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HYDROGEOLOGICAL STUDIES ON WADI AL-QARN BASIN, EASTERN DESERT, EGYPT.

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ABSTRACT

The present work deals with flash floods, hydrogeological and hydrogeochemical conditions of Wadi Al-Qarn. This basin is subdivided into seven hydrographic sub-basins. The studying of the hydromorphometric parameters of these sub-basins shows low bifurcation ratios and high values of drainage densities and frequencies, consequently more possibilities for flash floods. W. Atallah and W.Zydun sub-basins are nearly circular in shape and they have high values of relief and ruggedness number and acquire the highest values of maximum runoff. Therefore, they are classified as very dangerous sub-basins. Under such conditions the construction of alternative barriers or boulder dams at the upstream parts of these basins will minimize flooding hazards and give more chance for groundwater recharge and improve groundwater quality.

The main water bearing formations within W. Al-Qarn basin are the basement rocks, the Nubian sandstone and the Quaternary aquifers. The basement rocks represent the main catchement area and watersheds. The Nubian sandstone aquifer exists under confining conditions and the present wells are characterized by natural flowing. The upward elevations of water levels in wells, decrease in electric conductivity, water salinity and concentrations of ions in water samples after the intensive precipitation indicate that the aquifers are mainly recharged during times of torrent floods. The hydrochemical compositions of the water samples indicate that the basement rocks and the Quaternary aquifers belong to Na_2SO_4 *water type of meteoric origin, while the Nubian sandstone aquifer reflects* $MgCl_2$ *water type of marine origin diluted with meteoric water percolation.*

1. *INTRODUCTION*

Wadi Al-Qarn is located east of Qift City (Fig. 1). It is bounded by latitudes 25° 30' & 26° 15' N and longitudes 32° 50 & 34° E. Wadi Al-Qarn represents one of the most important drainage basins draining toward the River Nile. The groundwater is considered the principal water resource for land reclamation projects and establishment of new settlements. Groundwater development cannot be achieved unless proper investigations are carried out for the identification of aquifer system, their characteristics and groundwater potential.

The studied area had been suffered from flash floods that frequently occurred during years, 1979, 1980, 1985 and 1994. These floods made defects on Qift-Qusseir road and vigorously affect on the villages exist at the outlet of this drainage basin. On the other hand, the flash floods increase the contribution of groundwater and improve groundwater quality. The studying of the morphometric parameters of W. Al-Qarn basins is very important in the determination of the intensity of floods and provides the suitable solutions for avoiding or reducing as much as possible hazards that occur.

2. AIM AND METHODS OF STUDY

The present work deals with flash floods, hydrogeological and hydrogeochemical conditions of Wadi Al-Qarn. The studied drainage basin (Fig 2) was mapped from topographic maps of scale 1:50,000. The main wadi is subdivided into seven hydrographic sub-basins namely W. Al-Timid, W. El-Mashash, W.Al-Atwany, W. Abu Wasil, W. Abu Tanudbah, W.Atallah and W.Zaydun (Fig. 2). Quantitative analysis of these sub-basins had been studied through eight hydromorphometric parameters. A trial was made to estimate the maximum value of runoff (m^3). Field measurements, observations and collection of water samples were carried out during June and December 1994 before and after the flash flood that occurred in November 1994. Chemical analyses of the collected water samples were carried out for the two periods. The data is processed and interpreted in various ways.

3. *GEOLOGIC SETTING*

The studied drainage basin carved its course through the basement rocks at the eastern part and sedimentary rocks at the western part. The sedimentary succession of the study area is more or less related to Upper Cretaceous-lower Eocene rocks in addition to Pliocene and younger sediments(Fig. 3). The description for different stratigraphic units can be summarized from base to top as follow:

1-The Nubian sandstone lies directly on the basement rocks. It is composed of coarse grained sandstone. Intercalations of thin marls and clays are also found. Concretions, mainly formed of iron oxides or silisified sandstones are common in some beds (Youssef, 1957). The thickness of this unit is 222.9 m at the low hills along Qena Qusseir road (Amer, 1970).

2-The Qusseir shale overlies conformably on the Nubian sandstone and underlies the Duwi Formation. It is composed of alternating succession of siltstone, shale and abundant sandstone. The Qusseir Formation reaches 200 m thickness (Ghanem et al., 1970).

3-The Duwi Formation overlies the Qusseir shale. It is composed of phosphate beds and constitutes in between hard semicrystalline siliceous limestone with other phosphate intercalations (youssef, 1957). Its thickness reaches up to 40 m (Ghanem, et al., 1970).

4-The Dakhla Shale overlies the Duwi Formation. It is composed of a lower part, rich in calcareous marls and an upper shale part (Said, 1962).

5-The Trawan Chalk overlies conformably the Dakhla Shale and underlies the Esna Shale. It has a thickness of 6 m (Soliman et al., 1986).

6-The Esna Shale overlies the Tarawan Chalk. It is composed of grey laminated shales and marls, which become more calcareous upward. Its thickness reaches 50 m (Soliman et al., 1986).

7-The Thebes Formation overlies conformably on the Esna Shale. It is composed of limestone containing flint concretions.

8-The Pliocene sediments cropout on both sides of the Nile Valley. It is composed of clay with some interbeds of sand (Said, 1981).

9-The Quaternary sediments represent the wadi deposits composed of detritus, sands and pebbles. This unit has a variability in thickness from place to other.

Faulting is the main structural feature affecting the different rock units in the studied area. They are mostly of high angle normal faults with various extensions and of relatively small throw values. Most of these faults have the NW-SW and NNW-SSE trends. The faults having the trends WNW-ESE, ENE-WSW and NE-SW are less abundant. The WNW-ESE faults are more or less parallel to the main channel of Wadi El-Mathula, and thus believed to control its course. The majority of the drainage lines in the studied area are partially structurally controlled (El-Hussaini et al., 1990).

4.MORPHOMETRIC PARAMETERS OF THE DRAINAGE BASIN

4.1 Stream order (Nu):

The first step in the drainage basins analyses is the designation of stream order, following a system introduced by Hotron(1945) and slightly modified by Strahler (1952). The smallest fingertip tributaries are designated order 1. Where two first order channels join, a channel segment of order 2 is formed. The trunk stream through which all discharge of water and sediments passes is therefore the stream segment of the highest order.

