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RECENT OBSERVATIONS ON GROUND WATER QUALITY OF SADAT CITY

BY

Y.M. Issa, H. Ibrahim, H.M. Abdel-Fattah and A.H. Esmaiel

Chemistry Department, Faculty of Science,

Cairo University, Giza, Egypt.

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ABSTRACT

The ground water quality of Sadat City was evaluated through the chemical analysis of 167 water samples collected from 15 wells. The chemical character of these water samples was studied by means of TDS, anionic and cationic composition including the trace and major elements. The ground water is classified based on genetic classification, salinity and chemical composition using the trilinear water analysis diagram. The study includes the periodical changes of the ground water chemical composition and the relation between physical and chemical properties of water with TDS.

INTRODUCTION

The earliest survey for the ground water conditions within Wadi El-Natrun area was given by Shotton (1) and Paver (2). A brief description of the main water points in that area was reported by the desert Institute(3-6) and the general company for Research and Ground Water (REGWA) (7-8). Diab (9) studied the ground water occurrence in the southern sector of Cairo- Alexandria desert road. The same author (10) determined the ground water pollution in the quaternary aquifer under the Nile Delta. The hydrogeochemistry of the area West of Rosetta branch and south of El-Nasr canal was studied in 1983 by Abd El-Badi (11).

The ground water resource of west Nile Delta aquifer was evaluated (12) and the design of the water well field for Sadat City was described (13). Bishay (14) studied the hydrogeology and the hydrogeochemistry of the area west of Nile Delta. The chemical composition and genesis of the ground water of Wadi El-Natrun were determined by Hamza et al, (15) Recently, the geology and the hydrology of Sadat City and vicinities were studied by Ibrahim (16).

The present work has been undertaken to study the hydrochemical characteristics of the ground water collected from Sadat City monthly for one year. The distribution of the anions, major and trace metals is determined and discussed.

EXPERIMENTAL

(1) In the Field

Two water samples were collected from every well, one was acidified with nitric acid (to 1% HNO_3) and kept for metal analysis and the other was kept as it is for the other analyses. The general parameters as temperature, conductivity and pH value were measured in the field.

(2) In the Laboratory

(a) Determination of the anions

Carbonate and bicarbonate were determined by titrating two aliquots of the filtered water samples using the conventional procedures. The chloride content was determined by Mohr's method. The concentration of sulphate was determined turbidimetrically using NaCl/HCl-glycerol-ethanol reagent, barium chloride crystal(20-30 mesh) (17).

(b) Determination of the major and trace elements

The major elements including Na, K, Mg and Ca and the trace elements including B, Mn, Fe, Zn, Cd and Pb in the water samples were determined by the direct current plasma atomic emission spectrometry (DCP-AES). Beckman spectrospan V emission spectrometer was used with the standard cross flow nebulizer and echelle grating monochromator. After the calibration of the instrument, each sample was aspirated directly into the plasma for the sequential determination of the respective elements.The computer provides direct output to the printer in either arbitrary intensity units or in concentration units. The plasma and grating positions were adjusted to maximize the emission signals of Na at 330.20, K at 776.45, Mg at 279.55, Ca at 393.37, B at 249.68, Mn at 259.37, Fe at 371,99, Zn at 206.20, Cd at 214.44 and Pb at 283,31 nm. The DCP results were confirmed by determining some elements using recommened procedures. Sodium and Potassium were determined using Jenway PFP 7 flame photometer. Magnesium and Calcium were determined compleximetrically using EBT and murexide indicators, Boron was determined spectroPhotometerically at 615 nm using carmine. Iron was determined also spectrophotometerically at 522 nm using bipyridine.

(c) Qualitative analysis of the elements by DCP photography

For qualitative analysis, the camera is attached to the spectrospan V DCP as described in the DCP operator's manual. The water sample is aspirated and the resulting photograph contains the spectral image of the elements in the sample solution.

RESULTS AND DISCUSSION

Chemical Composition of the Ground Water

The chemical composition of the ground water determines its quality and suitability for certain use. The variations in the chemical composition are generally related to different factors e.g, distance from area of recharge, depth, temperature, pH, rate of ground water flow, lithology of sediments and geological structures.

The TDS of the studied samples ranges from 233 to 1817 mg/L. The high TDS in some wells especially in winter is to the possible sea water encroachment as a result of successive pumping and the increased discharge. In summer, the increase of TDS is due to the successive pumping and the increased evaporation resulting from the increased temperature.

The common concentration of carbonate and bicarbonate is between 50 and 400 mg/L in ground water(18). The concentration of these anions in the studied wells ranges between 140 mg/L in well 90 I and 320 mg/L in well 90 II (Fig, 1), The presence of these anions in ground water is related to the dissolution of carbonate rocks and CO_2 of the atmosphere and in soil.

