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RESEARCH ARTICLE

INVESTIGATIONS OF SOME HEAVY METALS OF GROUNDWATER AQUIFER OF WADI EL NATRUN AREA IN EGYPT.

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Abstract

In Wadi El Natrun depression the Pliocene aquifer receives inflow of Miocene and Pleistocene aquifer waters and from the agricultural activity and septic tanks. Groundwater samples were collected from 25 water wells and seven principle salt lakes at Wadi El Natrun area.

Heavy metal (Cu, Zn, Mn, F, Cr, Ni, Cd, and Pb) concentrations of Wadi El Natrun aquifer were investigated. The determination of trace metals (Cu, Zn, Fe, Mn, and Pb) has been performed in order to study environmental pathways. Evaluation of Groundwater of the Pliocene Aquifer for Drinking Purposes According to International standards for the quality of drinking water The Samples that are away from the saline lakes are acceptable water for drinking but the samples which are close to the saline lakes permissible water for drinking.

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Introduction:-

Groundwater is the main source for domestic, industrial and agriculture uses in most of the new reclaimed areas.

The hydrochemistry of major ions (K^+ , Na^+ , Mg^{2+} , Ca^{2+} , Cl^- , SO_4^{2-} , HCO_3^- , CO_3^{2-}) together with trace elements (Fe, Mn, Zn, Pb, Cd, Cr, Cu, Ni) has been used to constrain the hydrochemical characteristics of groundwater, western Nile Delta aquifers. The groundwater wells, varying in depth from 27.5 to 120 m.

physico-chemical parameters and chemical compositions of the groundwater and to obtain additional information on the possible contamination with major elements, and trace elements (heavy metals).

The Fresh water is mainly concentrated in the central-eastern part The chloride (Cl^-) and sulfate (SO_4^{2-}) ions acquire the higher concentrations of the anions, while sodium (Na^+), calcium (Ca^{2+}) and magnesium (Mg^{2+}) acquire the higher concentrations of the cations. The concentrations of the major ions are higher than the maximum standard limits, according to the World Health Organization (WHO, 1996).

The hydrochemical composition reflects the $Na-HCO_3$ water type for the Quaternary aquifer, indicating recent meteoric water. Another major water type ($Na-Cl$) is recorded in the high salinity areas of northern and western parts. (A. M. Sharaky, 2007).

At Wadi El Natrun the available water resources include surface water (Rosetta branch and its irrigation channels) and relatively shallow groundwater that is mainly recharged from the surface water. Groundwater is the main source for domestic, industrial and agriculture use in the western Nile Delta region (Dawoud et al., 2005).

The present study focuses on:-

1. Hydrochemical characterizations of the groundwater.
2. Chemical analysis of pollutants and determination of their source.
3. Evaluation of the groundwater suitability for different purposes

The recent studies including RIGW and IWACO (1991) indicate that the main recharge source for the groundwater in Wadi El Farigh and Wadi El Natrun was recent to old Nile water as well as some contributions from Western Desert Palaeowater. There are several factors capable of impinging on groundwater quality not only the natural factors such as the lithology of the aquifer, the quality of recharge water and the type of interaction between water and aquifer, but also the human activities. Thus, there is a need to regularly evaluate groundwater quality for improving water management (Mahmood et al., 2011).

Location and climate of the study area:-

Wadi El-Natrun, with its alkaline lakes, is an elongated depression about 90 Km North West of Cairo between latitudes $30^{\circ} 15'$ north and longitude $30^{\circ} 30'$ east (Fig. 1&2). Its average length is 60 Km and average width about is 10 Km. The bottom of the Wadi is 23 m below sea-level and 38 m below the water level of the Rosetta branch of the Nile (Abdel Malek et al 1963).

The climate is characterized by a long hot summer and a short warm winter, low rainfall and high evaporation.