4.2 Bifurcation Ratio (R_b):

This is defined as the ratio of segments of a given order Nu to the segments of the next higher order and is expressed by:

$$R_b = Nu / Nu + 1 \quad (1)$$

Horton (1945) in his law of stream order stated that, the number of stream segments of each order form an inverse geometric sequence with order number that is

$$Nu = R_b^{k-u} \quad (2)$$

Where k is the order of the trunk segment

u is the stream order

Nu is the number of segments of a given order.

The theoretical minimum possible value of 2 is rarely approached under natural conditions. The elongate basins with high R_b (> 17) would yield a low but extended peak flow, while the rotund basin with low R_b will produce a sharp peak flow (Strahler, 1964). The R_b of the studied sub-basins ranges among 2.9 and 4.6 (Table 1). These low values of R_b give more possibilities to flash floods.

4.3 Drainage Frequency (F):

Horton (1932) introduced stream frequency (F) as the number of stream segments per unit area, or

$$F = \sum_{i=1}^{k} Nu / A_k \qquad (4)$$

where

$\sum_{i=1}^{k} Nu$ is the total number of segments of all orders within the given basin of order k,

A is the area of that basin in Km^2.

Stream frequency has the dimensions of L^{-2}, high values tend to give more possibilities for the collection of runoff. W. Al-mashash, W. Atwany, W. Atallah and W. Zaydun have the highest frequencies among the studied sub-basins (Table 1).

4.4 Drainage Density(D):

Horton (1932) introduced the drainage density as the length of stream segments per unit area.

$$D = \sum_{i=1}^{k} \sum_{i=1}^{N} L_u / A_k \qquad (5)$$

where L_u is the total length of all streams of all orders

A is the area of the basin in Km^2.

Melton (1958) analysed in detail the relationship between the drainage density and drainage frequency, both of which measure the texture of the drainage basin and he found that:

$$F = 0.694\, D^2 \qquad (6)$$

where D is the drainage density.

F is the drainage frequency.

0.684 is a constant value.

Horton (1932) found that the mean drainage density is 0.93 and increases to 1.24 Km/Km^2 in the mountainous area with impermeable rocks having high precipitation. It decreases in the drainage basins covered by permeable rocks. Regions of high drainage density are associated with larger flood flows and low proportion of groundwater contribution. With increasing drainage density, the path length of overland flow decreases, consequently the velocity of runoff increases (El-Rakaiby, 1989).

The studied sub-basins have high densities, it ranges between 2.3 and 2.8 Km/Km^2. This reflects high relief, impermeable subsurface material, sparse vegetation, and low contribution for groundwater, specially in the area covered by the Pliocene deposits (downstream part of W.Al-Qarn) and basement rocks (upstream part of W.Al-Qarn). The central part of W.Al-Qarn is occupied by Nubian sandstone (60%) and acquires low drainage density and wide channels. This reflects that, the contribution of local rainfall to the groundwater is expected to be high.

4.5 Elongation Ratio (Re):

Schumm (1956) used an elongation ratio (Re), defined as the ratio of diameter of a circle of the same area as the basin to the maximum basin length. Values near 1 are typical of regions of very low relief, and the basin shape is nearly circular, whereas values in the range 0.6 to 0.8 are generally associated with strong relief and steep ground slopes. The estimated values of the Re for the studied sub-basins indicate that, W.Al-Mashash (0.79) and W.Atallah (0.75), W. Abu Wasil(0.66) and W.Zydun (0.63) are nearly circular in shape, and this reflects the most favorable shape and conditions for the shortest runoff distance.

4.6 Maximum Basin Relief (H_m):

The Maximum Basin Relief (H_m) is the elevation difference between basin mouth and the highest point on the perimeter, in meters. Relief measures are indicative of the potential energy of a drainage basin (Strahler, 1964). W. Atallah and W. Zydun have the highest relief(H_m) among the studied drainage sub-basins (846 & 529m respectively).

4.6 Relief Ratio(R_h):

Schumm (1956) measured relief ratio (R_h) as the ratio of maximum basin relief to the horizontal distance along the longest dimension of the basin parallel to the principal drainage line. The relief ratio measures the overall steepness of a drainage basin and is an indicator of the intensity of erosion processes operating on slopes of the basin (Strahler, 1964). With increasing relief, steepness of hillslopes and high stream gradient, time of concentration of runoff decrease, increasing potential of flooding (El-Rakaiby, 1989). W. Atallah and W. Al-Timid and W. Abu Wasil have the highest relief ratio(R_h), among the studied drainage sub-basins (14, 8.2 and 8.1m, respectively).

4.7 Ruggedness Number (HD):

Ruggedness number (HD) is a dimensionless parameter and is formed of the product of relief (H_m) and drainage density(D) (Melton, 1957). The ruggedness number is very useful parameter and summarizes the interaction of relief and dissection (Patton, 1988). The Ruggedness numbers of W. Atallah, W.Zydun and Abu Wasil sub-basins are 2326.5, 1304 and 1111.7, respectively. These values are the highest among those of other sub-basins, and this reflects that the time of concentration of runoff is short. Thereby the probability of flooding is very high in the above mentioned drainage sub-basins. Considering the above mentioned discussions the constructions of alternative barriers or boulder dams and according to El-Shamy(1985,1988 and 1992) at the upstream parts of this drainage sub-basins(Fig 2) allow slow water flow to the down stream parts. This prevent the flooding hazards, increase the contribution of groundwater and improve groundwater quality. The retardation barriers or dams must be constructed at narrow parts of gentle slope course in the drainage basins.

5. METEOROLOGICAL CONDITIONS

The nearest meteorological stations to the studied area are located in Qena Qusseir and Luxor areas. The mean annual rainfall in W.Qena is 14.4 mm^3 and the maximum daily rainfall is 21 mm^3 (El-Rakaiby, 1989). The maximum temperature during summer is 42 °C, whereas the minimum is 5.75 °C in winter. The average values of the relative humidity are 29.9 % and 50.4 % during summer and winter, respectively. The maximum recorded wind velocity is 5.9 Km/hr. The rainfall in Luxor area is insignificant throughout the year (El-Hosary, 1994). This reflects that, the flash floods that frequently occur in winter are in the storms form.

