UNIVESITY OF DIYALA COLLEGE OF SCIENCE
DEPARTMENT OF PETROLEUM
AND MINERAL GEOLOGY

Hydrochemistry of Groundwater in AlKhalis District- Diyala Governorate

By
Ayat Abd Alkareem
Muhameed Alwan
Taha Jassim
Sajad Fadel

Supervised By
Dr. Mutadhid Majeed

١٤٤٣ ٢٠٢٢

(بِسْمِ اللَّـهِ الرَّحْمَـٰنِ الرَّحِيمِ)

(وَأَنْزَلْنَا مِنَ السَّمَاءِ مَاءً بِقَدَرٍ فَأَسْكَنَّاهُ فِي الْأَرْضِ
وَإِنَّا عَلَى ذَهَابٍ بِهِ لَقَادِرُونَ)

صدق الله العظيم

سورة المؤمنون - الآية ١٨٠

Supervisor certification

I Certify That This Research Was Prepared Under My Supervision By
(Ayat Abd Al-Kareem _ Muhameed Alwan _ Sajad Fadel _ Taha Jasim)
At The College Of Sciences – University Of Diyala –Department Of Petroleum Geology And Minerals As A Partial Fulfillment Of Requirements For The Award Of Bachelor Degree In Science /Geology.

Signature :

Name :

Scientific Title :

Address : Department Of Petroleum Geology And Minerals – College Of Sciences –University Of Diyala

Date :

Recommendation Of The Head Of The Department Or The Head Of The Scientific Committee Based On The Available Descriptions Search For Discussion.

Signature :

Name :

Address :

Date :

Abstract:

(12) A sample of well water engraved in al-Khalis district in Diyala Governorate was taken from the General Committee for Groundwater, from hydro chemical tests conducted on water models showing that the groundwater of the study area is equivalent and tends to base, and was also characterized by high insolvent water values and that the concentration of the main ions of the study area was identical to the usual concentrations of groundwater as well as containing high concentrations of chloride ion and the study explained that the reason for the increase in concentration of sulphur ions and chlorine can Due to the presence of evaporative salts such as gypsum and satellite, where they are the main source of ions in groundwater, and were an excellent conductor of electricity in addition, it was found that the groundwater of the study area is not drinkable by humans while it can be used for -animals and irrigate most agricultural crops in addition, most of which were found to be suitable for construction purposes.

CHAPTER ONE

1-1 INTRODUCTION :

Groundwater is one of the main pillars for the expansion of the agricultural area, as a result of the increasing demand for food and the high rates of population growth, which contributed to the trend to invest groundwater from its hydrogeological basins in order to invest this natural resource in achieving sustainable development in an optimal way. Quality is more important than quantity when evaluating groundwater. Determining the chemical, physical and bacterial properties of this water is of very great value and benefit in supplying municipal, commercial, agricultural, industrial and domestic water networks. An important point must be paid attention to, which is that the water has acceptable physical and chemical properties for agricultural uses. It is not necessary to be a source of domestic water .The hydro chemical study of groundwater includes multiple measurements such as the acidity function, electrical conductivity, total dissolved solids, concentration of ions , cations and nitrates whose concentrations in these samples will be studied and knowing the effect of their presence in different proportions and even their absence. (8)

١-٢ Aim Of The Study :

1_ hydrochemistry study for the groundwater in AlKhalis district and determining the most important physical and chemical properties .

2_ Indicating to the probable effects of ground water on humans health and the possibility of its use for irrigation, livestock and construction work.

1-3 Office work :

The Excel program was used to do the calculations, as well as to make graphs for these results, and the Microsoft Word program to write the research.

1-4 Location of the study area :

The study area is situated in the middle part of the eastern side of Iraq in Diyala province. This area is located at the west of the Zagros Fold-Thrust Belt. In fact it lies partly in the low folded and partly in the Mesopotamian Fore deep which extended from the southern Hemrin lake to the south of the province Figure-1. The area is bounded by : latitudes (33° 54′ 08′- 34° 00′ 04′′ North) longitudes (44° 15′ 36′- 46° 10′ 83′′ East).