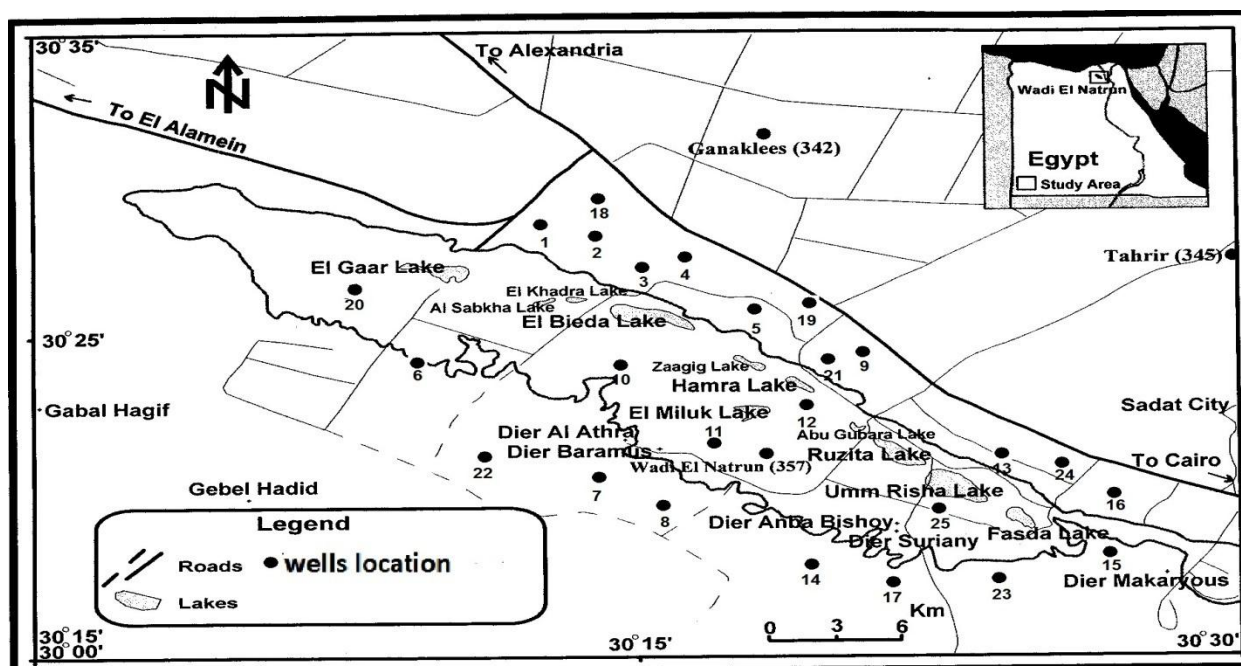


Fig. 1:- Location map of the studied water wells at Wadi El-Natrun area.

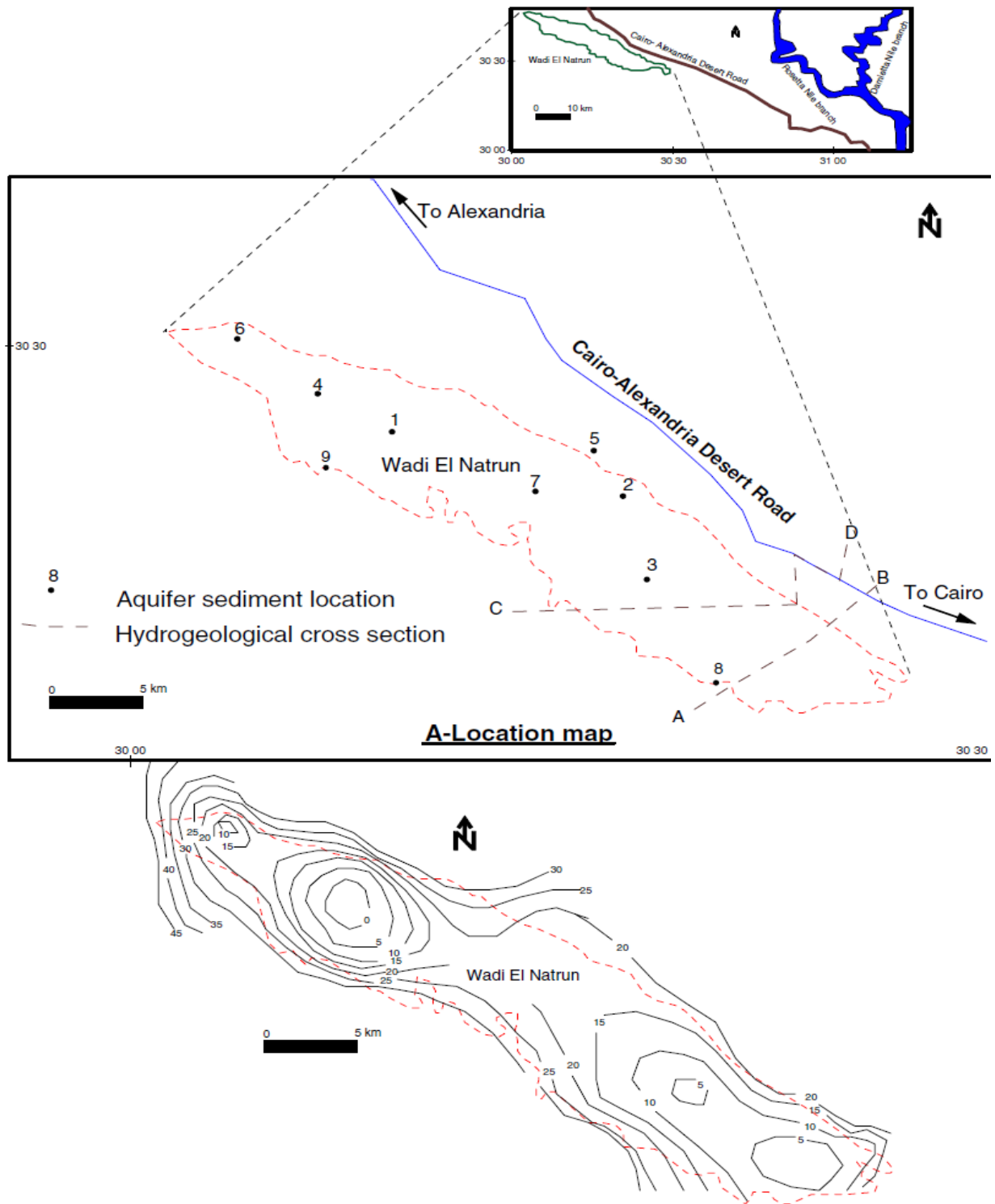


Fig 2:- Location map of Pliocene aquifer sediments (a) and water depth (b) (El Abd 2005) in Wadi El Natrun.

The geomorphology:-

The geomorphology the area of Wadi El Natrun Depression and its surroundings was studied by many workers them are; (Shata 1959), (La Moreaux 1962), (Shata 1962);(El Fayoumy 1964), Abu El Ezz (1971), (Sanad 1973), (Attia 1975), (El Ghazawi 1982), (Abdel Baki 1983) and (Gomaa 1995),Taher (1999), El Abd (2005), . Based on these works and others, area of Wadi El Natrun Depression can be subdivided into the following geomorphic units:-

The northern slopes and depression edge,

The southern slopes, and The depression floor (Gomaa 1995).