Due to the lack of meteorological stations covering the area, a trial is made to estimate the expected maximum values of runoff (m^3) were calculated according to the equation (Ball, 1937) as scenarios 25, 50 and 100 mm precipitation per day:

$V = 750\ A\ (R-8)$

where R is the average weighted maximum rainfall in one day (mm^3)
A is the basin area (Km^2)

The estimated data (Table 1) shows that W.Zydun has the highest values of maximum floods among the other sub-basins (ranges from 26.7 to 146.5 Mm^3) and followed by W.Atallah (ranges from 20.4 to 110.Mm^3), W. Abu Wasil (ranges from 15.12 to 81.56 Mm^3) and W.El-Mashash(ranges from 11 to 59.6 Mm^3). This reflects the dangerousness of these drainage sub-basins.

6. HYDROGEOLOGIC UNITS

The Basement rocks, Nubian sandstone and the Quaternary sediments represent themselves as aquifers. The hydrogeological characters of these aquifers are given as follow:

6.1 The basement rocks aquifer

The igneous and metamorphic rocks crop out at the eastern part of the area (Fig.3), where they represent the main catchement area and watersheds. They are highly weathered and strongly fractured, jointed and faulted. Such structural features permit the accumulation and movement of groundwater. The accumulated amount of water depends up on the depth, width and extension of fractures, where the water volume is oftenly limited but services as water supply for local populations.

At EL-Fawakheir area the wells were penetrated on a shear zone(N 65 W trend) between the old granite and the ultramaphic rocks(Talc carbonates). The structural elements such as faults(NS trend), joints(N70E) plays a major role for groundwater accumulation. At W. Al-Sad, the groundwater was accumulated in meta-gabbroic rocks on a highly fractured shear zone. Dykes which crossing wadi Al-Sad cause the entrapment of water. At El-Hammamat well, the water was accumulated through faults, joints and fractures in Hammamat Group(unmetmorphosed conglomerate, greywake, arenite, and siltstone). The upward elevation of water levels in the wells after flash floods that occurred during November 1994 ranges between 1 and 2.5 m. The decrease in electric conductivity, water salinity(Fig. 4), and concentrations of ions(Table 2) in water samples after the intensive precipitation support that the aquifer is mainly recharged during times of torrent floods.

6.2 The Nubian sandstone aquifer

The Nubian sandstone aquifer is composed of medium to coarse grain sandstone with thin marl and clay intercalations. It is exposed at the central part of the study area unconformably overlies the basement aquifer. Its thickness ranges among 200 and 250 m. The aquifer is recharged from the high mountainous range at the east while it discharged through fault plains as upleakage to the Quaternary aquifer under high pressure water or through the flowing wells. The pumping tests executed by the Red Sea Development Organization (1985) on sex wells tapping this aquifer reveal the following hydrological characters:

1-The transmissivity ranges among 150 and 310 m^2/ day.

2-The permeability ranges among 1.1 and 1.5 m/ day.

3- The storage coefficient is 3.8×10^{-4}.

The aquifer exist under confining conditions and the present wells characterized by natural flowing. The rate of flowing ranges among 265 m^3/day and 1500 m^3/day.

The decrease in electric conductivity, water .salinity (Fig. 4) and concentrations of ions(Table 2) in water samples is attributed to the direct precipitation and occasional torrents that occurred during November 1994, which cause dilution for groundwater.

6.3 The Quaternary aquifer

The Quaternary aquifer is composed of detritus, sands and pebbles with clay lenses. It is widely distributed in the area as wadi fillings. This unit has a variability in thickness from place to other. It ranges among 45 and 83 m(RSDO, 1985). The aquifer is recharged from the direct precipitation and occasional torrents, which reach down along the mountain slopes and from the deeper aquifer through fault plains and joints. The aquifer is discharged through pumping from excavated borehole.

The upward elevation of water levels in the wells ranges between 0.6m and 1m. The decrease in electric conductivity, water salinity (Fig. 4)and concentrations of ions(Table 2) in water samples after the intensive precipitation supports that the aquifer is mainly recharged during times of torrent floods.

7. GROUNDWATER QUALITY

The chemical analyses of water samples were carried out and were checked for error to be less than 5% (Table 2). The groundwater of the basement rocks is fresh where the salinity ranges between 822.5 and 974 ppm except for al-Sad and Al-Hamamat wells are classified as slightly saline and moderately saline, respectively. The groundwater of the Nubian sandstone is slightly saline where the water salinity ranges between 1567 and 1581 ppm. The groundwater of the Quaternary aquifer is moderately saline to saline where the water salinity ranges between 2900 and 11000 ppm.

Saturation index(SI) is difined as the logarithm of the ion activity product divided by the equilibrium constant. The saturation indices of groundwater samples(SI) are calculated (Table 3) using Computer Program WATEQP by Appelo and Postma (1993). For SI= 0, there is equilibrium between minerals and the solution; SI $<$ 1 reflects subsaturation, and SI $>$ 1 supersaturation. For subsaturation dissolution is expected, and supersaturation suggests precipitation(Appelo and Postma (1993). All groundwater samples are supersaturated for calcite and dolomite minerals and subsaturated for gypsum. Hence, low concentrations of bicarbonate ions are due to calcite and dolomite minerals precipitation. On the other hand high concentrations of sulphate ions are due to dissolution processes. The hydrochemical compositions in the studied area show different water types in different hydrogeological units. The hydrogeochemical aspects of each unit can be discussed as follow:

7.1 - The basement rocks aquifer

The hydrochemical composition of the water samples shows that the water is alkaline in reaction where the pH ranges between 7.6 and 8. The ionic concentrations of sulphates are the highest between the anions and followed by chloride ions. Among the cationic concentrations the sodium ions prevail and followed by calcium ions(Table 2). The hydrochemical compositions of the water samples indicate the meteoric genesis of water, where the equivalent concentrations of potassium and sodium are greater than that of the chloride($r(K+Na)/rCl>1$).

