ISSN : 2350-0743

www.ijramr.com

International Journal of Recent Advances in Multidisciplinary Research
Vol. 04, Issue 04, pp.2493-2497, April, 2017

ORIGINAL ARTICLE

HYDROGEOCHEMISTRY OF GROUNDWATER QUALITY IN THE AREA BETWEEN OF ABU QURQAS - DAYER MAWAS DISTRICTS, EL MINYA GOVERNORATE, UPPER EGYPT

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ARTICLE INFO

Article History:
Received 17th January, 2017
Received in revised form
24th February, 2017
Accepted 28th March, 2017
Published online 30th April, 2017

Keywords:
Groundwater, Heavy metals,
Geochemistry, Genesis.

ABSTRACT

Groundwater is the second source of drinking and irrigation water in the study area, especially in the regions which lack of the surface water. Accordingly, twenty-five sample of groundwater have been collected from an area between of Abu Qurqas - Dayer Mawas districts and analyzed physically and chemically. The means of pH and TDS of the studied samples were 7.50 and 554 ppm, respectively. The majority of groundwater samples were fresh but very hard water. The groundwater high contents of the analyzed ions are attributed to leaching processes, the effect of marine sediments, agriculture drainage, sewage water, pesticides and fertilizers applications in the study area. The studied samples are earth alkaline water with prevailing sodium and bicarbonate ions due to ion exchange process of the rainfall which recharges the aquifers. Therefore, the majority of groundwater samples are of meteoric origin.

INTRODUCTION

The most prevailing idea is the good quality of deep groundwater than other water resources (Banks *et al.,* 1998). The geology, surface environment and water-rock interactions led to a load of groundwater with chemical ions (Parriaux and Bensimon, 1997; Kortatsi, 2007). Therefore, the groundwater chemistry would display significant data on the geological setting of the aquifers and the suitability of water for different purposes (Subramani *et al.,* 2005). Groundwater contamination with heavy metals is important environmental issues as their toxicity and persistence (Momodu and Anyakor, 2010). Human activities in the environment such as industry, agriculture, solid waste disposal increase the concentrations of heavy metals in various environmental matrices (e.g. water, soil and air), fruits, vegetables, fishes. etc. (Batayneh, 2010). Heavy metals become toxic when they enter the human body ingestion, inhalation or absorption through the skin (Dupler, 2001). The groundwater is the second source for the freshwater. In Upper Egypt, it is mainly recharged from the local surface water sources in Upper Egypt (Farrag, 2005). The demand for water in Egypt was increased in the last decades as a result of overpopulation. So, a lot of wells were dug for abstracting groundwater for different purposes around Egypt especially for agriculture purpose (Moghaddam and Najib, 2006). The objective of the present study is to interpret hydrogeochemistry of groundwater in the west bank of the River Nile between Abu Qurqas and Dayer Mawas districts, El Minya Governorate, Egypt.

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Location

The study area occupied the middle part of the Nile Valley between longitudes 30° 29′ and 30° 54′ E and latitudes 27° 37′ and 27° 56′ N (Fig. 1). It is bounded by the River Nile from the east and the calcareous plateau at the west between Abu Qurqas northward and Dayer Mawas at the south. The stratigraphic succession in El Minya area is represented by Tertiary and Quaternary sedimentary rocks (Fig. 2). The distribution of the different rock units was indicated in Said (1981). The main aquifer in the study area is represented by Pleistocene sediment which composes of sand and gravel of different sizes with some clay intercalation. The thickness of this aquifer ranged from 25 to 300 m from desert fringes to central Nile Valley (Sadek 2001). The aquifer is underlined by impermeable Pliocene clay layer and overlain by semi-permeable silty clay layer (Fig. 3). The impermeable bed (silty clay) is missed outside the floodplain and the aquifer becomes unconfined westward in the desert fringes. The groundwater flows generally from the southern part to the northern part of the study area. Therefore, the River Nile is a recharge zone. The aquifer is recharged by Nile water, irrigation system, drains, agricultural infiltration and vertical upward from the deeper saline aquifers (Korany *et al.,* 2006).

