm⁻¹ in Wadi Sidri soils, 0.56 to 8.26 dSm⁻¹ in Wadi El-Arishia Soils, and from 0.40 to 0.75 dSm⁻¹ in Wadi Bodra soils, while some soils in Wadi El-Arishia are saline (from 4.25 to 8.62 dSm⁻¹) and some other are non-saline (from 0.56 to 3.64 dSm⁻¹)

Organic Matter Content

Organic matter content ranges from 6.70 to 26.8 g kg⁻¹ in Wadi El-Sheikh Soliman Soils, 6.7 to 30.2 g kg⁻¹ in Wadi Sidri Soils, 6.7 to 30.2 g kg⁻¹ in Wadi El-Arishia soils and from 20.0 to 23.5 g kg⁻¹ in Wadi Bodra soils.

Micronutrients Status

Table 2 gives the total and DTPA available Fe, Mn, Zn and Cu contents in soils of Abu-Rudeis district. The recorded micronutrient can be discussed do following:

Iron

The values of total Fe ranged from 1020 to 9000 mg kg⁻¹ in soil of Abu-Rudeis district. The total soil Fe was ranged from 1020 to 2320 mg kg⁻¹ with an average of 1628 mg kg⁻¹ in Wadi El-Sheikh Soliman, from 1050 to 8000 mg kg⁻¹ with an average 1795 mg kg⁻¹ in Wadi Sidri, from 1120 to 5500 mg kg⁻¹ with an average of 2087 mg kg⁻¹ in Wadi El-Araishia and from 2900 to 9000 mg kg⁻¹ with an average 4777 mg kg⁻¹ in Wadi Bodra. The average of total soil Fe can be arranged for the different wadis in the following descending order: Wadi Bodra > Wadi El-Araishia > Wadi Sidri > Wadi El-Sheikh Soliman. This feruling may be due to dredged sediment disposal by torrents from mountains to plains of these wadis.

Table 2 and Fig. 3 show the DTPA extractable Fe values in the soils of Abu-Rudeis district that range from 4 to 25 mg kg⁻¹ with an average of 10.5 mg kg⁻¹. Based on the average values for each soils of Abu-Rudeis district, Fig. 3 was constructed to show the Fe adequate limits (4-8 mg Kg⁻¹) as defined by **Viets and Lindsay (1973) and El-Gala *et al.* (1986)**. These authors reported that the critical level of available-Fe as determined by the DTPA method is about 4 mg kg⁻¹. Soils containing available Fe below this

level would not be able to provide growing plants with their nutritional requirement. The soils of Wadi El-Sheikh Soliman contain an adequate available Fe level in the range of 4-8 mg kg⁻¹. The soils of Wadis Sidri and El-Araishia contain adequate abundant and an excessive available Fe amount in the ranges of 4-8 mg kg⁻¹ and 8-16 mg kg⁻¹, and level >16 mg Kg⁻¹ respectively while the soils of Wadi Bodra contain abundant and an excessive available Fe level in the range of 8-16 mg kg⁻¹ and Fe level higher than 16 mg kg⁻¹, respectively.

Fig. 3 shows that the studied soil samples are divided into three divisions, that are adequate, abundant and an excessive available Fe content. Adequate division is represented by soil samples from 1 to 43, except certain soil samples abundant one is represented by soil samples (16, 34, 38, 41, 47,49 ,50) and 51 while an excessive one is represented by soil samples (26, 44, 45, 46 and 48). Therefore, the studied soils belong to 74.5%, 15.7 and 9.8% adequate, abundant and an excessive, respectively.

The respective correlation coefficients (r) between chemically extractable Fe and some soil variables; Table 3 shows that chemically extractable Fe significant and negatively correlated with clay% (r = -0.02) and OM mg kg⁻¹ (r = -0.01), but significant positively correlated with silt + clay% (r = - 0.02), CaCO₃ mg kg⁻¹ (r = 0.34), pH (r = 0.23) Ec dSm⁻¹ (r = 0.03) in the studied soils.