The hydrochemical parameter $r(K+Na)-rCl/rSO_4<1$(Table 3).of the water samples indicate that the water belongs to $Na_2 SO_4$ water type of meteoric origin, Where the excess sodium ions in solution are lesser than the total concentration of sulphates after the formation of sodium chloride salts(Sulin, 1946). The values of the hydrochemical parameters rK/rCl, rNa/rCl, rMg/rCl, rCa/rCl, and rSO_4/rCl in equivalent concentrations are calculated (Table 3) and compared with the values of similar parameters of normal sea water (Ovitchinikov, 1963) which are 0.0181, 0.8537, 0.1981, 0.0385 and 0.103, respectively. A relative increase in the concentrations of potassium, sodium, magnesium, calcium and sulphates is noticed, which indicates that the hydrochemical composition is mainly formed due to leaching of meteoric water to the fragments of rock constituents.

7.2 The Nubian Sandstone aquifer

The hydrochemical composition of the water samples shows that the solution is alkaline in reaction where the pH ranges between 7.6 and 8. The ionic concentrations of chloride are the highest between the anions and followed by sulphate ions. Among the cationic concentrations the sodium ions prevail and followed by calcium ions(Table 2). The hydrochemical compositions of the water samples indicate the marine genesis of water, where the equivalent concentrations of potassium and sodium are lesser than that of the chloride($r(K+Na)/rCl<1$).

The hydrochemical parameter $rCl-r(K+Na)/rMg<1$ (Table 3).of the water samples indicate that the water belongs to $MgCl_2$ water type of marine origin, Where the excess chloride ions in solution are lesser than the total concentration of magnesium after the formation of sodium chloride salts(Sulin, 1946). The calculated values of the hydrochemical parameters rK/rCl, rNa/rCl, rMg/rCl, rCa/rCl, and rSO_4/rCl in equivalent concentrations(Table 3) show by comparison with the values of similar parameters of normal sea water (Ovitchinikov, 1963) a relative increase in the concentrations of potassium, sodium, magnesium, calcium and sulphates. This increase reflects leaching processes to the rock constituents by meteoric water percolation before mixing with the original marine water genesis between rock pores.

7.3 The Quaternary aquifer

The hydrochemical composition of the water samples shows that the water is alkaline in reaction where the pH ranges between 7.6 and 7.9. The ionic concentrations of chloride are the highest between the anions and followed by sulphate ions. Among the cationic concentrations the sodium ions prevail and followed by calcium ions(Table 2). The hydrochemical compositions of the water samples indicate the meteoric genesis of water, where the equivalent concentrations of potassium and sodium are greater than that of the chloride($r(K+Na)/rCl>1$).

The hydrochemical parameter $r(K+Na)-rCl/rSO_4<1$ (Table 3).of the water samples indicate that the water belongs to Na_2SO_4 water type of meteoric origin, Where the excess sodium ions in solution are lesser than the total concentration of sulphates after the formation of sodium chloride salts(Sulin, 1946). The study of the hydrochemical parameters rK/rCl, rNa/rCl, rMg/rCl, rCa/rCl, and rSO_4/rCl(Table 3) and compared with the values of similar parameters of normal sea water (Ovitchinikov, 1963)show a relative increase in the concentrations of potassium, sodium, magnesium, calcium and sulphates, which indicates that the hydrochemical composition is mainly formed due to leaching of meteoric water to the fragments of rock constituents.

8. CONCLUSIONS

The studies of the morphometric parameters of seven drainage sub-basins in W. Al-Qarn reveal the following:

1- All the studied drainage sub-basins show low bifurcation ratios (R_b) and have high values of drainage densities and frequencies. This values give more possibilities for flash floods and low contribution for groundwater. With exception of the central part of W. Al-Qarn that occupied by Nubian sandstone and characterized by wide drainage channels and low density, thus the contribution for ground water is expected to be high.

2-W. Atallah and W.Zydun are nearly circular in shape (Re are 0.75 & 0.63 respectively) and this reflects the most favorable shape for the shortest runoff distance.

3-W.Atallah and W.Zydun have high values of relief and ruggedness number and this gives short time of concentration of runoff. Therefore, the probability of flooding is very high.

4-W.Atallah has the highest value of maximum runoff and followed by W.Zydun and this reflects the dangerousness of these drainage basins. Under such conditions the construction of alternative barriers or boulder dams at the narrow and low slopes parts of these basins will minimize flooding hazards and give more chance for groundwater recharge and improve groundwater quality.

The main water bearing formations within W. Al-Qarn basin are the basement rocks, Nubian sandstone and the Quaternary sediments . The studying of the Hydrogeological and hydrogeochemical characters for each aquifer reveal the following:

1-The basement rocks represent the main catchement area and watersheds and they are highly weathered and strongly fractured, jointed and faulted at the water points. The water volume is oftenly limited but services as water supply for local populations.
2-The Nubian sandstone aquifer exists under confining conditions and the present wells are characterized by natural flowing. The transmissivity ranges among 150 and 310 m^2/ day, the permeability ranges among 1.1 and 1.5 m/ day and the storage coefficient is 3.8×10^{-4}.
3-The upward elevation of water levels in the wells, the decrease in electric conductivity, water salinity and concentrations of ions in water samples after the intensive precipitation supports that the aquifers are mainly recharged during times of torrent floods.
4-All groundwater samples are supersaturated for calcite and dolomite minerals and subsaturated for gypsum. Hence, low concentrations of bicarbonate ions are due to calcite and dolomite minerals precipitation. On the other hand high concentrations of sulphate ions are due to dissolution processes.
5-The hydrochemical compositions of the water samples of the basement rocks and the Quaternary aquifers show that the water belongs to Na_2SO_4 water type of meteoric origin. The hydrochemical parameters rK/rCl, rNa/rCl, rMg/rCl, rCa/rCl, and rSO_4/rCl indicates that the hydrochemical composition is mainly formed due to leaching of meteoric water to the fragments of rock constituents.
6-The hydrochemical composition of the water samples of the Nubian sandstone aquifer show that the water belongs to $MgCl_2$ water type of marine origin. The hydrochemical parameters rK/rCl, rNa/rCl, rMg/rCl, rCa/rCl, and rSO_4/rCl reflects leaching processes to the rock constituents by meteoric water percolation before mixing with the original marine water genesis between rock pores.