The northern slopes and depression edge; covers the area between the northeastern El Tahrir gravelly plain and depression floor. The northern slope is rather gentle and is distinguished into a number of steps or benches which correspond to the equivalent lithological variation. The surface of this slope is either degraded or covered with down wash deposits consisting of rock debris flinty pebbles. The slope surface is dissected by a number of short shallow runnels all directed towards the central depression area (Gomaa 1995).

The northern depression edge is structurally controlled and extended parallel to the general trend of the depression. This edge is structurally controlled and extended parallel to the general trend of the depression. This edge, rising about 80 m above the depression floor, is capped by weather resistant porcellaneous and cherty limestones. Underlying these limestones, there is a succession of soft gypsiferous sandy clay and sands intercalated with chalky and flinty limestones bands (Gomaa 1995).

The southern slopes; this slope is characterized by a rolling surface sloping in the northward direction from the southern El Mekhimien edge to Wadi El Natrun depression for a distance of about 45 km. Structurally, this slope is associated with the northern flank of the southern Wade El-Farigh anticline, hence, it is a homoclinal slope. Such slope is underlain by sands and sandstones belonging to the Miocene and Early Pliocene and is almost covered by a thin gravel mantle. This slope is dissected by a number of oriented wadies which are all directed towards the depression floor of Wadi El Natrun(Gomaa 1995).

The depression floor; comprising the areas occupied by the present salt lakes and marshy lands, as well as the series of disconnected deep patches dominated by aeolian sand deposits. This configuration reflects the existing geological structures, noticed on the surface or detected in the subsurface (Gomaa, 1995).

The Wadi El Natrun, Depression:-

The Wadi El Natrun, depression represents a marked land feature in the area. It exhibits various morphological features that reflect the local geologic and topographic settings. The depression exists at the western extreme of the old alluvial plain. It represents a huge, oval, double plunging anticlinal structure that is bounded by normal faults and trends in a NW-SE direction. According to(El Fayoumy, 1964 and Sanad, 1973), three local geomorphic provinces were distinguished within direction. According to(El Fayoumy, 1964 and Sanad, 1973), three local geomorphic provinces were distinguished within Wadi El Natrun area, they are: the main depression with salty lakes, El Ralat Depression and Dier Makaryous (Beni Salama) Depression rich in natural soda or natrun, thenardite and halite. In addition, variable wind blew barriers of sand influence the subdivision of lakes. The number of Lakes present at any time is therefore variable (Taher, 1999).

Material and Methods:-

Sampling and analysis:-

Groundwater samples were collected from 25 water wells and seven principle salt lakes at Wadi El Natrun area (Fig. 1). The wells have depths varying from 25.0 to 120 m. Each well has a standard galvanized iron pipe that was enforced vertically into the ground. The groundwater samples were collected in two-liter polyethylene bottles during 2013. They were chemically analyzed in order to determine the trace elements; the chemical analyses were carried out in the Ministry of Health -Central Health laboratories.

The concentrations of trace elements (Fe, Mn, Zn, Pb, Cd, Cr, Cu, Ni) were performed using atomic absorption flame spectrometric technique (GBC 908 AA) with lower detection limits ranging from 0.001 to 0.1 mg/L

All samples were analyzed with a PerkinElmer Optima 8300® ICP-OES equipped with an ESI prepFAST™ Auto-Dilution System with an ESI SC-2 DX Autosampler.

Results and Discussion:-

Trace elements cause growth reduction due to toxicity, According to the National Academy of Science (1972), the maximum concentration for some trace elements in permanent irrigation of all soils, iron 5 ppm, manganese 0.2 ppm copper 0.2 ppm, lead 5 ppm and zinc 2 ppm. Comparing the obtained results (Table 19) with these values, we can deduce the following:

The toxic metal concentrations (Pb, Fe, Cu, Cd, and Mn) in Miocene groundwater are elevated in the southwestern part of Wadi Farigh (El Kashouty 2004), which includes the south eastern part of Wadi El Natrun

The Pleistocene groundwater flow is from the northern, eastern, and southeastern regions toward the depression. Therefore, the depression receives groundwater inflow from the Miocene and Pleistocene aquifers along with these toxic heavy metals. Part of these toxic metals is dissolved, some are suspended, and the rest (most) are precipitated to be included in the Pliocene aquifer sediments. In some cases, the inflow of groundwater with these toxic metals and anthropogenic activity into Pliocene aquifer increases the metal concentrations (Abdo and Sayed 2009), Particle chemistry, mineralogy, and pollution input control the heavy metal composition of the Pliocene aquifer sediments. The Wadi El Natrun is covered by intense agricultural activity. In addition, it receives pollution from domestic sewage, septic tanks, and fertilizers. Since the evaporation rate is high and the lakes lie in closed basins without outlet, the water in the lakes has a high salt concentration and is susceptible to the shallow aquifers in the depression. A number of authors have shown that sediments rich in organic materials (bottom saline lakes in Wadi El Natrun (Abdo and Sayed 2009),

The distribution pattern of Mn and Fe in Wadi El Natrun was attributed to the inflow of groundwater from the Miocene and Pleistocene aquifers carrying suspended matter and agricultural wastewater. The increase in the association of Mn and Fe in finer clastics (mud) is primarily related to the greater surface area of these particulates. The adsorptive ability of particulates increases considerably as the surface area increases (Gibbs 1977; Thorne and Nickless 1981)

Table 1:- Sample numbers and location of some selected water resources in Wadi ElNatnm area.