MATERIALS AND METHODS

In November 2014, twenty five water samples were collected from groundwater resources at the study area (Fig. 1). Pre-rinsed polypropylene bottles were filled with the samples, sealed tightly. The temperature, pH, TDS and electrical conductivity (EC) were determined at the site with the help of digital pH meter (HANNA HI 991300) which was calibrated prior to taking the readings. The samples were filtered and analyzed for chemical constituents by using standard procedures (APHA 1995). Sodium and potassium were determined by flame photometer. Total hardness (TH) as $CaCO_3$, carbonate, bicarbonate and chloride were analyzed by volumetric methods. Sulfate and nitrate were determined by using Spectrophotometer (HANNA HI 83215). Calcium, magnesium, iron, manganese, copper, zinc, chromium, lead and cadmium were analyzed by using atomic absorption spectrometer instrument (Perkin Elmer 400) in National Research Centre Laboratories. The analytical precision of the measurements of ions was determined by the ionic balances, which was below 5%.

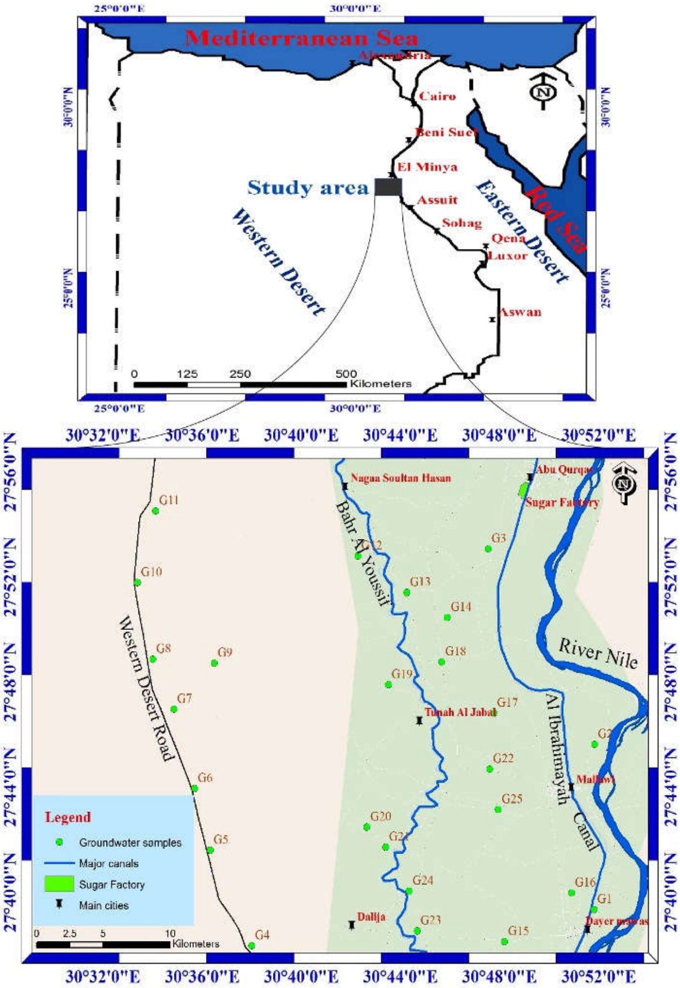

Fig. 1. Location map of the study area

RESULTS AND DISCUSSION

Geochemistry of water and classification

The minimum, maximum and means of the studied parameters and heavy metals contents are listed in Table (1). The means concentration of all elements in the groundwater samples is increased on their means in natural water worldwide except Ca and Fe (Langmuir (1997). According to Hem (1970), the majority of groundwater samples were fresh water (Table 2). In Table (3), all the groundwater samples are very hard water except sample (G_1). Based on Boyed (2000) classification the highest values of TH are due to the leaching processes and effect of the marine sediments. The means concentration of Fe, Mn, Cu, Zn, Cr, Pb and Cd were 94, 444, 133, 31, 12, 243 and 24µg/l, respectively. It is noticed that the increased values of these metals are attributed to leaching processes, effect of marine sediments, agriculture drainage, sewage water, pesticides and fertilizers (El Kashouty *et al.,* 2012 and Zaki *et al.,* 2015). As well, Salman *et al.,* (2016) refer to the role of P-fertilizers in the contamination of the environment with Cd and Pb.