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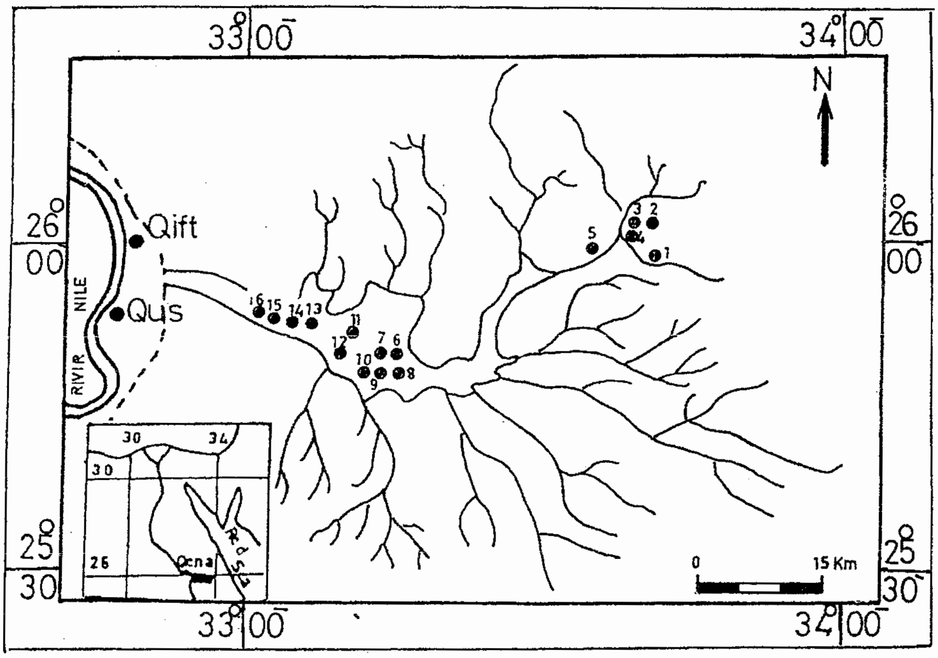