Manganese

Table 2 shows that the total Mn content of soils in Abu Rudeis district ranges between 370-900 mg kg⁻¹. It should be pointed out that these values are much lower than the comparable values for Fe. Similar findings were reported by **Mohamed (1982) and Tahoun (1999)**. The total soil Mn was ranged from 650 to 900 mg kg⁻¹ with an average 755 mg kg⁻¹ in Wadi El-Sheikh Soliman while it ranges, from 400 to 820 mg kg⁻¹ with an average 650 mg kg⁻¹ in Wadi Sidri; Mn ranges from 370 to 800 mg kg⁻¹ with an average 576 mg kg⁻¹ in Wadi El-Araishia and from 500 to 760 mg kg⁻¹ with an average 585 mg kg⁻¹ in Wadi Bodra. An average of total soil Mn can be arranged for the different Wadis in the following descending order: Wadi El-Sheikh Soliman > Wadi Sidri > Wadi Bodra > Wadi El-Araishia.

Table 2. Total and available content of heavy metals, mg kg⁻¹ in some wadis soils of Abu -Rudeis district at South Sinai Governorate

Location	Sample No.	Fe		Mn		Zn		Cu	
		Total	Available	Total	Available	Total	Available	Total	Available
Wadi El-Sheikh Soliman	1	2320	7.5	800	2.3	500	2.2	220	2.1
	2	2210	7.2	750	2	400	2	210	2
	3	2110	7.0	900	2.5	500	2.2	280	2.2
	4	2010	6.0	650	3	350	2.5	160	1.3
	5	1800	5.0	680	3.1	330	2.7	260	1.3
	6	1280	6.0	700	2	400	2	220	1.5
	7	1500	5.5	750	3.5	420	3	210	3
	8	1310	4.5	800	4.2	470	3.8	250	1.7
	9	1250	5.0	830	4	460	3.7	250	1.8
	10	1020	5.0	700	2.5	400	2.3	210	1.7
	11	1100	4.5	750	2.6	380	2.4	190	1.6
	12	1170	5.0	640	4	350	3.5	180	2
	13	1200	5.2	600	3.2	330	3	170	1.9
	14	1150	4.9	720	3.5	400	3.1	210	2
Wadi Sidri	15	1550	6.0	700	3.0	410	2.8	220	1.8
	16	4000	14.0	650	3	420	2.9	200	3
	17	1400	7.0	400	2	250	1.7	180	2.2
	18	1350	6.0	500	2.5	270	2.3	170	2.1
	19	1860	5.5	630	4	320	3.5	190	3
	20	1150	5.0	550	2	380	2	200	2.5
	21	1200	5.3	720	3	360	2.9	180	2.7
	22	1250	5.4	570	2.5	390	2.4	210	2.5
	23	1150	4.8	600	3	350	2.8	180	2
	24	1170	4.5	620	3.3	300	3	160	1.8
	25	1050	4.0	770	3.6	360	3.5	200	2

Table 2. Cont.

Location	Sample No.	Fe		Mn		Zn		Cu	
		Total	Avail.	Total	Avail.	Total	Avail.	Total	Avail.
Wadi Sidri	26	8000	20	820	2.5	270	2.3	130	2
	27	1810	7	800	2	300	2	160	2.1
	28	1500	6	820	2.2	400	2.1	200	2
	29	1410	5.5	600	1.7	270	1.6	150	2.3
	30	1350	6	650	1.9	350	1.8	150	3
	31	1150	5.5	500	2	500			2.7
	32	1300	6	570	2.4	2	160	170	3
	33	1210	6	600	3	310	2.8	140	2.8
	34	2020	8	750	2	400	2	200	2.9
	35	1700	7	800	2.7	380	2.5	180	2.3
Wadi El-Arishia	36	1350	7.3	600	2.3	370	2.2	170	2.4
	37	1400	7.5	550	2	400	2	190	3
	38	1510	8	800	2.5	380	2.4	200	2.5
	39	1120	6	540	2.1	290	2	150	2.6
	40	1600	6	570	1.6	300	1.5	160	2
	41	2100	8	650	1.5	320	1.4	130	2.1
	42	1200	5.5	450	1.2	250	1.1	120	2.2
	43	2020	6	480	1.6	270	1.5	130	1.7
	44	4400	18	620	2	310	1.9	160	3
	45	5500	17.5	500	1.8	280	1.6	150	3.2
Wadi Bodra	46	2700	20	370	1.2	190	1.1	90	2.5
	47	2500	10	450	2	220	2	100	2.7
	48	9000	25	550	1.5	300	1.4	140	3
	49	3000	12	500	2.3	310	2.2	160	2.8
	50	2900	11	630	2.5	320	2.4	170	2.7
	51	4210	15	760	2	400	1.9	150	2.8