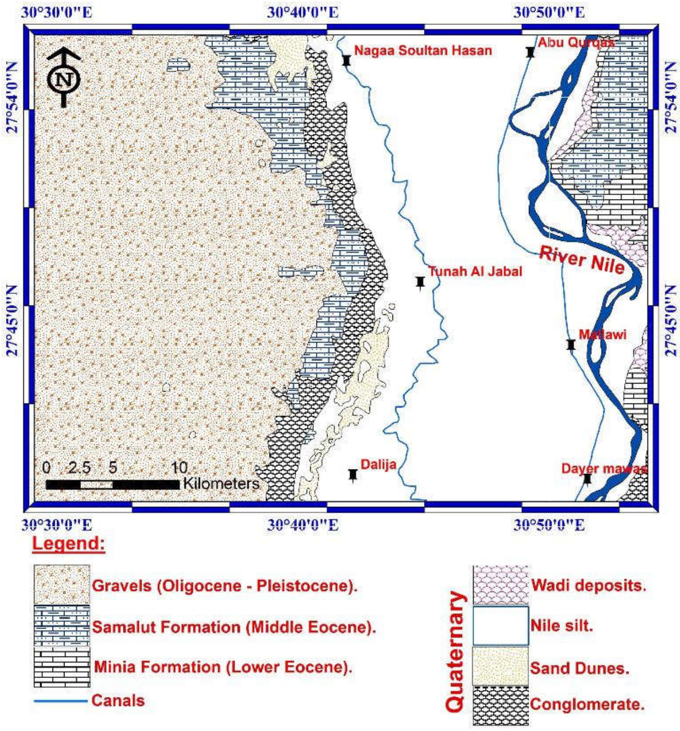

Fig. 2. Geologic Map of the study area

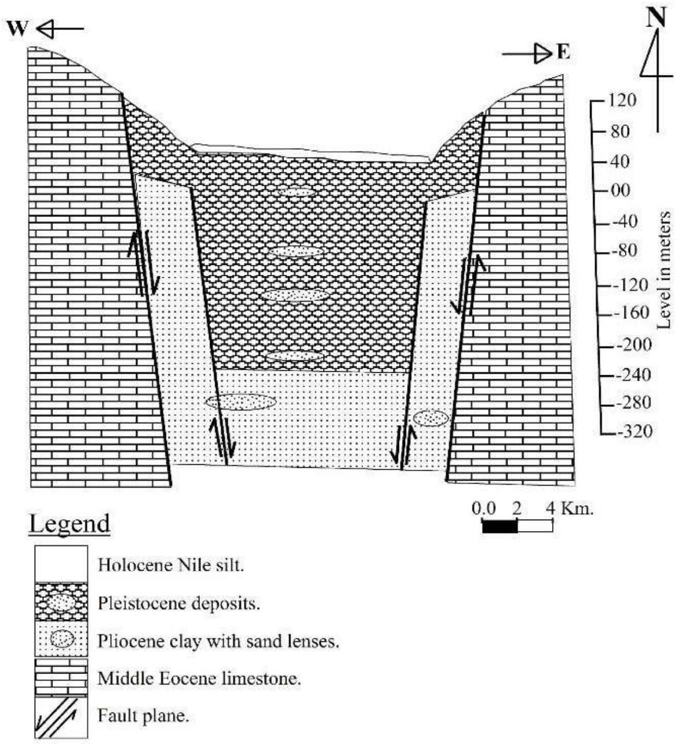

Fig. 3. Subsurface geological cross section in of the study area

Table 1. The physico-chemical parameters of the groundwater samples in the study area

	Unit	Min.	Max.	Mean	*World
pH	-	7.20	8.00	7.50	7.4
T°C	°C	22.60	29.70	25.60	-
EC	µS/cm	625	2432	1287	-
TDS	ppm	273	1056	554	350
TH	ppm	225.7	1348	601	-
TA	ppm	50	700	317.6	-
Ca	ppm	11	110	45	50
	epm	0.5	5.5	2.3	-
Mg	ppm	10	90	39	7
	epm	1.2	7.4	3.2	-
Na	ppm	31	303	109	30
	epm	1.3	13.2	4.7	-
K	ppm	6	58	14	3
	epm	0.1	1.5	0.3	-
HCO_3	ppm	177	953	391	200
	epm	2.9	15.6	6.4	-
Cl	ppm	22	249	97	20
	epm	0.6	7.0	2.7	-
SO_4	ppm	24	166	66	30
	epm	0.5	3.5	1.4	-
NO_3	ppm	ND	69	11	-
	epm	ND	1.11	0.18	-
Fe	µg/l	10	210	94	100
Mn	µg/l	100	2000	444	15
Cu	µg/l	60	240	133	3
Zn	µg/l	ND	140	31	20
Cr	µg/l	ND	71	12	1
Pb	µg/l	90	410	243	3
Cd	µg/l	2	49	24	1