Figure(1) Location map of the studied area and sample sites

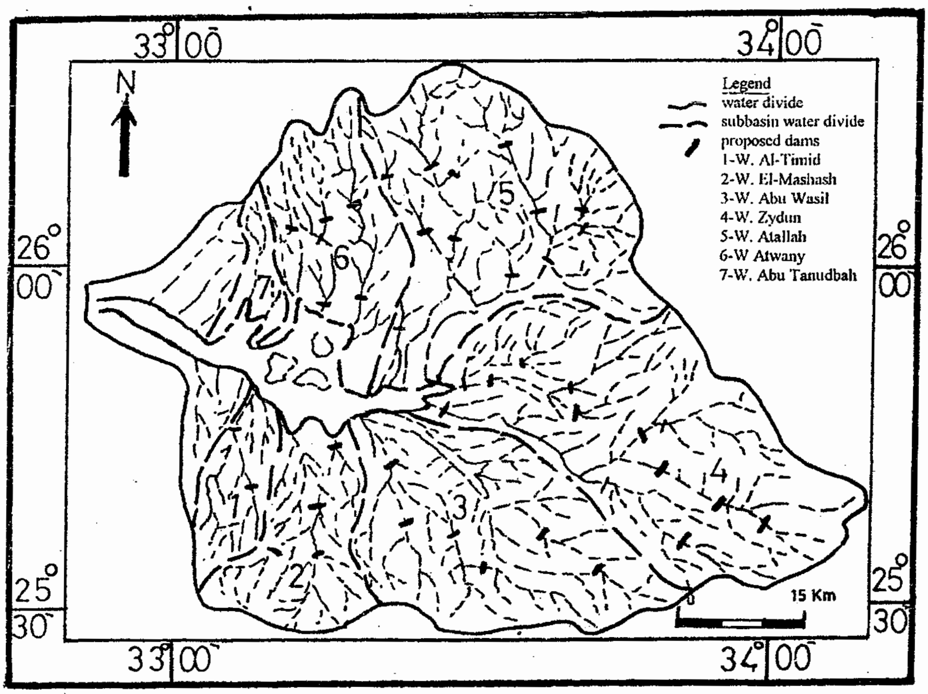


Figure (2) Drainage basin map of W. Al-Qarn

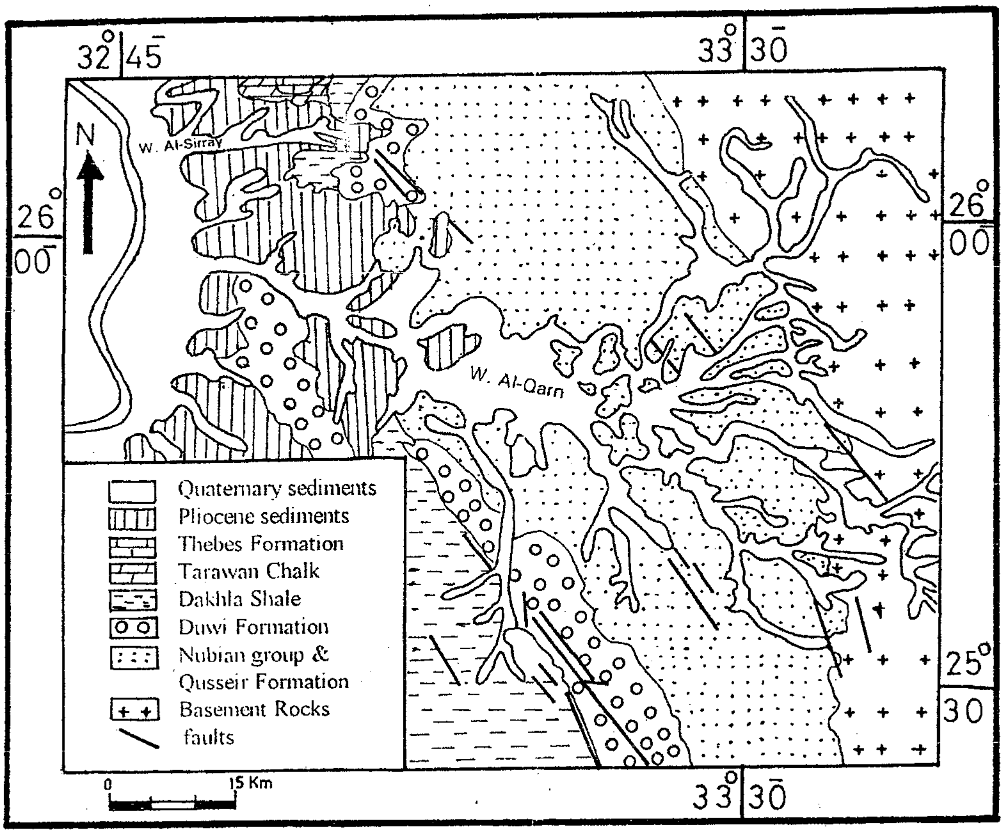
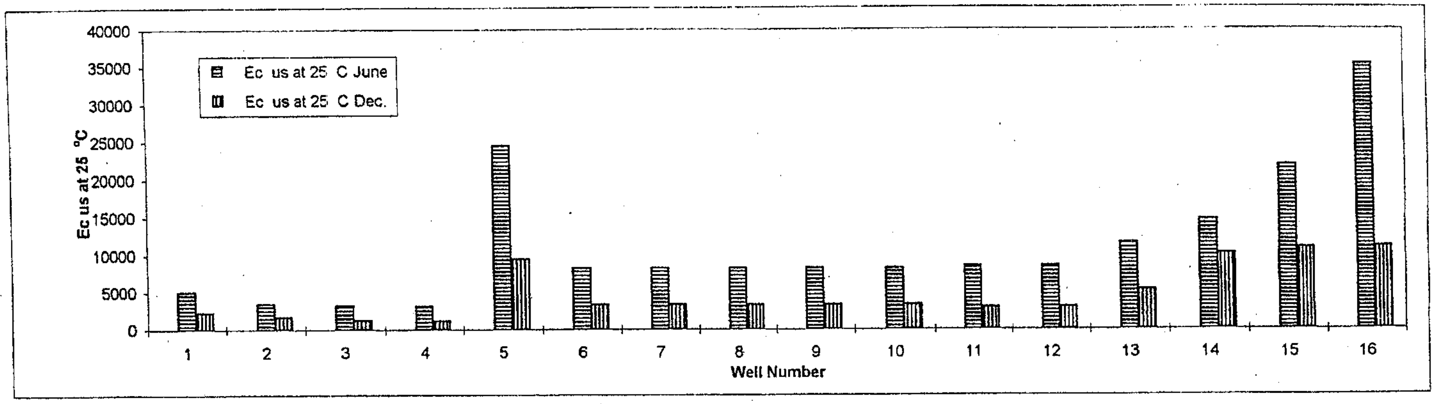


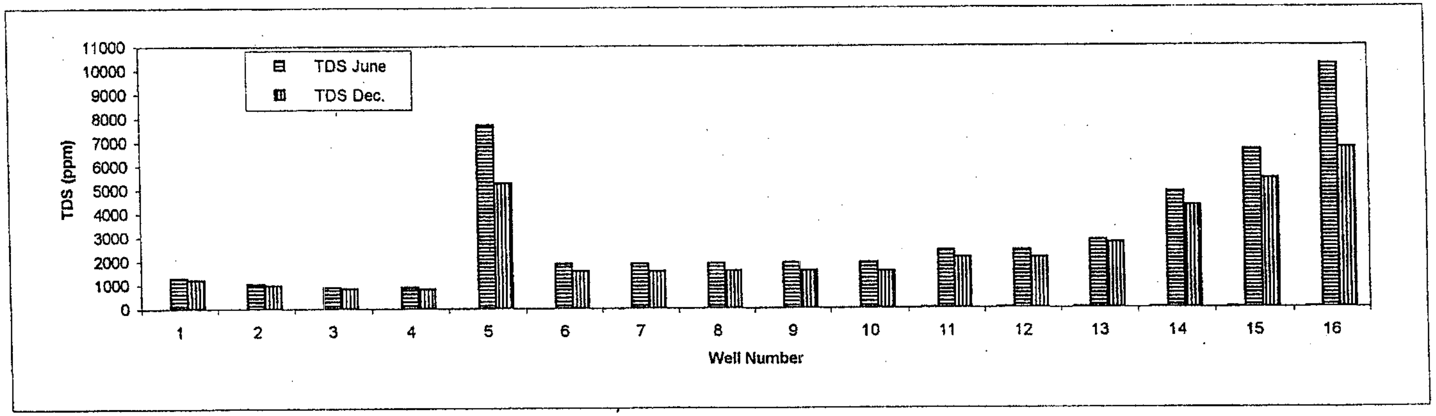
Figure (3) Geologic map of the studied are (Compiled after the Geological Survey, 1978).