Sample No.	Well location	Well No.
1	village of kafr dawood	1
2	El Hammam well	2
3	Bani salim Village	3
4	well near urban communities	4
5	well near elhamra lake	5
6	well near el gaar lake	6
7	near kafr dawood village	W.St 18
8	near kafr dawood village	W.St 19
9	near kafr dawood village	W.St 20
10	L.El Gaar	
11	L.El Khadra	
12	L.El Beida	
13	wells of wadi Elnatrun city	7
14	El Hamra village well	8
15	wells of wadi Elnatrun city	9
16	well near el hamra lake	10
17	well near abu gebara lake	11
18	well near El Rosina lake	12
19	water station in wadi El natrun city	W.St 21
20	water station in kafr El hamra village	W.St 22
21	water station in wadi El natrun city	W.St 23
22	L.ElHamra	
23	L.Gabbboura	

24	L.El Rosonya	
25	Near El Rest house 1	13
26	Near El Rest house2	14
27	Near El Rest house 3	15
28	Near El fasda lake	16
29	Near om ElRisha lake	17
30	Residential city at rest house2	W.St 24
31	Residential city at rest house 1	W.St 25
32	L.El Fasda	
33	L.Om ElRisha	

Table 2:- Trace elements concentration in (ppm) of some selected water resources in Wadi ElNatnm area.

well no	Fe	Mn	Zn	Pb	Cd	Cr	Cu	Ni
1	0.60	0.10	0.20	0.00	0.00	0.04	0.04	0.10
2	0.02	0.09	0.44	0.00	0.00	0.04	0.05	0.08
3	2.20	0.06	1.30	0.00	0.00	0.04	0.08	0.06
4	0.20	0.30	0.50	0.00	0.00	0.04	0.05	0.06
5	0.50	0.10	1.40	0.00	0.00	0.04	0.10	0.10
6	0.90	0.10	1.20	0.00	0.00	0.04	0.10	0.05
7	0.50	0.10	0.15	0.00	0.00	0.05	0.05	0.15
8	0.40	0.08	0.09	0.00	0.00	0.01	0.01	0.08
9	0.50	0.60	0.01	0.00	0.00	0.02	0.03	0.10
10	1.30	0.10	1.40	0.00	0.00	0.05	0.10	0.10
11	0.20	0.06	1.30	0.00	0.00	0.04	0.01	0.07
12	0.20	0.10	0.70	0.00	0.00	0.04	0.01	0.30
13	1.3	0.1	0.3	0.003	0.0014	0.045	0.06	0.1
14	0.2	0.1	0.4	0.004	0.0015	0.043	0.06	0.2
15	0.14	0.2	0.11	0.004	0.0024	0.0044	0.034	0.14
16	0.3	0.1	0.2	0.003	0.003	0.04	0.014	0.3
17	0.3	0.1	0.3	0.003	0.0025	0.043	0.033	0.14
18	0.5	0.1	0.3	0.004	0.0025	0.041	0.03	0.17
19	0.2	0.3	0.3	0.04	0.0024	0.045	0.07	0.2
20	0.2	0.1	0.07	0.003	0.0015	0.003	0.008	0.1
21	0.12	0.1	0.2	0.04	0.0024	0.045	0.04	0.1
22	0.2	0.2	0.16	0.004	0.0015	0.043	0.1	0.1
23	0.7	0.1	0.5	0.003	0.003	0.042	0.06	0.1
24	1.4	0.1	0.7	0.004	0.0003	0.044	0.1	0.09
25	1.20	0.06	1.30	0.00	0.00	0.04	0.10	0.30
26	0.10	0.10	1.20	0.00	0.00	0.04	0.08	0.04
27	0.20	0.20	0.15	0.04	0.00	0.44	0.08	0.06
28	0.60	0.20	0.20	0.00	0.00	0.04	0.01	0.10
29	0.30	0.30	0.10	0.00	0.00	0.04	0.02	0.20
30	0.10	0.05	0.90	0.00	0.00	0.00	0.06	0.10
31	0.80	0.04	0.50	0.00	0.00	0.00	0.10	0.30
32	0.30	0.10	1.40	0.00	0.00	0.04	0.01	0.10
33	0.25	0.20	0.30	0.00	0.00	0.04	0.10	0.10

All the selected samples show lead and zinc concentration below the maximum recommended limits Fig(8,9):. Samples No. 4, 9, 19, 29 show that manganese ion concentration are higher than the maximum recommended limits Fig(6):.

From the previous mentioned data and when the groundwater is used for irrigation purpose in the study area, the element Mn, must be taken into consideration in case of sensitive crops. Iron contaminant is most probably produced from iron oxides that occur in the Pleistocene sediments Fig(10):.

The other trace elements (Ni, Cd, Cr and Cu) are most probably attributed to secondary minerals in the aquifer rocks Fig (3,4,5,7):.

Evaluation of Groundwater of the Pliocene Aquifer for Drinking Purposes the groundwater of the study area is the only available source of water:-

According to the international standards for drinking water (WHO, 1984), the groundwater samples of the northern sector,

Samples No 2,7,8,9 are classified into acceptable water for drinking.

Samples No. 4,1,3 are classified into permissible water for drinking.

Samples No. 5,6 are classified into unsuitable water for drinking (Tables 2 & 3).

With regards to the groundwater of the central sector, the samples No19,20,21 are classified into acceptable water for drinking.

Samples No. 13,14,15,17 are classified into permissible water for drinking.

Finally, samples No. 16,18 are classified into unsuitable water for drinking (Tables 2 & 3).