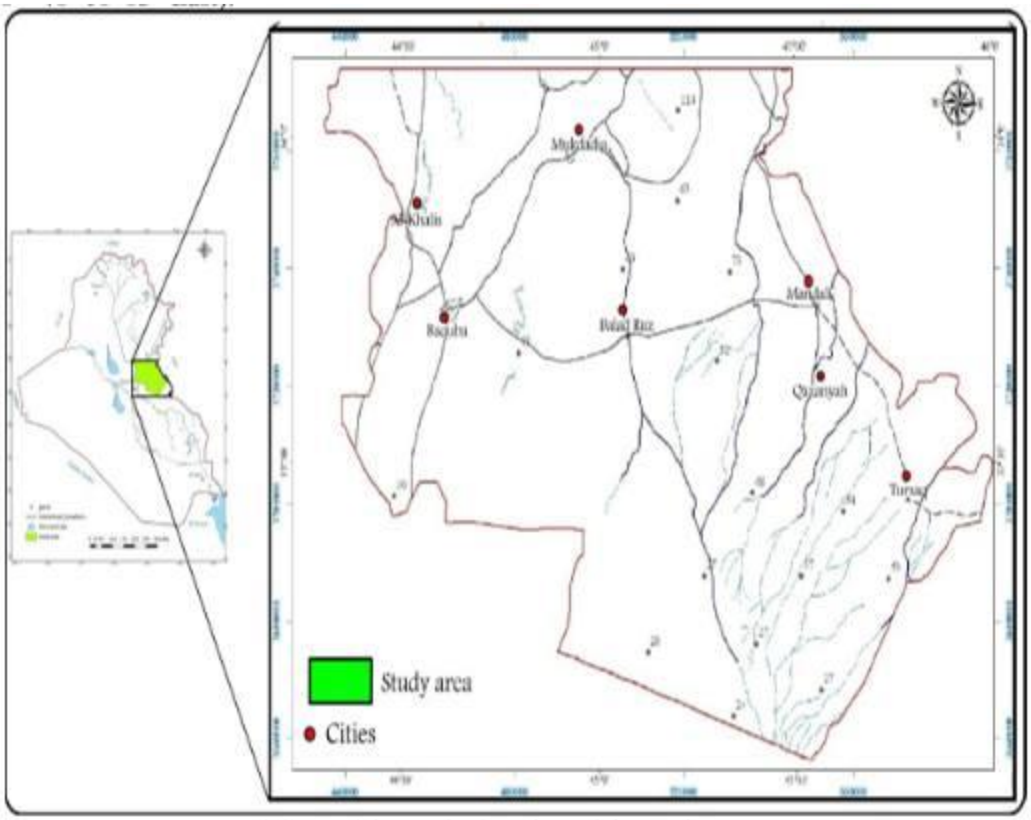


Figure 1 _ A picture showing the study area .[1]

1-5 Geology of the Study Area :

The near surface or exposed rocks is covered mainly by Quaternary and Pre-Quaternary sediments [1] Figure-1. The Pre-Quaternary sediments Include: The Middle Miocene Sequence comprises a carbonate and marls of the Fatha (Lower Fars) Formation. Late Miocene -Pliocene includes a fluvial system of Fatha, Injana, Mukdadiya and Bai Hassan Formations [٢] . Quaternary sediments of the Mesopotamian zone were deposited by the interacting Tigris and Diyala rivers. The alluvial fans emanating from the surrounding elevated areas. Flood plain deposits include channel deposits and flood plain depression, sabkha and deltaic deposits [٣].