Table 2. Classification of water type according to their TDS (after Hem, 1970)

Water type	TDS (ppm)	Groundwater samples
Very fresh	<300	G_1
Fresh	300-1000	From G_2 to G_{24} except G_7
Slightly Saline	1000-3000	G_7, G_{25}
Moderately Saline	3000-10000	-
Very Saline	10000-35000	-
Briny	>35000	-

Table 3. Classification of water type according to their T.H (after Boyd, 2000)

Water type	TH (ppm)	Groundwater samples
Soft	< 50	-
Medium hard	50 - 150	-
Hard	150 - 300	G_1
Very hard	>300	From G_2 to G_{25}

Hydrogeochemical classification

By plotting the samples on Piper's diagram (1944), most of them were fallen in field No. 4 (Fig. 4) of the diamond shape (earth alkaline water with increased portion of alkalis with prevailing bicarbonate). This may be due to leaching of bicarbonate from the eastern and western carbonate plateau (Abd Elsanad, 2010). According to Durov's diagram (1948), 12 groundwater samples are located in field No. 2 while the other samples fall in field No. 3 (4 samples), field No. 4 (2 samples) and field No. 5 (7 samples) as shown in figure (5). These indicate that the dominance of Na and HCO_3 ions due to the ions exchanges process of rainfall which recharges the wells (Abd Elsanad, 2010). According to Schoeller's diagram (1962), indicates the dominant of Na and HCO_3 ions in the groundwater samples (Fig. 6). This may be indicating the deriving of groundwater from meteoric water (Abd Elsanad, 2010).