With regards to the groundwater of the southern sector, The samples No. 25,26,27,30,31,32 are classified into acceptable water for drinking.

Samples No. 29 are classified into permissible water for drinking.

Finally, samples No. 28 are classified into unsuitable water for drinking (Tables 2 & 3)

It is worth mentioning that the selected water samples (Table 2) show that Cu, Mn and Zn concentration are less than permissible values for drinking while the majority of the samples (12, 28, 30, 31 and 38) show that Fe concentration are more than the permissible values for drinking. So, Fe concentration must be taken into consideration when using for drinking (Tables 2 & 3)

TDS in drinking water originate from natural sources, sewage, urban run-off, and industrial wastewater. Reliable data on possible health effects associated with the ingestion of TDS in drinking-water are not available and no health-based guideline value is proposed (WHO, 1993). However, the presence of high levels of TDS in drinking-water may be objectionable to consumers (WHO, 1993).

Table 3:- Specification of standard drinking water according to World Health Organization (1984):

Item	Acceptable(mg/L)	Penmissible (mg/L)	Unsuitable (mg/L)
Colour (Co-Pt-Scale)	5	50	>50
Turbidity	5	25	>25
pH	7-8.5	6.5-9.2	>9.2
TDS	500	1500	>1500
Fe	0.3	1	>1
Mn	0.1	0.5	>0.5
Cu	1	1.5	>1.5
Zn	5	15	>15
Ca	75	200	>200
Mg	50	150	>150
SO4'	200	400	>400
Cl	200	600	>600
samples of the northern sector,	2,7,8,9	4,1,3	5,6
samples of the central sector,	19,20,21	13,14,15,17	16,18
samples of the southern sector,	25,26,27,30,31,32	29	28

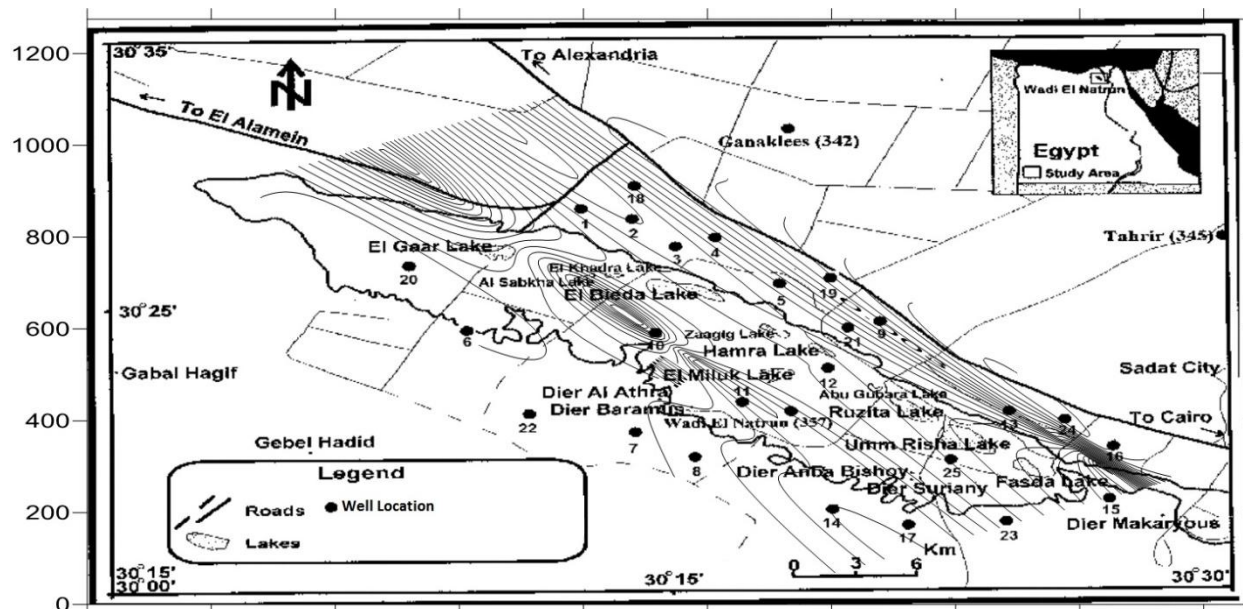


Fig 3:- Distribution of (Cd.)of the groundwater at Wadi E1-Natron area.