Table 3. Simple correlation coefficient (r) between some soil variables and available Fe, Mn, Zn and Cu in the studied soils of Abu Rudeis district

Available tract nutrient	Soil variables					
	Clay, %	Silt + Clay, %	CaCO ₃ , g kg ⁻¹	pH	EC, dSm ⁻¹	O.M, g kg ⁻¹
Fe	-0.020	0.024	0.340	0.230	0.080	-0.009
Mn	0.008	0.024	-0.179	0.022	-0.318	0.001
Zn	-0.033	0.024	0.008	-0.001	0.042	-0.008
Cu	0.002	0.024	0.040	0.008	0.036	0.000

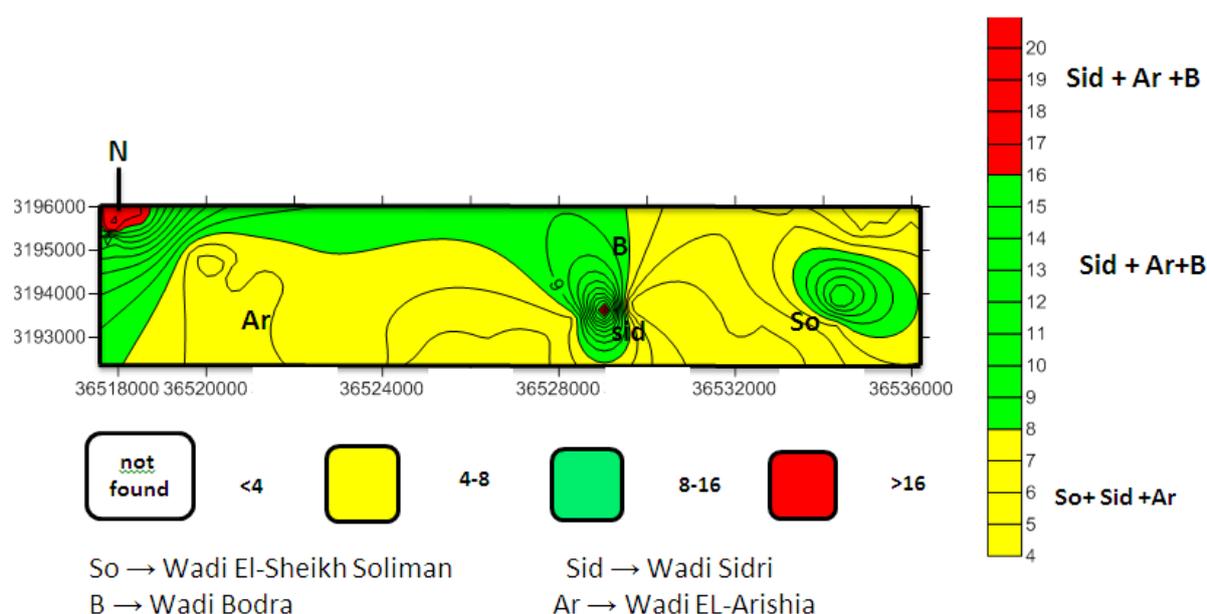
**Fig. 3. Contour map showing the distribution of Fe in the studied area**

Table 2 and Fig. 4 Shows the DTPA extractable Mn values in the soils of Abu Rudeis district which it ranges from 1.2 to 4.2 mg kg⁻¹ with an average of 2.43 mg kg⁻¹. Based on the available Mn values for each soils of Abu Rudeis district, Fig. 4 was constructed to show the Mn adequate and abundant limits as defined by Viets and Lindsay (1973), El-Gala *et al.* (1986) and Tahoun *et al.* (1999). They workers reported that the critical Mn level as determined by the DTPA method is about 1.0 mg kg⁻¹. Soils containing available Mn below this level would not be able to provide, growing plants with their

nutritional requirement. The soil Mn of Wadi El-Sheikh Soliman contains an adequate and available Mn level in the range of 1-4 and 4-8 mg kg⁻¹, respectively. The soils of Wadis Sidri, El-Araishia and Bodra contain adequate available Mn content in the ranges of 1-4 mg kg⁻¹.

Fig. 4 shows that the investigated soil samples are divided into two divisions, adequate and abundant available Mn content. Division adequate is represented by soil samples from 1 to 51, except (8, 9, 12, 19), while abundant one is represented by soil samples 8, 9, 12 and 19.