Ground water contains 1000 mg/L or more of chloride(19). The concentation of chloride in the studied wells varies from 598 to 15 mg/L. The water containing less than 30 mg/L tells us that such ground water is subject to heavy precipitation.

The common concentration of sulphate in the ground water is generally less than 100 mg/L. The sulphate concentration in the collected water samples ranges from 172 to 5 mg/L. The small sulphate concentration may be attributed to the percolation of the recharge water through soil containing active sulphate reducing bacteria (19). On the other hand, the high sulphate concentration in some wells may come from the oxidation of sulphides from igneous rocks and sediments in the area.

The studied water samples have sodium and potassium con centrations in the range 45-560 and 2.1 - 5.7 mg/L respectively. However, well 92 accomodates higher concentration of potassium amounting to 350 mg/L indicating the unsuitability of its water as potable ground water. The corcentration of calcium is 8 - 38.4 mg/L which lies in the range of normal potable ground water. Only the old well 92 accomodates higher concentration of 220 mg/L of calcium. The concentration of calcium is almost related to the dissolution of sedimentary rocks. Magnesium concentration in the studied samples ranges from 2-42.8 mg/L which is near its common concentration range (Table 1).

Some trace elements were determined and the analytical results are shown in Table (1). The results indicate that the water samples under investigation are free from cadmium and manganese. The Pb concentration in most wells are less than those permitted by the WHO for drinking water (20).

Classification of Ground Water According to salinity

Ground water have been classified according to their salinity into three classes (21):

(1) Fresh water, 500 - 2500 mg/L

(2) Brakish water, 2500 - 5000 mg/L

(3) Salt water, more than 5000 mg/L

The ground water samples collected from most wells are mainly good as potable water. The wells located in the west side of the studied area have brakish water. Such increase in salinity on going from the east to the west is due to increasing the salt leaching from soil being away from the river Nile.

Classification According to Chemical Composition

As a matter of fact, the most important major ions in natural water are Cl^-, SO_4^{2-}, CO_3^{2-}, Na^+, K^+, Ca^{2+} and Mg^{2+} which determine the character or the hydrochemistry of water. More accurately, the geochemical classification of the ground water can give a good picture of the type of water.

The trilinear water analysis diagram

This method was proposed by Piper to show the different types of water (22). The water analysis diagram has 3 separate fields for plotting; 2 triangle diagrams (for cations and anions) and a diamond - shaped between them , Fig. (2). The plotted points in the diamond-shaped field indicate the general charater of water. From Piper diagram it can be concluded that:

(A) In the anion triangle, the point representing well 92 lies in the SO_4^{2-} region, those representing wells 90 I and 90 II lie in the high Cl^- region whereas those of the other wells fall in the high CO_3^{2-} and HCO_3^- region.

(B) From the cation triangle, all water samples are of high Na^+ concentration type.

(C) The points in the diamond-shape indicate the following:

(i) The alkalies exceed the alkaline earths i.e. $(Na^+ + K^+) > (Ca^{2+} + Mg^{2+})$ in the water collected from most wells This may be attributed to the exchange of Ca^{2+} and Mg^{2+} by Na^+ and K^+ions at the interface of sand.

(ii) Some of the studied wells (e.g. well 90 1,90 II and 92)have primary salinity $(Cl^- + SO_4^{2-})$ exceeding 50% The chemical properties of such wells are dominated by alkalies and strong acid i.e.$(Na^+ + K^+) > (SO_4^{2} + Cl)$.

(iii) The water in all other wells contain weak acids much more than strong acids i.e. $(CO_3^{-2} + HCO_3^-) > (SO_4^{2-} + Cl^-)$. The type of these waters is of the sodium bicabronate type.

Periodical Changes in Chemical Composition of Ground Water Sadat City

There is a general trend in variation in the salinity and the concentration of cations and anions from one season to another. The change in salinity may be due to the change in concentration of the main anions and cations i. e. HCO_3^- and

Na^{+} ions, The Cl^{-}, SO_4^{2-} , Ca^{2+} and Mg^{2+} remain mostly unchanged over the year, However, the wells of Sadat City can be divided into 3 groups having different trends in the periodical changes:

(1) The wells 1,2,... . 12, PI and PII are characterized by salinity < 350 mg/L, Most of them show a slight increase in TDS during March, April and May, then decrease from June to September and begins to increase again to reach maximum in November. The minimum TDS of most of these wells was observed in December and January.

(2) The wells 90 Iand 90 II have salinity between 350 and 920 mg/L. The salinity attains its maximum value in July, then decreases gradually until October and starts to increase again in November. The minimum TDS is registered in December and January.