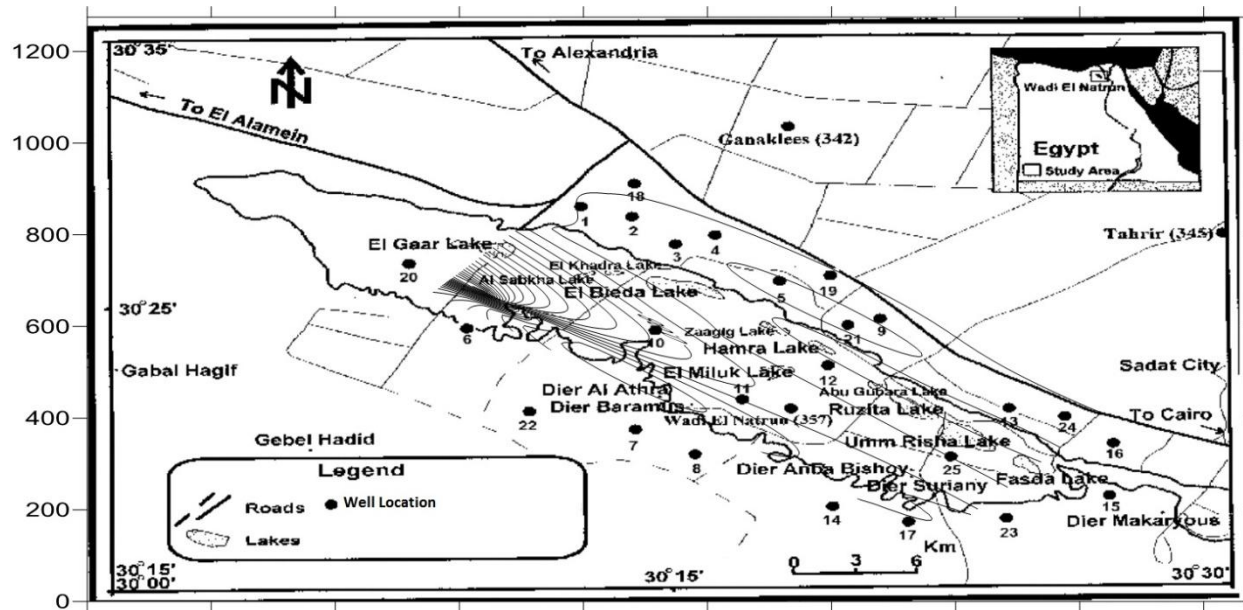


Fig 4:- Distribution of (Cr.)of the groundwater at Wadi E1-Natron area.

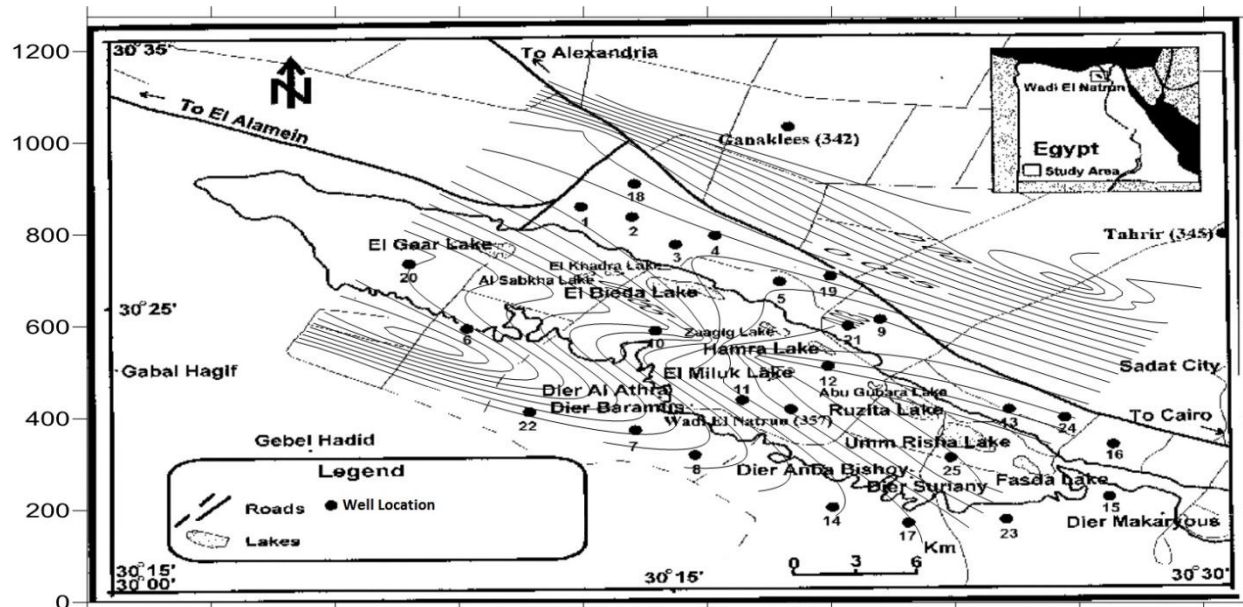


Fig 5:- Distribution of (Cu.) of the groundwater at Wadi El-Natron area.

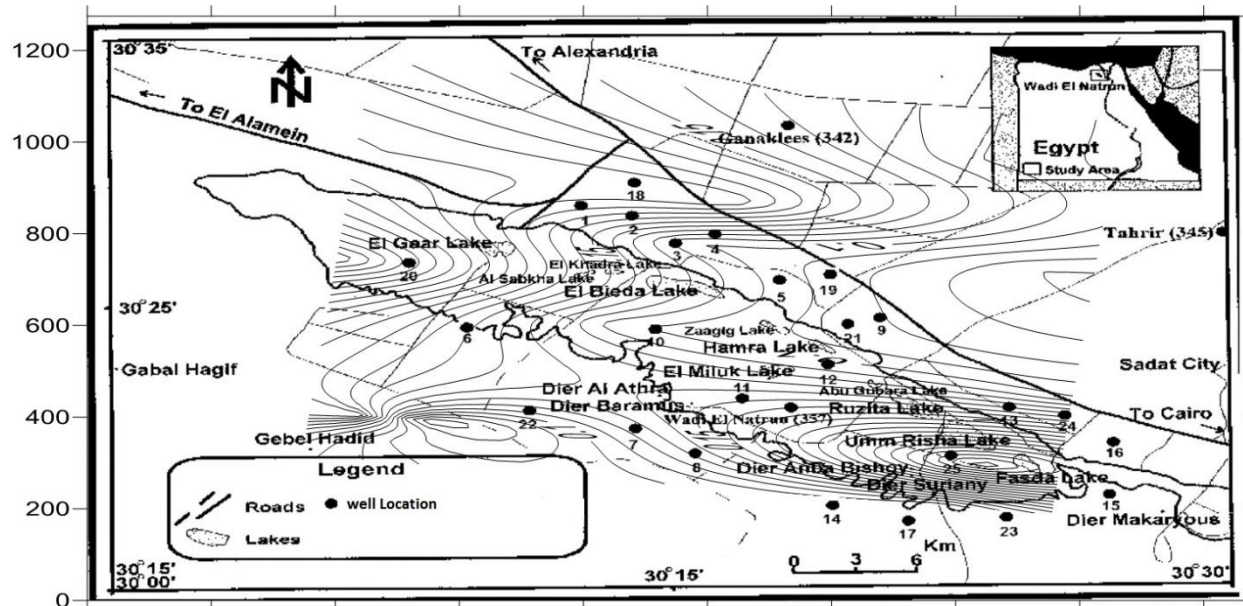


Fig 6:- Distribution of (Mn.) of the groundwater at Wadi El-Natron area.

