

## SUMMARY AND CONCLUSIONS

The present thesis deals with the geomorphological, hydrogeological, hydrochemical and the evaluation of ground water for different uses of El-Tor area and its vicinities in the middle part of El-Qaa plain. It delineated by latitudes  $28^{\circ} 10'$  and  $28^{\circ} 20'$  N, and longitudes  $33^{\circ} 35'$  and  $33^{\circ} 40'$  E. The geomorphological and hydrogeological survey depending on the previous work while the hydrochemical study depend on the field and laboratorial work. This thesis includes four chapters:

### **Chapter I : Experimental work**

This chapter includes the procedure of measuring The instrumental methods of analysis include measuring hydrogen ion concentration (pH), electrical conductivity (EC), sodium ( $\text{Na}^+$ ), potassium ( $\text{K}^+$ ), calcium ( $\text{Ca}^{2+}$ ), magnesium ( $\text{Mg}^{2+}$ ), sulphate ( $\text{SO}_4^{2-}$ ), carbonate ( $\text{CO}_3^{2-}$ ), bicarbonate ( $\text{HCO}_3^-$ ), nitrate ( $\text{NO}_3^-$ ), silica as ( $\text{SiO}_2$ ), iodide, bromide and heavy metals (iron, manganese, copper, and cadmium).

### **Chapter II : Geomorphological, geological and hydrological aspects**

#### **1- Geomorphological and geological setting :**

Geomorphologically the study area lies in the middle part of El-Qaa plain which is an extensive gravelly plain stretching in NW-SE direction. The Quaternary deposits in the southern area of El-Qaa plain (the investigated area) are divided into three units, the upper unit occurs in limited area along the downstream of Wadi Awag and El Wadi village near El-Tor (it is composed of gravels and sands with a thickness less than 100 m), the middle unit represents the prospective aquifer in El Gobeil area and the lower unit is mainly consisted of sands and gravels

with unknown thickness. El-Qaa plain is divided into two areas separated by inferred fault that runs through Wadi Isla and the subsurface structures of the area consist of a large number of tilted blocks.

## **2- Hydrogeological setting:**

In the investigated area the depth to groundwater surface in El-Gobeil area ranges between 1.05 m and 20.03 m and the depth to groundwater surface in El-Wadi area ranges between 1.50 m and 23.11 m Regionally, the groundwater flow direction is westward, where groundwater level in El-Gobeil area the groundwater level ranges descends from 9.91 m in the east to 1.17 m in the west with an average hydraulic gradient of about 3.43 m/km, and in El-Wadi area descends from 13.51 m in the east to 8.5 m in the west with an average hydraulic gradient of about 9.77 m/km.

## **Chapter III : Hydrochemical aspects**

The aim of this chapter is to study the water chemistry, water types and the hydrogeochemical process affecting water quality.

Fifty three water samples were collected from the study area 26 samples from El-Gobeil area and 27 from El-Wadi area the study of chemistry of the quaternary aquifer is the main target of this thesis. The following topics are discussed:

### **1- Total salinity:**

**a- El-Gobeil area:** The groundwater salinity range from 1015 mg/l and 5411mg/l with an average 3678 mg/l.

**b- El-Wadi area:** The groundwater salinity range from 465 mg/l and 5233 mg/l with an average 1651.259 mg/l.

## 2- Total hardness :

a- **El-Gobeil area:** The total hardness range from 1015 mg/l as CaCO<sub>3</sub> and 5241mg/l as CaCO<sub>3</sub> with an average 1758.1 mg/l as CaCO<sub>3</sub>.

b- **El-Wadi area:** The total hardness range from 189 mg/l as CaCO<sub>3</sub> and 2340mg/l as CaCO<sub>3</sub> with an average 758.62mg/l as CaCO<sub>3</sub>

## 3- Alkalinity :

a- **El-Gobeil area:** The groundwater alkalinity range from 68.07 mg/l as CaCO<sub>3</sub> and 141.64 mg/l as CaCO<sub>3</sub> with an average 94.9 mg/l as CaCO<sub>3</sub>.

b- **El-Wadi area:** The groundwater alkalinity range from 68.57 mg/l as CaCO<sub>3</sub> and 157.16 mg/l as CaCO<sub>3</sub> with an average 93.3 mg/l as CaCO<sub>3</sub>

## 4- Major componentes:

a- **El-Gobeil area:** The concentration of calcium ranges between 43 mg/l and 531 mg/l with an average 161.67mg/l. The concentration of magnesium ranges between 51 mg/l and 410 mg/l with an average content of about 203.31 mg/l. The concentration of sodium and potassium ranges between 151 mg/l and 1132 mg/l with an average content of about 630.25 mg/l. The concentration of carbonate and bicarbonate ranges between 76 mg/l and 173 mg/l with an average content of about 116.19 mg/l. The concentration of sulphate ranges between 310 mg/l and 2550 mg/l with an average content of about 1375.9 mg/l. The concentration of chloride ranges between 230 mg/l and 2100 mg/l with an average content of about 1136.70 mg/l. The concentration of silica ranges between 10.69 mg/l and 32.20 mg/l with an average content of about 17.07 mg/l