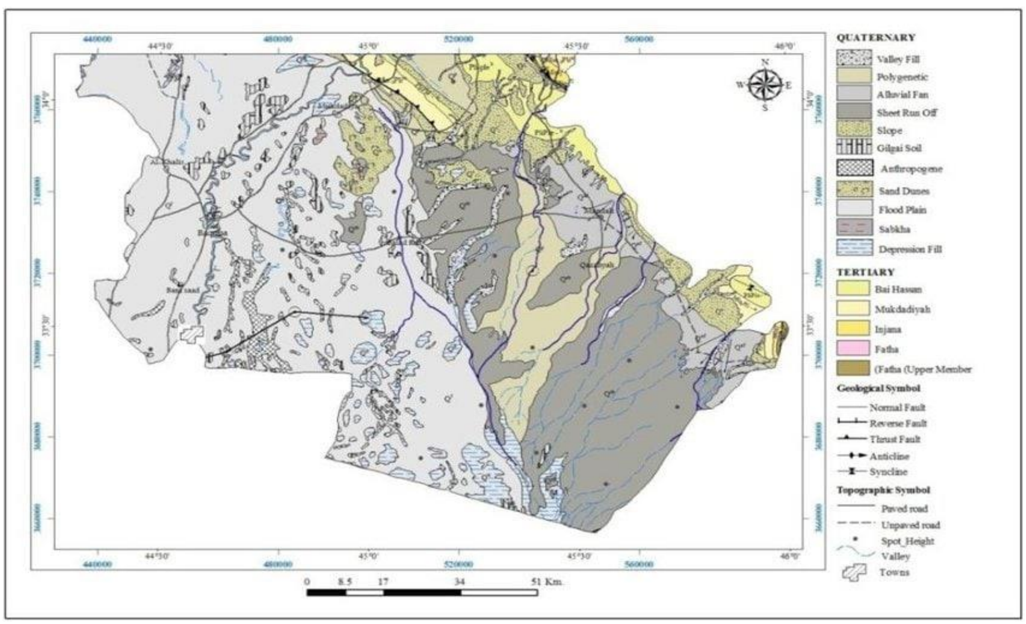


Figure 2_ geological map of the study area [1] .

1-6 Tectonic Setting :

The studied area is located within the low folded zone and Mesopotamian Foredeep. Tectonically the study area is part of the unstable shelf, most of this area represented by Tikrit - Amara subzone and northeastern is belong to Hemrin subzone [4] Figure-3, which is affected by the late regional intensive tectonic movements of the Alpine orogeny [٥]. This tectonic movement caused the uplifting of Hemrin structure, in the Low Folded Zone and the development of asymmetrical sinking basin in the Mesopotamian Foredeep. In the Late Pliocene , the influence of this movement is extended to deform the sediments of the Mesopotamian Foredeep. The evidence of this deformation is the uneven paleo-surface of the pre-Quaternary rocks, which is now covered by thick Quaternary Sediments [٦].

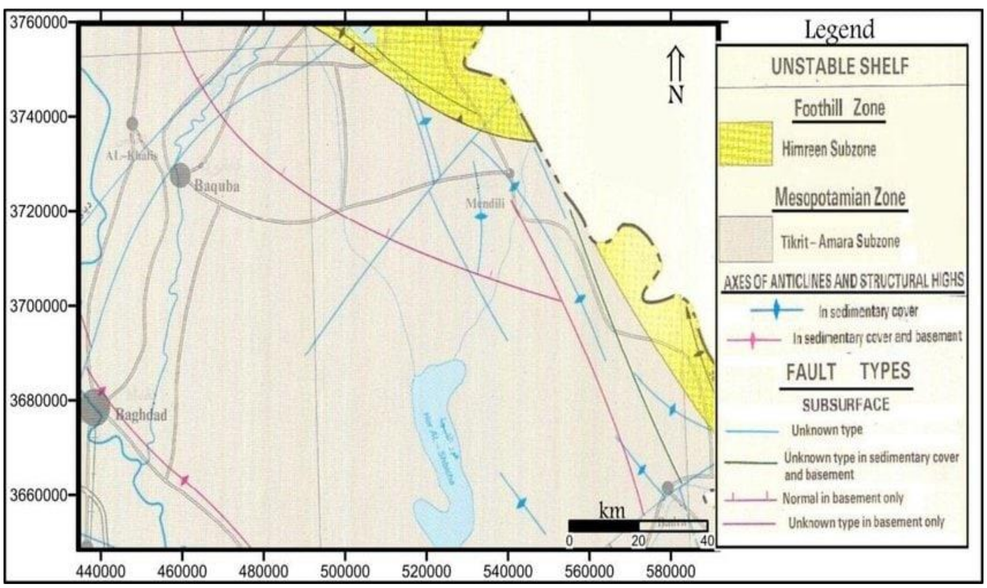


Figure 3- Tectonic map of study area [4] .

١-٦ Previous Studies :

- Study of the company (1956, Parsons), which studied about Mandali and the study dealt with some detail about the hydrogeology of the mud fan, which starts from the north of Mandali and ends to the southwest. The study indicated the conditions of the existence of groundwater in the plain areas below The fan is in a confined layer, and this indicates that the groundwater system in the fan is an operating system and has a limited impact on the groundwater in the axial areas, except for the effect of spring waters that flow at the edges of the fan and the effect of the Kalal River, whose water seems to be leaking to ground water. In another study, the same company calculated the safe investment of groundwater for the Mandali area. These calculations were built on a set of assumptions about the percentage of water increase achieved from the total rainfall and the amount of the resulting water from floods and irrigation to groundwater, which are assumptions that need to be reconsidered on the basis of field measurements.