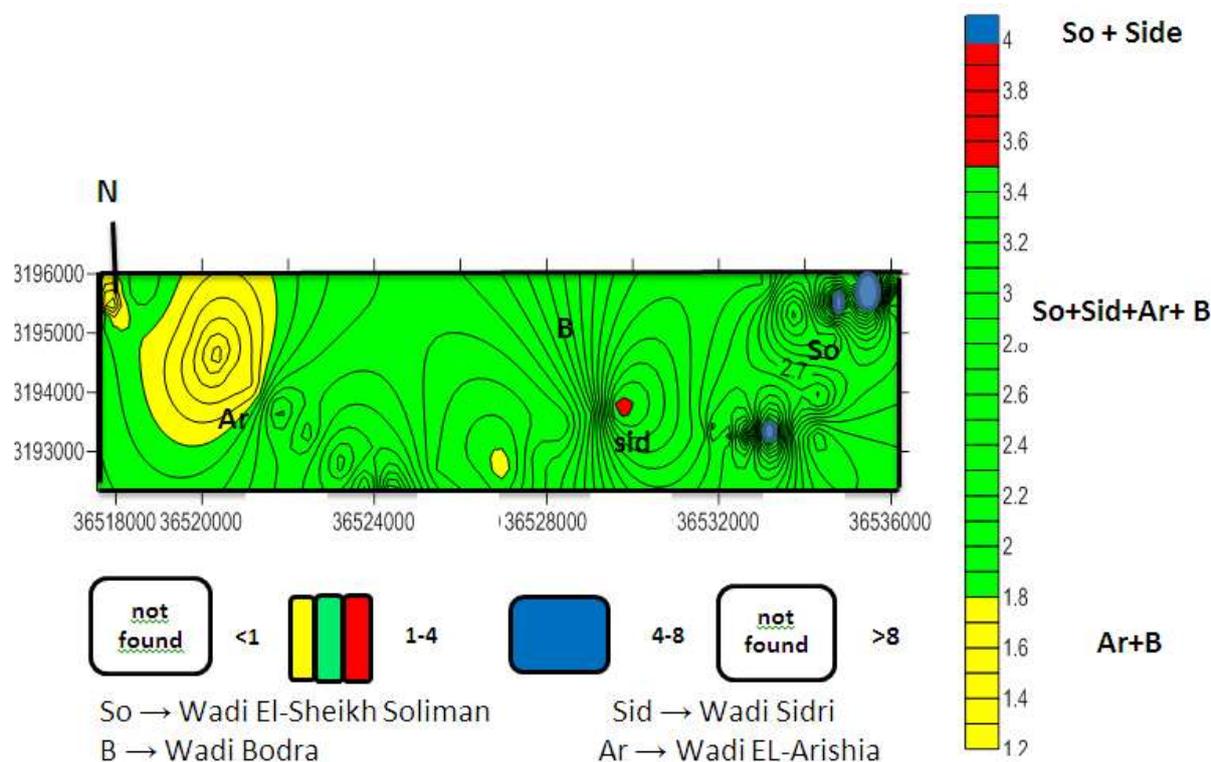


Fig. 4. Contour map showing the distribution of Mn in the studied area

Therefore, the tested soil samples belong to 92.2% and 7.8% adequate and abundant, respectively.

The respective correlation coefficients (r) between chemically – extractable Mn and some soil variables, are presented in Table 3 showed that, where it chemically – extractable Mn significant and positively correlated with clay % ($r = - 0.01$), O.M mg kg^{-1} ($r = - 0.001$) silt and clay % ($r = 0.02$) and pH value ($r = 0.02$), but significant negatively correlated with CaCO_3 mg kg^{-1} ($r = - 0.18$) and Ec dSm^{-1} ($r = - 0.32$) in the studied soils.