**b- El-Wadi area:** The concentration of calcium ranges between 43 mg/l and 531 mg/l with an average content of about 161.67 mg/l. The concentration of magnesium ranges between 21 mg/l and 258 mg/l with an average content of about 123.59 mg/l. The concentration of sodium and potassium ranges between 87 mg/l and 941 mg/l with an average content of about 294.67 mg/l. The concentration of carbonate and bicarbonate ranges between 84 mg/l and 192 mg/l with an average content of about 115.30 mg/l. The concentration of sulphate ranges between 120 mg/l and 2000 mg/l with an average content of about 115.30 mg/l. The concentration of chloride ranges between 128 mg/l and 1456 mg/l with an average content of about 534.30 mg/l. The concentration of silica ranges between 10.14 mg/l and 31.36 mg/l with an average content of about 19.46 mg/l.

**5- Minor and trace componentes:** The concentration of nitrate in El-Gobeil area ranges between 12.23 mg/l and 87.32 mg/l with an average content of about 52.62 mg/l, the concentration of nitrate in El-Wadi area ranges between 11.31 mg/l and 73.87 mg/l with an average content of about 27.87 mg/l. The range of iron concentration in the investigated area is between 0.028 mg/l and 0.7276 mg/l with an average 0.3551 mg/l. The range of manganese concentration is from 0.0001 mg/l to 0.2772 mg/l with an average 0.02809 mg/l. The range of copper is from 0.0001 mg/l to 0.104 mg/l with an average 0.01567 mg/l. The range of cadmium concentration is from 0.0001 mg/l to 0.0076 mg/l with an average 0.00117 mg/l

## 6- Major ion relations :

**a- El-Gobeil area:** The water types is chloride – sodium and sulphate – sodium. There is one type of hypothetical salts which is NaCl, MgCl<sub>2</sub>, MgSO<sub>4</sub>, CaSO<sub>4</sub> and Ca(HCO<sub>3</sub>)<sub>2</sub> in this case the  $rCl^- - rNa^+ / rMg^{2+} < 1$  the existence of MgCl<sub>2</sub> and

**b- El-Wadi area:** The water types is chloride – sodium and sulphate – sodium. There are two types of hypothetical salts which are:

A – NaCl, MgCl<sub>2</sub>, MgSO<sub>4</sub>, CaSO<sub>4</sub> and Ca(HCO<sub>3</sub>)<sub>2</sub>.

B – NaCl, Na<sub>2</sub>SO<sub>4</sub>, MgSO<sub>4</sub>, CaSO<sub>4</sub> and Ca(HCO<sub>3</sub>)<sub>2</sub>.

## 7- Seawater interference:

By measuring the iodide and bromide concentrations and the calculations of I<sup>-</sup>/Br<sup>-</sup> and Cl<sup>-</sup>/Br<sup>-</sup> ratios indicate that the groundwater in the investigated area affected by seawater intrusion.

## Chapter IV : Evaluation of groundwater quality for different uses

The evaluation of groundwater in the study area shows that :

### a- El-Gobeil area :

**For drinking and domestic uses** the percentage of groundwater wells which are permissible is 11.5% and groundwater wells which are unsuitable is 88.5%. **For livestock and poultry** the percentage of groundwater wells which are very Satisfactory is 14.8%, groundwater wells which are satisfactory is 66.6% and groundwater wells which can be used (not acceptable for poultry only) 18.6%. **For irrigation uses** 89.5% of the area generally unacceptable for irrigation except for very salt tolerant plants and 11.5% which the groundwater wells have salinity which will adversely affect most plants. **For industrial uses** most of

ground water wells are not suitable for most industries except petroleum industries.

**b- El-Wadi area :**

**For drinking and domestic uses** the percentage of groundwater wells which are excellent is 3.8%, groundwater wells which are permissible is 51.8% and groundwater wells which are unsuitable is 44.4%. **For livestock and poultry** the percentage of groundwater wells which are excellent is 65.5%, of groundwater wells which are very Satisfactory is 3.8%, groundwater wells which are satisfactory is 26.9% and groundwater wells which Can be used ( not acceptable for poultry only ) 3.8%. **For irrigation uses** 3.5% of the groundwater wells is acceptable but sensitive plants may shows stress, 51.9% of the groundwater wells generally unacceptable for irrigation except for very salt tolerant plants and 44.4% the groundwater wells at El-Wadi area have salinity which will adversely affect most plants. **For industrial uses** most of groundwater wells are not suitable for most industries except petroleum industries.