(3) The well No. 92 has a salinity higher than 2000 mg/L and its water is considered slightly brakish, The salinity of this well attains its maximum in January to June, then a drastic decrease takes place in July and August. The salinity starts to increase again from August to December.

Relation between physical and chemical properties of water

(1) The electrical conductivity of water can be used to express the content of dissolved salts. For most water samples, a linear relation could be observed between the specific conductance of ground water and its TDS. The specific conductance (uS/cm) measured for any water sample is approximately 0.617 times its TDS (ug/mL). Therefore, the measurement of the conductivity in the field

can give a hint about the salinity of the ground water in Sadat City.

(2) The ground water of Sadat City is found to be alkaline with pH value higher than 8. This is related to the presence of carbonate and bicarbonate salts in these ground water.

Conclusion

The ground water of Sadat City can be used for drinking and for irrigation. The wells of this area should be monitored periodically to determine any change in their water quality. Such changes are related to the climatic conditions and agricultural seasons. Before irrigation, the water of some wells should be demineralized to avoid salt accumulation in soil. For drinking from some wells, the disinfection, fluorination and desalination are also required.

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Table (1): Chemical composition of some ground water samples of Sadat City

Element	Concentration range (mg/mL)		Comment
	reported for potable water	in studied water samples	
Na	20 - 175	45 - 560	fairly high
K	1 - 10	2.1 - 5.7 (350 in well 92)	normal range (high concn.)
Ca	10 - 100	8 - 38.4 (200 in well 92)	normal range (high concn.)
Mg	1 - 50	2 - 42.8	normal range
B	0.01 - 1.00	0.01 - 1.06	normal range
Mn	0.02 - 0.05	nil	free
Fe	0.05 - 0.20	0.00 - 1.57	high concn.
Pb	< 0.05	0.00 - 0.135	normal with exceptions
Zn	> 0.10	0.00 - 0.885	high concn.
Cd	> 0.005	nil	free

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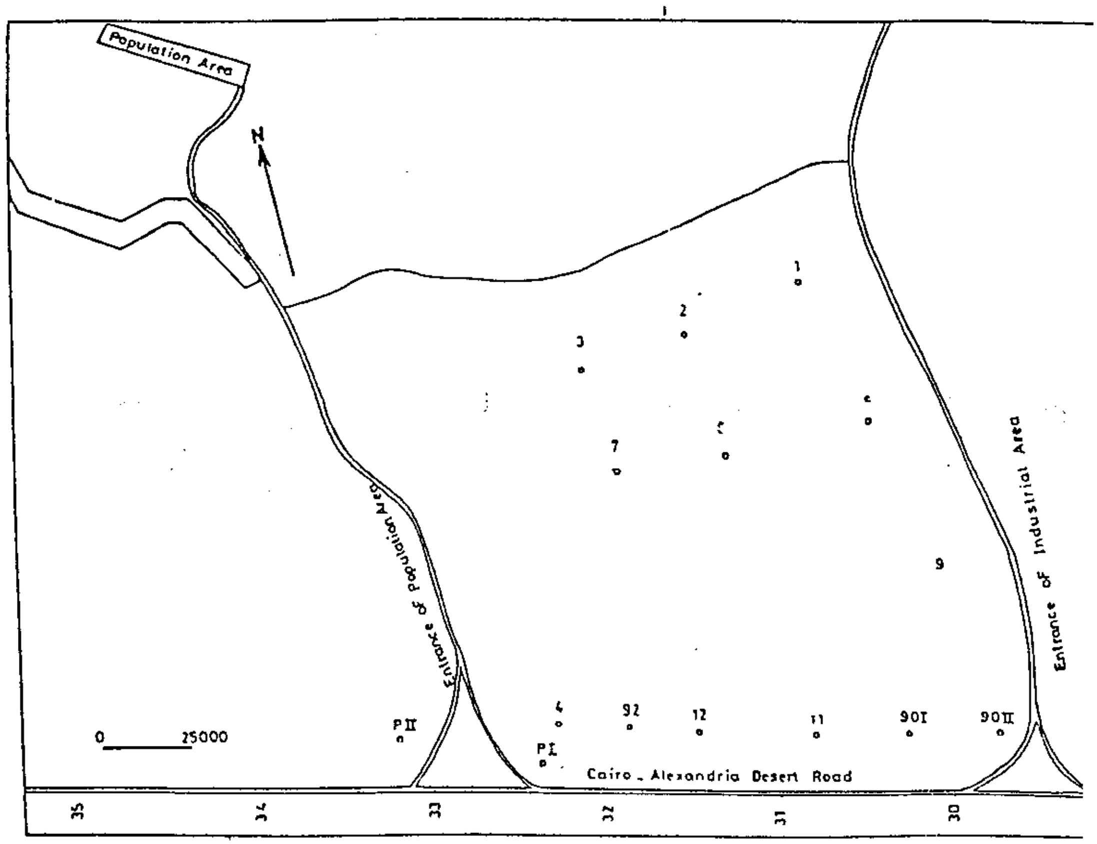