Table (1) Morphometric parameters and volume of maximum floods(Mm^3) of the studied drainage sub-basins

Basin	Nu								Σ Nu	R_b	A	L	P	F	D	R_e	H_m	R_h	HD	Volume of max. floods, Mm3		
	1	2	3	4	5	6	7	8			Km^2	Km	Km	Km^{-2}	Km^{-1}		m			25 mm	50 mm	100 mm
W. Al -Timid	676	175	37	7	2	1			898	2.93	179.8	30	91.5	4.99	2.68	0.5	247	8.2	662	2.3	5.66	12.4
W. El-Mashash	2704	523	129	30	7	1			3394	4.64	863.9	42.5	147	3.92	2.37	0.79	312	7.3	739.4	11	27.22	59.6
W. Abu Wasil	3397	774	166	37	9	4	1		4388	3.55	1186.2	59	255	3.69	2.3	0.66	479	8.1	1111.7	15.12	37.23	81.56
W. Abu Tanudbah	441	101	21	5	1				569	3.98	145.94	54.3	86	3.9	2.37	0.25	255	4.7	604.4	1.9	4.6	10.1
W. Atwany	1708	421	85	19	3	1			2237	4.64	494.12	50	135	4.52	2.54	0.5	279	5.6	700.3	6.3	15.56	34
W. Atallah	6772	1241	280	62	15	4	1		8375	3.98	1600.6	60.5	250	5.2	2.76	0.75	846	14	2326.5	20.4	50.4	110.4
W. Zaydun	7469	1674	357	100	15	5	1		9621	3.98	2092	82.5	280	4.6	2.56	0.63	529	6.4	1304	26.7	65.96	146.5
W. Al-Qarn	24522	5617	1139	274	57	18	3	1	31629	4.2	7129	130	505	4.4	2.5	0.73	566	4.4	1426	90.89	224.6	491.88

Stream ordering (Nu) Bifurcation ratio(Rb) Drainage area(A) Elongation ratio(f Drainage Frequency(F relief ratio(Rh)
Sub-basin perimeter(P) Drainage density (D) Maximum basin relief(Hn Sub-basin length Ruggedness number(HD)
25, 50, 100 mm are the suggested scenarios of precipitation per day





Figure(4) The Variations of electric conductivities and water salinities for the collected water samples during June and December 1996

Table(2)Depth to water and chemical analyses of collected groundwater samples during June and December 1996

well	Locality	Aquifer	depth to water,m		pH		Ec us/cm		unit	TDS		K^+		Na^+		Mg^{+2}		Ca^{+2}		Cl^-		$HCO3^-$		$SO4^{-2}$	
No			June	Dec.	June	Dec.	June	Dec.		June	Dec.	June	Dec.	June	Dec.	June	Dec.	June	Dec.	June	Dec.	June	Dec.	June	Dec.
1	Al-Sad	Basement	4.2	3.2	7.8	7.8	5100	2300	ppm	1295	1216	16	20	276	236	45.8	40	112.2	109	343.8	310	88	214	456	390
									epm			0.41	0.5	12	10.3	3.8	3.29	5.6	5.44	9.7	8.7	1.44	3.5	9.5	8.1
2	Al-Fawahkeir	Basement	14.5	13	7.7	7.6	3470	1700	ppm	1033	974	20	31	220	190	32	31	95	88	259	229	105	205	354	301
									epm			0.51	0.8	9.57	8.26	2.6	2.55	4.74	4,39	7.31	6.46	1.72	3.35	7.37	6.27
3	Al-Fawahkeir	Basement	11.8	10.3	7.8	7.9	3250	1220	ppm	894	832	12	15	192	160	25	24	88	85	222	201	74.8	142	317	275
									epm			0.31	0.4	8.35	6.96	2.1	1.98	4.39	4.24	6.26	5.67	1.23	2.33	6.6	5.73
4	Al-Fawahkeir	Basement	11.9	10.4	7.8	8	3120	1200	ppm	890	823	10	14	186	162	27.99	22	90	83	225.1	195	78.9	133	307	273
									epm			0.26	0.4	8.1	7.05	2.3	1.8	4.49	4.14	6.35	5.5	1.29	2.17	6.39	5.68
5	Al-Hamamat	Basement	29.5	25	7.6	7.7	24500	9460	ppm	7708	5264	32.8	16	1322	929	184	125	843	752	2024	1393	84.5	129	2334	1984
									epm			0.84	0.4	57.5	40.4	15	10.3	22.1	37.5	57.1	39.3	1.39	2.11	48.6	41.3
6	Al-Laqitah	Nubian	flowing	flowing	7.87	8	8200	3300	ppm	1863	1567	26	12	360	300	73	67	180	168	650	496	121	322	513	360
		Sandstone							epm			0.67	0.3	15.7	13.05	6	5.51	8.98	8.38	18.3	14	1.98	5.28	10.7	7.5
7	Al-Laqitah	Nubian	flowing	flowing	7.9	8	8200	3300	ppm	1879	1570	26.97	12.1	366	303.5	74.11	67.3	180.4	170	655.8	503.4	105	303	524	365
		Sandstone							epm			0.69	0.3	15.9	13.2	6.1	5.54	9	8.5	18.5	14.2	1.72	4.96	10.9	7.6
8	Al-Laqitah	Nubian	flowing	flowing	8	7.9	8215	3310	ppm	1889	1581	23.46	12.5	368	301.2	75.33	66.8	182.4	168	659.4	499.8	116	306	524	384
		Sandstone							epm			0.6	0.3	16	13.1	6.2	5.5	9.1	8.3	18.6	14.1	1.9	5.01	10.9	8
9	Al-Laqitah	Nubian	flowing	flowing	8	8	8221	3318	ppm	1915	1579	26.2	13.7	366	310.3	76.55	64.4	186.4	164	670	492.7	127	313	528	379
		Sandstone							epm			0.67	0.4	15.9	13.5	6.3	5.3	9.3	8.2	18.9	13.9	2.08	5.1	11	7.9
10	Al-Laqitah	Nubian	flowing	flowing	7.9	7.9	8229	3324	ppm	1917	1570	26.5	12.1	370	303.5	80.19	67.3	186.4	170	659.4	503.4	136	303	528	365
		Sandstone							epm			0.68	0.3	16.1	13.2	6.6	5.54	9.3	8.5	18.6	14.2	2.23	4.96	11	7.6
11	Al-Laqitah	Quaternary	5.6	4.2	7.8	7.9	8500	2900	ppm	2440	2128	27	22	669	556	63	57	156	147	921	854	205	199	504	394
									epm			0.69	0.56	29.1	24.2	5.15	4.66	7.8	7.35	26	24.1	3.4	3.26	10.5	8.2
12	Al-Laqitah	Quaternary	4.3	3.5	7.7	7.6	8440	3000	ppm	2438	2134	31	22	667	560	62.98	58	156	145	921.7	860	217	198	490	389
									epm			0.79	0.6	29	24.36	5.2	4.77	7.78	7.24	26	24.26	3.55	3.2	10.2	8.1
13	South	Quaternary	3.5	2.75	7.8	7.8	11500	5300	ppm	2874	2760	20	9	680	608	123	90	200	224	1024	922	55.9	154	800	818
	Al-Laqitah								epm			0.51	0.2	29.6	26.45	10	7.4	9.98	11.2	28.9	26	0.92	2.5	16.7	17
14	'South	Quaternary	3.6	2.6	7.7	7.9	14600	10100	ppm	4903	4306	22	17.5	1067	700	231.9	178	355.9	537	1600	1087	57.9	114	1597	1701
	Al-Laqitah								epm			0.56	0.5	46.4	30.45	19	14.6	17.8	26.8	45.1	30.66	0.95	1.87	33.3	35.4
15	'South	Quaternary	3.6	2.77	7.9	7.7	21800	10900	ppm	6652	5459	38.98	12	1500	1221	245.9	198	564	410	2300	1834	62.2	63	1972	1744
	Al-Laqitah								epm			1	0.3	65.3	53.11	20	16.3	28.1	20.5	64.9	51.72	1.02	1.03	41.1	36.3
16	'South	Quaternary	3.5	2.9	7.8	7.8	35300	11000	ppm	10202	6740	39.99	24	2600	1150	299.9	331	799.9	747	4000	1744	75.8	199	2424	2642
	Al-Laqitah								epm			1.02	0.6	113	50	25	27.3	39.9	37.3	113	49.2	1.24	3.26	50.5	55