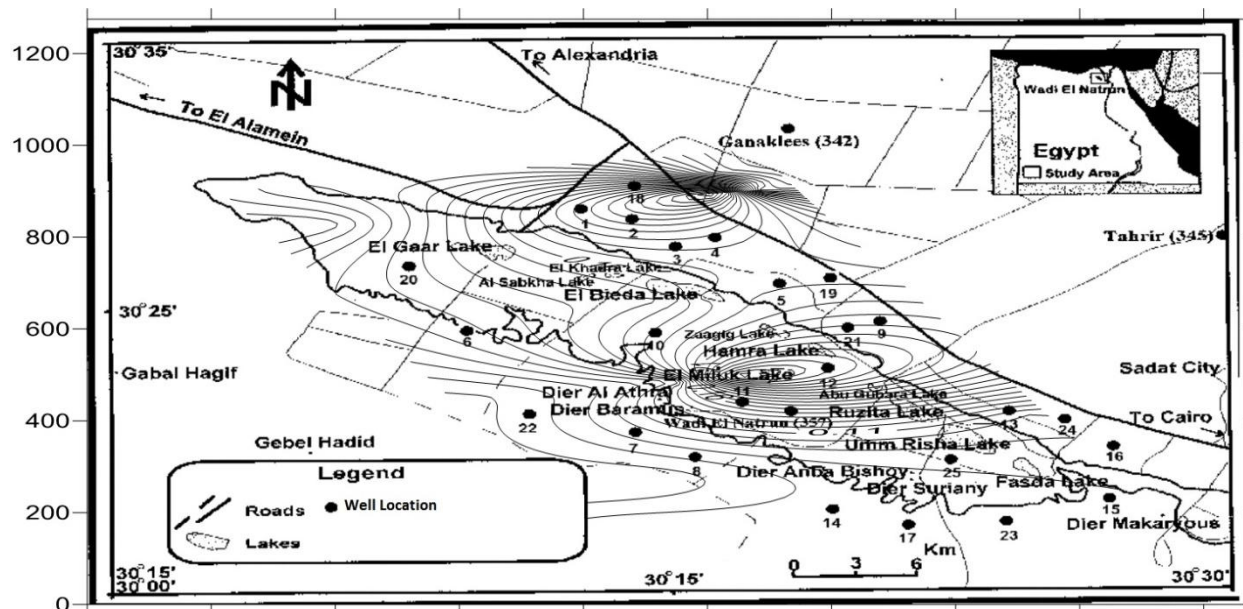


Fig 7:- Distribution of (Ni.)of the groundwater at Wadi E1-Natron area.

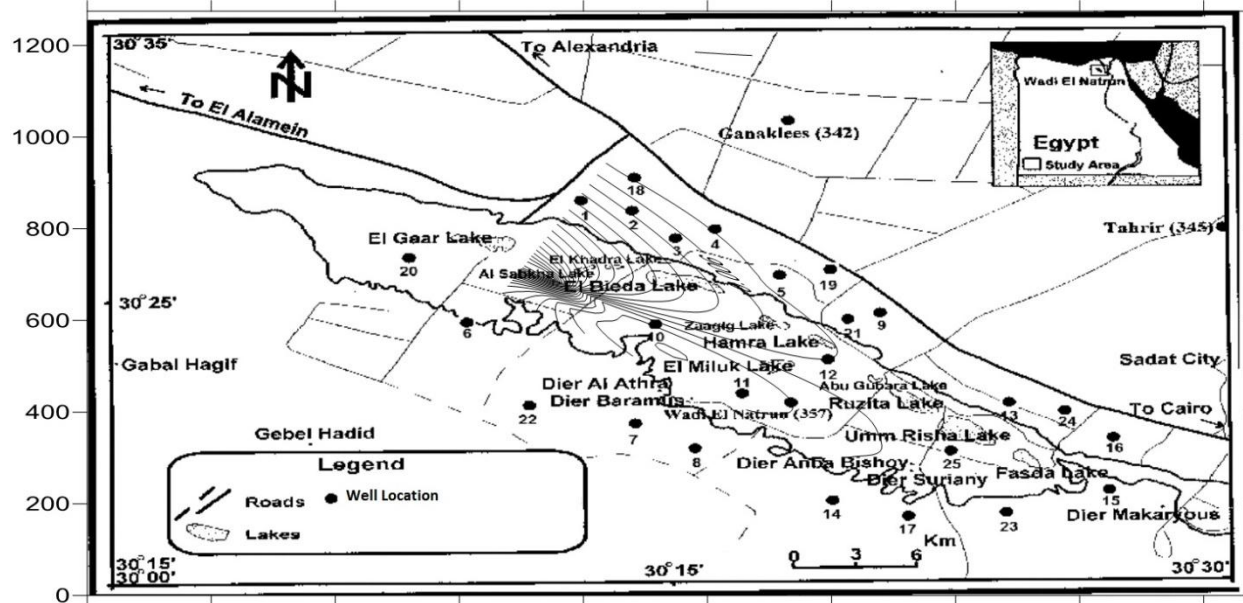


Fig 8:- Distribution of (Pb.)of the groundwater at Wadi E1-Natron area.