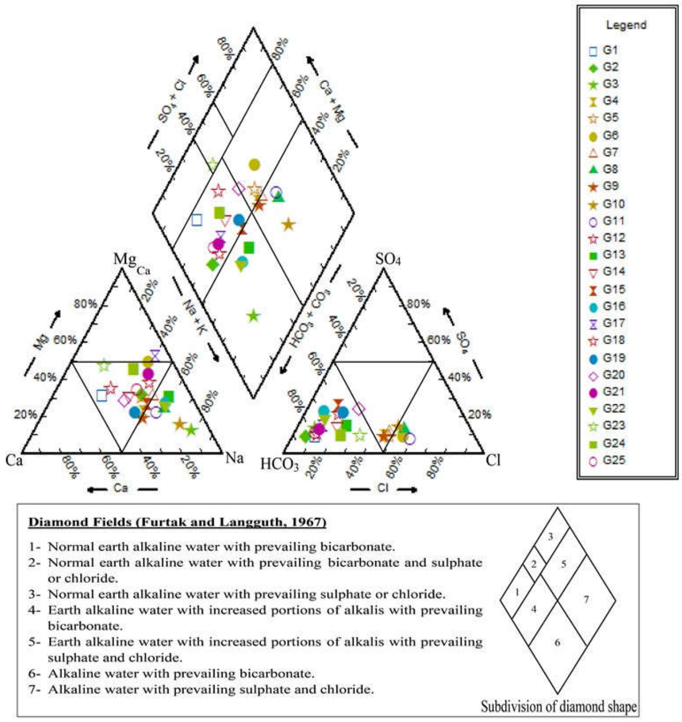

Fig. 4. Piper's diagram for classification of groundwater of the study area

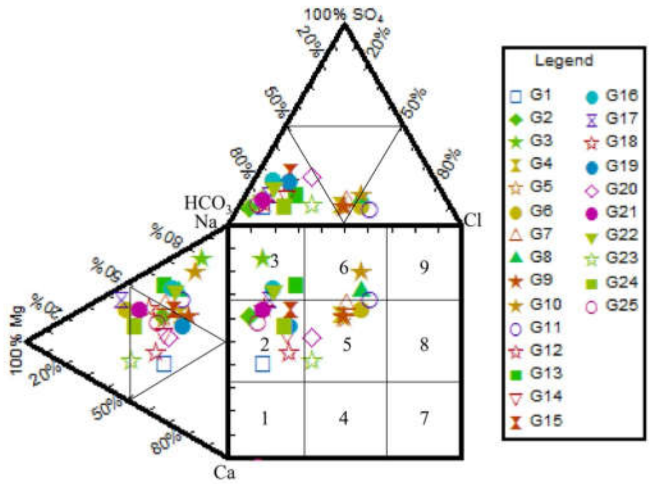

Fig. 5. Durov's diagram for the classification of groundwater of the study area

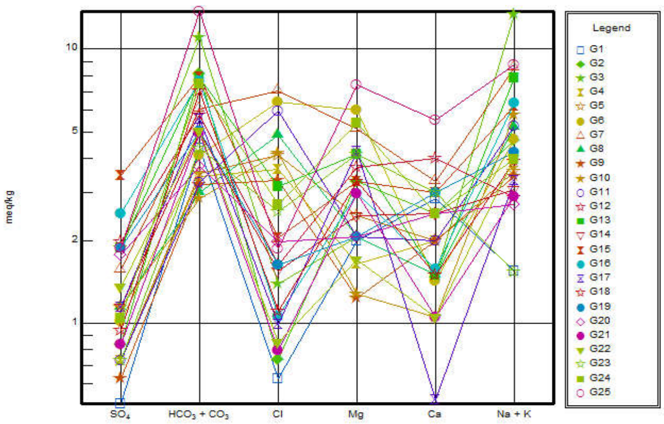

Fig. 6. Schoeller's semi-logarithmic representation of the study groundwater samples

According to Sulin's diagram (1946), the majority of groundwater samples are occupied the $NaHCO_3$ type of the meteoric origin (Fig. 7). This refers that the meteoric water may be influenced by salt water (Korany, 2006) or most probably rainwater in the investigated area partially occurs and recharges the groundwater (Abd Elsanad (2010)**.**

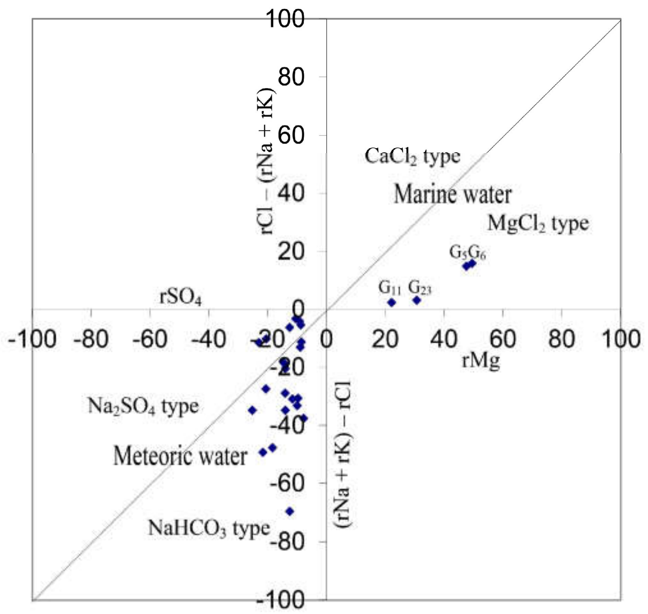

Fig. 7. Sulin's diagram classification of groundwater in the study area

Conclusion

The study area located on the western bank of River Nile between Abu Qurqas and Dayer Mawas districts, El Minya Governorate. The water is fresh to very fresh water and very hard water with salinity fluctuated around 55 ppm. The increased concentrations of elements result of leaching processes, the effect of marine sediments, agriculture drainage, sewage water, pesticides and fertilizers. The studied water samples represented earth alkaline water with prevailing bicarbonate due to leaching of bicarbonate from the eastern and western carbonate plateau. Both of Na and HCO_3 are the prevailing ions in the studied water related to the ion exchange process in the rainfall which recharges the groundwater aquifers. The majority of waters are derived from the meteoric origin which may be affected by salt water or rainfall.

Acknowledgments

The National Research Centre is the organization that funded this research as a Ph.D. internal project and the grant no. is (8/5/9) to support Mr. Ahmed A. Asmoay to do the lab work.

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