Zinc

The total Zn content of the soils of Abu Rudeis district is given in Table 2. The data indicate that the content varies between 190 and 500 mg kg^{-1} . It should be pointed out that these values are less than the comparable values for Mn. These results are in agreement with those obtained by **Tahoun et al. (1999)** and **Khalil et al. (2004)** and **Walid (2007)**. The total soil Zn

was ranged from 330 to 500 mg kg^{-1} with an average 419 mg kg^{-1} in Wadi El-Sheikh Soliman, while it ranges From 250 to 420 mg kg^{-1} with an average 341 mg kg^{-1} in Wadi Sidri; it ranges from 190 to 500 mg kg^{-1} with an average 320 mg kg^{-1} in Wadi El-Araishia while it ranges from 300 to 400 mg kg^{-1} with an average 332 mg kg^{-1} in Wadi Bodra. An average of total soil Zn can be arranged for the different tooted wadis in the following descending order: Wadi El-Sheikh Soliman > Wadi Sidri > Wadi Bodra > Wadi El-Araishia.

The values of DTPA available Zn are shown in Table 2 and Fig. 5, where they ranged from 1.1 to 3.8 mg kg^{-1} with an average of 2.27 mg kg^{-1} in the soils of Abu Rudeis district. **Kamh (1981)** reported values extending from 1.0 to 5.8 mg kg^{-1} in different textured soils. **Tahoun et al. (1999)** found that these values ranged from 0.1 to 28.2 mg kg^{-1} in soils of Abu-Hammad district, while **Khalil et al. (2004)** showed that these values range between 0.0 and 1.49 mg kg^{-1} in soils of west El-Gidida region, El-Dakhla