Fig.(1): Inventoried Water Points oF Sadat City

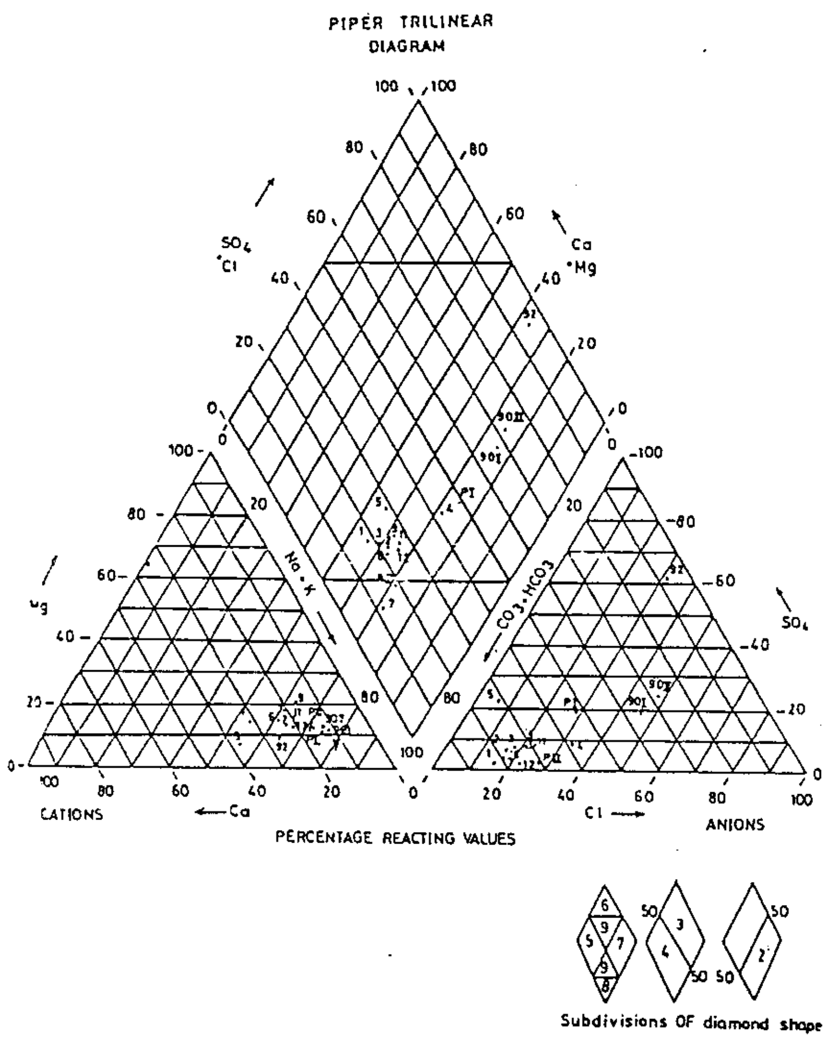

Fig.(2): PIPER TRI Linear Diagram of Sadat City Ground Water

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دراسات حديثة لجودة المياه الجوفية بمدينة السادات

يسرى مصطفى عيسى ، حسنى ابراهيم ، حسين عبد الفتاح ، أمل حسنى اسماعيل
قسم الكيمياء - كلية العلوم - جامعة القاهرة - الجيزة
جمهورية مصر العربية

تم تقييم المياه الجوفية فى مدينة السادات وذلك بالتحليل الكيميائى ل ١٦٧ عينة مياه من خمسة عشر بئر ، وقد تم دراسة الخصائص الكيميائية لها بقياس مايسمى بمحتوى المواد الصلبة الذائبة TDS وكذلك تركيز الانيونات والكاتيونات متضمنة العناصر الثقيلة النادرة ، وقد تم تقسيم أنواع المياه الجوفية طبقا لتركيز الأملاح بها والتكوين الكيميائى وذلك باستخدام المنحنى الخطى الثلاثى لتحليل المياه ، كما تم متابعة التغيرات الدورية للتكوين الكيميائى للمياه الجوفية ووضع علاقة بين الخواص الفيزيائية والكيميائية للمياه وبين TDS ورقم الاس الهيدروجينى PH .