Table(3) Hydrochemical Parameters and Saturation Indices of groundwater sample

well No	K/Cl	Na/Cl	Mg/Cl	Ca/Cl	SO4/Cl	r(K+Na)-rCl / rSO4	rCl-r(K+Na) / rMg	'Saturatin indices		
								Calcite	Gypsum	Dolomite
1	0.0575	1.184	0.3782	0.6207	0.931	0.2592		0.51	-1.07	0.87
2	0.1238	1.2786	0.3947	0.6811	0.971	0.4242		0.43	-1.21	0.7
3	0.0705	1.2275	0.349	0.7407	1.011	0.2949		0.28	-1.23	0.3
4	0.0727	1.2818	0.327	0.7455	1.033	0.3433		0.34	-1.24	0.4
5	0.0101	1.028	0.262	0.9669	1.051	0.0363		1.27	0	2.05
6	0.0214	0.9357	0.3936	0.6	0.536		0.1165	0.85	-1	1.67
7	0.0218	0.9295	0.39	0.5985	0.535		0.1245	0.95	-1	1.88
8	0.0227	0.929	0.39	0.5886	0.567		0.1236	1.04	-0.99	2.07
9	0.0252	0.9712	0.3812	0.5899	0.568		0.0009	1.15	-0.99	2.27
10	0.0228	0.9103	0.3931	0.6724	0.531		0.1701	1.06	-1	2.12
11	0.0232	1.0041	0.1933	0.3049	0.34	0.0804		0.63	-1.04	1.11
12	0.0247	1.004	0.1963	0.2963	0.333	0.0864		0.64	-1.06	1.18
13	0.0077	1.019	0.2846	0.4231	0.654	0.0412		0.38	-0.66	0.67
14	0.0163	0.9935	0.4756	0.8795	1.153	0.0084		0.84	-0.16	1.51
15	0.0058	1.027	0.3153	0.3868	0.702	0.0468		0.32	-0.29	0.65
16	0.0122	1.0163	0.5545	0.752	1.118	0.0254		1.34	0.02	2.65

بسم الله الرحمن الرحيم

دراسات هيدروجيولوجيه علىحوض وادى القرن.الصحراء الشرقيه.مصر

محمد عبد الله الفخرانى[1] وكمالالدهب٢

١-قسم الجيولوجيا-كلية العلوم-جامعة بنها

٢-قسم الجيولوجيا-كلية العلوم-جامعة المنوفيه

يتناول هذا البحث دراسة السيول وتاثيرها على المياه الجوفيه فى جوض وادى القرن. ولهذا الغرض تم تقسيم هذا الحوض الى سبعة احواض لدراسة معاملاتها المورفومتريه وقد اتضح من الدراسه ان جميع الأحواض تكون خطيره اثناء السيول الا ان احواض زيدون وعطاالله تكون.اشدها خطرا ولذلك فان اقامة حواجز متباداله او سدود ركاميه يقلل من شدة اندفاع المياه ويساعد فى تغذية المياه الجوفيه وتحسين نوعيتها.

يوجد بمنطقة الدراسه ثلاث وحدات هيدروجيولوجيه هى صخور القاع وخزان الحجر المرملى النوبى وخزان الرباعى ومن دراسة الخصائص الهيدروجيولوجيه والهيدروكيميائيه لهذه الوحدات تبين الأتى:

١-ارتفاع مناسيب المياه الجوفيه فى جميع الأبار وتحسن نوعية المياه وذلك بعد سيول نوفمبر ١٩٩٤ وهذا يدل على ان المصدر الرئيسى لتغذية المياه الجوفيه هو مياه الأمطار اثناء السيول.

٢-اوضح التكوين الهيدروكيميائى للمياه الجوفيه فى خزان صخور القاع ان المياه تكون عذبه ومن اصل جوى ونوعيتها تكون Na_2SO_4.

٣-اوضح التكوين الهيدروكيميائى للمياه الجوفيه فى خزان الحجر المرملى النوبى ان المياه تكون قليلة الملوحه ومن اصل بحرى ونوعيتها تكون $Mg Cl_2$ و هذه المياه تكون معرضه للخلط والتخفيف بالمياه المتعمقه الجوية الأصل.

٤-اوضح التكوين الهيدروكيميائى للمياه الجوفيه فى خزان الرباعى ان المياه تكون شبه مالحه ومن اصل جوى ونوعيتها تكون Na_2SO_4.

٥-تكون جميع عينات المياه مشبعه بالنسبه لمعدن الكالسيت والدولوميت وهذا يعكس انخفاض نسبة البيكربونات نتيجه لترسيب هذه المعادن.