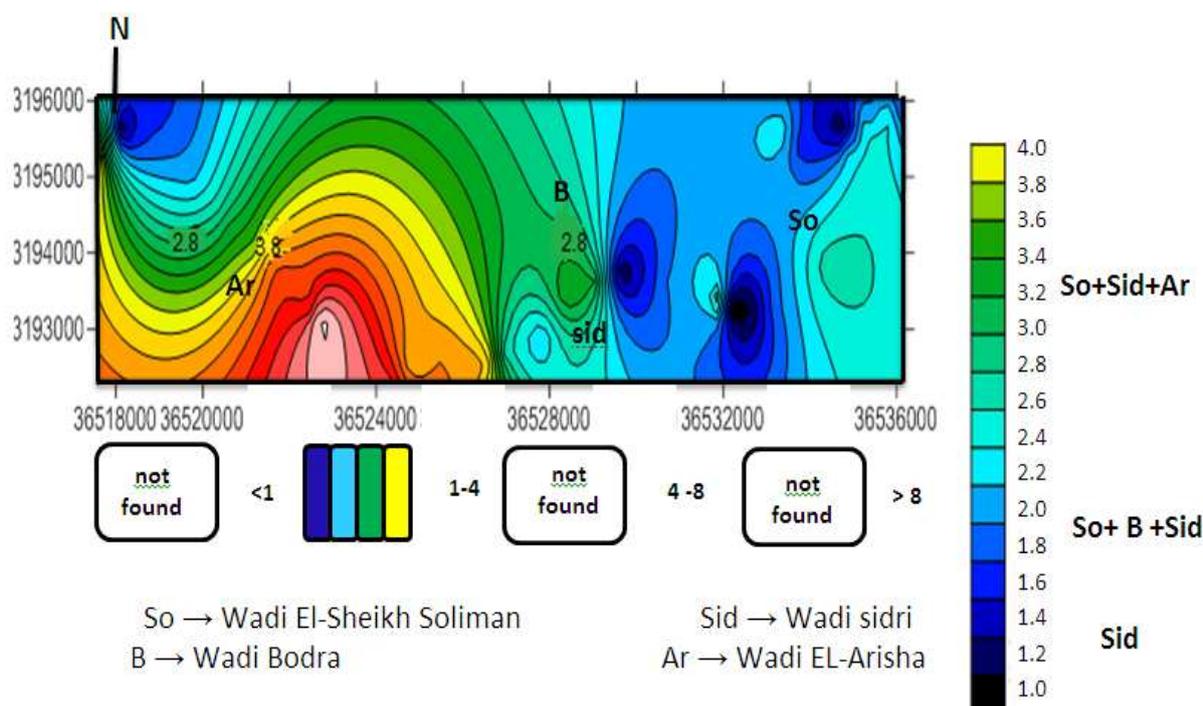


Fig. 5. Contour map showing the distribution of Zn in the studied area

Oases and the New Valley. Based on the available Zn values for each soils of Abu Rudeis dstrict, Fig. 5 was constructed to show the Zn adequate limits as defined by Viets and Lindsay (1973), El-Gala *et al.* (1986), Tahoun *et al.* (1999) and Khalil *et al.* (2007). They reported that the critical Zn level as determined by the DTPA method is about 1 mg kg^{-1} . Soils containing available Zn below 1 mg kg^{-1} level would not be able to provide growing plants with their nutritional requirement. All Soils of the four Wadis at Abu Rudeis dstrict contain an adequate available Zn level in the range of $1\text{-}4 \text{ mg kg}^{-1}$. Fig. 5 shows that the tested soil samples are considered as one division that is adequate available Zn content. This division is represented by all soil samples under study. Therefore, the studied soil samples belong 100% adequate. The respective correlation coefficients (r) between chemically-extractable Zn and some soil variables; are listed in Table 3 where it shows that chemically-extractable Zn significant and negatively correlated with clay% ($r = -0.03$), pH ($r = -0.001$) and O.M mg kg^{-1} ($r = -0.01$), but significant positively correlated with silt + clay ($r = 0.02$), $\text{CaCO}_3 \text{ mg kg}^{-1}$ ($r = 0.01$), EC dSm^{-1} ($r = 0.04$) in the studied soils.

Copper

Data in Table 2 Shows that values of the total Cu ranged from 90 to 280 mg kg^{-1} in soils of Abu Rudeis district. The total soil Cu was ranged from 160 to 280 mg kg^{-1} with an average 224 mg kg^{-1} in Wadi El-Sheikh Soliman, while it ranged from 130 to 220 mg kg^{-1} with an average 176 mg kg^{-1} in Wadi Sidri; It ranged from 90 to 200 mg kg^{-1} with an average 153 mg kg^{-1} in Wadi EL-Araishia and from 140 to 170 mg kg^{-1} with an average 155 mg kg^{-1} in Wadi Bodra. The average of total soil Cu can be arranged for the different wadis in the following descending order: Wadi El-Sheikh Soliman > Wadi Sidri > Wadi Bodra > Wadi EL-Araishia Table 2 and Fig. 6 shows the DTPA extractable Cu values in the soils of Abu Rudeis dstrict the values range from 1.0 to 2.7 mg kg^{-1} with an average of 1.91 mg kg^{-1} . Based on the available Cu value for each soils of Abu Rudeis district Fig. 6 was constructed to show the Cu an excessive limits as defined by Viets and Lindsay (1973) and El-Gala *et al.* (1986). Who reported that the critical Cu level as determined by the DTPA method is about 0.2 mg kg^{-1} . Soils containing available Cu below this level would not be able to provide