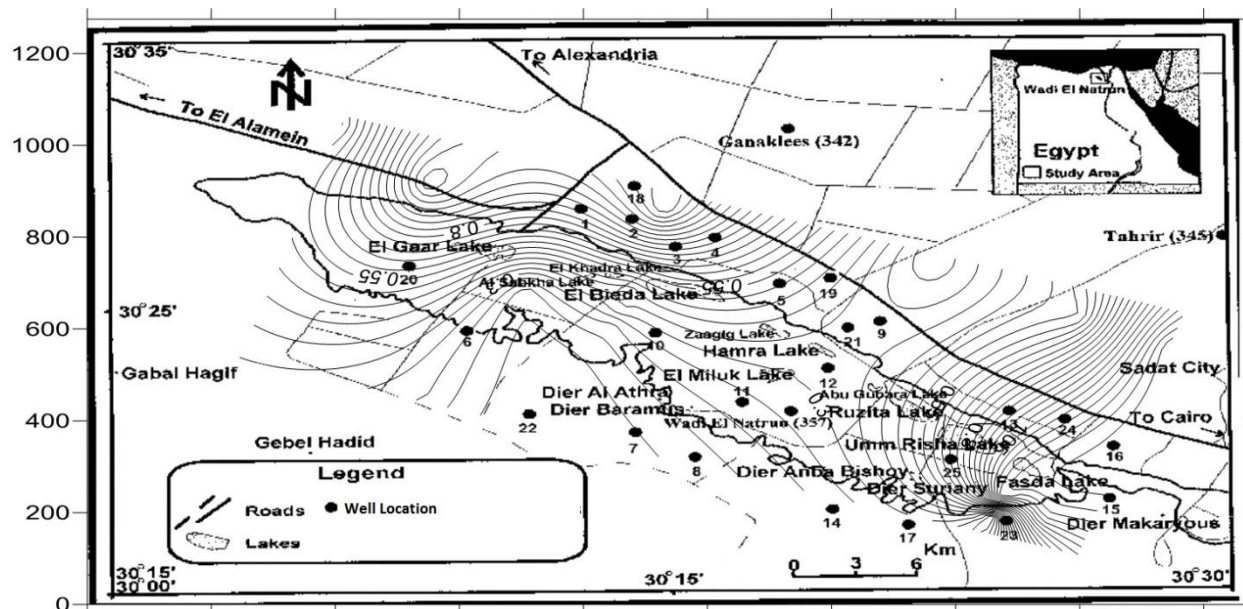


Fig 9:- Distribution of (Zn.) of the groundwater at Wadi El-Natron area.

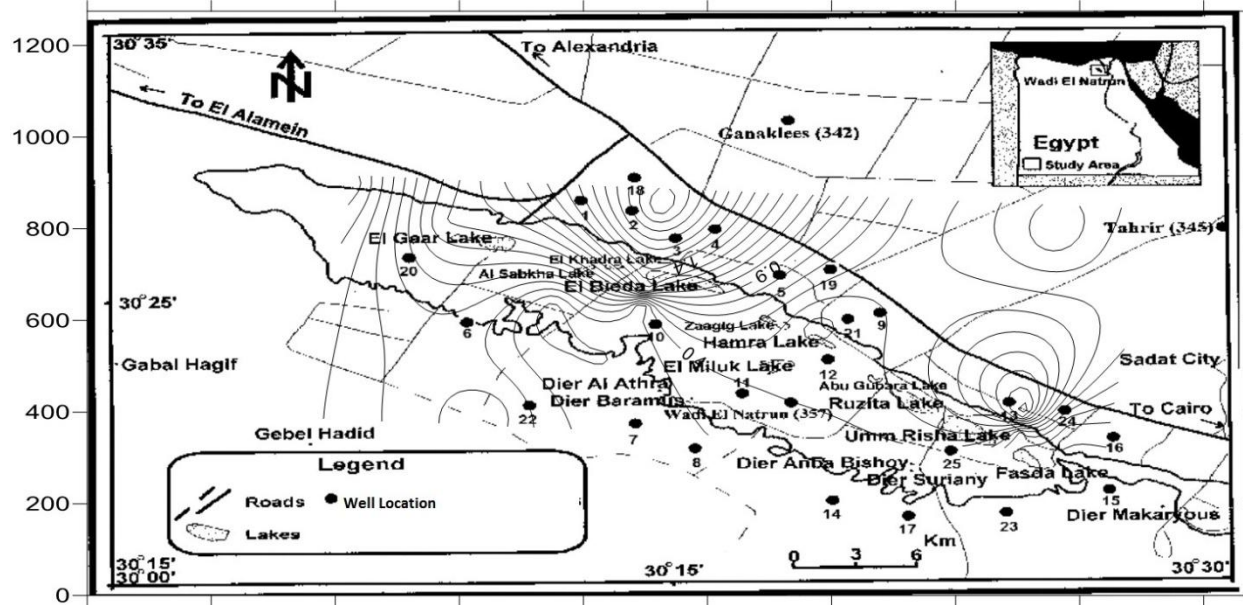


Fig 10:- Distribution of (Fe.) of the groundwater at Wadi El-Natron area.

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