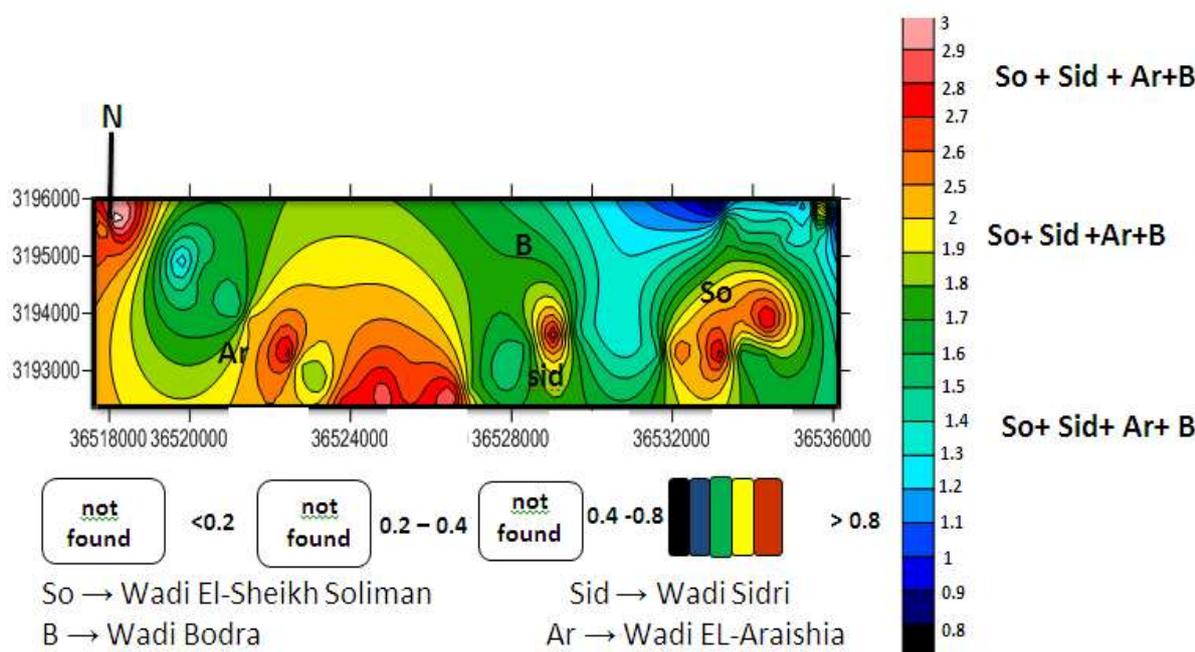


Fig.6 . Contour map showing the distribution of Cu in the studied area

growing plants with their nutritional requirement. All soils of Abu Rudeis district contain an excessive Cu level higher than 0.8 mg kg^{-1} . Fig. 6 shows that the investigated soil samples are considered as one sector that is excessive available Cu content. This sector is represented by all soil samples under study. Therefore, the tested soil samples belong 100% excessive.

The respective correlation coefficients (r) between chemically – extractable Cu and some soil variables, are listed in Table 3 showed significant positively correlation with clay % ($r = 0.002$), O.M mg kg^{-1} ($r = 0.0004$), silt + clay ($r = 0.04$), $\text{CaCO}_3 \text{ mg kg}^{-1}$ ($r = 0.04$), pH ($r = 0.01$), EC dSm^{-1} ($r = 0.04$) and O.M mg kg^{-1} ($r = 0.0004$) in the studied soils.

Conclusion

Based on the previously mentioned data it can be concluded that the studied soils of Abu Rudeis district have available Fe ($>4 \text{ mg kg}^{-1}$), Mn, Zn, Cu ($>1 \text{ mg kg}^{-1}$) where these values are determined by DTPA method. The most of wadis soils of the studied area have their DTPA available Fe, Mn, Zn and Cu higher than the critical levels. These values able to provide growing plants with their nutritional requirement.

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حالة بعض العناصر الغذائية الدقيقة في بعض أراضي وديان منطقة أبورديس بجنوب سيناء- مصر

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تم تجميع عدد 51 عينة أرضية من بعض أراضي وديان منطقة أبو رديس التي تقع بين بعض السلاسل الجبلية وذلك لتقدير بعض الخصائص الطبيعية و الكيميائية وتقييم المحتوى الكلي والميسر من الحديد والمنجنيز والزنك والنحاس، ولقد أوضحت النتائج أن منطقة الدراسة تتميز أراضيها بأنها رملية إلى متوسطة القوام وأن محتواها من كربونات الكالسيوم والمادة العضوية وملوحة التربة وقيمة الـ pH تتراوح بين 12.4 - 579 جم كجم¹ وبين 6.7 - 30.2 جم كجم¹ وبين 0.23-8.62 ديسيسيمنز م⁻¹ وبين 7.6-9.3 علي التوالي. المحتوى الكلي للحديد و المنجنيز والزنك والنحاس يتراوح بين 9000-1020، وبين 370 -900، وبين 190-500، وبين 90-280 مللجم كجم⁻¹ علي التوالي. معظم أراضي وديان منطقة الدراسة محتواها الميسر من الحديد والمنجنيز والزنك والنحاس أعلى من الحد الحرج وهو كالتالي (4-1-1-2،) ويحتاج هذا العمل دراسة التأثير المتداخل للمحتوى الميسر من هذه العناصر الدقيقة وأثر ذلك علي مدى استجابة المحاصيل لهم، وتشير نتائج التحليل الإحصائي إلي وجود ارتباط موجب ومعنوي بين %الطين و% (السلت + الطين) ومحتوي كربونات الكالسيوم وقيمة الـ pH ودرجة التوصيل الكهربائي ومحتوي المادة العضوية وكلاً من المحتوى الميسر من الحديد والمنجنيز والزنك والنحاس بإستثناء المحتوى الميسر لكل من (الحديد والزنك) و(المنجنيز والزنك) و(المنجنيز) و(الحديد والزنك) أوضح ارتباط معنوي سالب مع % الطين ومحتوى كربونات الكالسيوم وقيمة pH التربة ومحتوى المادة العضوية.

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