- He (1960, Buringh) studied the soil of the region and concluded that the soil of the region is generally sedimentary Transferred from the border areas by torrential rains, as well as the sedimentation of floodplains that are of high concentration It is high in salt, in which gypsum is abundant. In general, the soil of the area is bare and moved from the areas Northeast through torrential rain torrents within the spreading valleys. The General Directorate of Groundwater Management (formerly the Euphrates Center) in 1994 conducted a hydrogeological study on Block 9, which has an area of (19000 km2), which includes a large area of Diyala Governorate. As a result of the high concentrations of salt in it, then the groundwater suitable for agricultural investment is limited to an area of no more than (4500) km2. In the best drainage conditions, it is confined to the form of a plain strip at the feet of the mountains (highlands).

And that the region is characterized by the presence of two hydrogeological systems, the first is the confined stratum system, which is represented by (Bay Hassan). The second is the free layer system, which is represented by the sediments of the Quaternary age, as in alluvial fans. The first tank is completely fed from outside Iraq, while the second tank is fed from inside Iraq. There are significant amounts of subsurface run-off for the two systems that, at the present time, end up in cesspools in the sedimentary plain after the concentration of salts in them increases.

- Zeinel (1997) made a geophysical study of the Mendelian fan. The study included the interpretation of the data of the vertical electric survey by applying the method of electrical specific resistance (Schlumberger deposition) in 58 electric points distributed in the study area, which are represented by recent deposits consisting of varying amounts of gravel, sand and clay, which gradually change in parts The study showed that the area consists of two submerged sedimentary valleys, the first called Wadi Mandali, and it is located towards the southeast, while the second is Wadi Al-Nidal towards the subsurface.

- Hassan (2002) conducted a hydro chemical study of groundwater for the areas under southern Hemrin in Diyala Governorate and calculating the concentrations of negative ions, where it was found that the negative ions are sulfates, while the positive ions differ from one site to another. Sulfates and dissolved salts, the results of bacterial tests also exceeded the standard determinants of the suitability of drinking water.

CHAPTER TWO

2-1 Methodology of work :

The analyzes were taken in ppm equivalent to Mg/L and converted to Mg.eq/L and then to Mg.eq/L% as shown in the following table:

Table show chemical and physical variables for the wells of the study area.

Well No.	TDS Mg/L	Cons	Ca^{+2}	Mg^{+2}	Na^{+}	k^{+}	SUM	Cl^{-}	$So_4^{=}$	Hco_3^{-}	Co_3	SUM	NO_3^{-}
1	2236	ppm	260	167	680	62		775	1584	173	0		0,1
		epm	6,48379	6,87243	29,5652	1,58568	44,5071	21,831	16,4828	2,87854	0	41,19234	0,00161
		epm%	14,568	15,4412	66,4281	3,56275		529956	40,0127	6,98776	0		0,0029154
2	1516	ppm	158	108	374	22		514	830	101	0		0,2
		epm	3,94015	4,44444	16,2609	0,56266	25,20815	14,4789	8,63684	1,68053	0	24,79627	0,00323
		epm%	18,9762	21,4049	78,314	2,70983		50,3795	30,052	5,83744	0		0,0112242
3	1940	ppm	198	127	570	145		645	1248	115	0		0,2
		epm	0,76154	0,76048	0,83824	2,33871	4,39897	0,83226	0,78788	0,66474	0	2,28488	2
		epm%	16,2065	16,184	17,8387	49,7708		19,4232	18,3874	15,5136	0		46,675788
4	1824	ppm	180	122	495	35		610	1065	111	0		0,2
		epm	1,13924	1,12963	1,32353	1,59091	5,1833	1,18677	1,28313	1,09901	0	4,59211	1
		epm%	21,979	21,7936	25,5345	30,6929		25,9749	28,084	24,0541	0		21,887045
5	1850	ppm	186	124	510	36		620	1094	112	0		0,2
		epm	0,93939	0,97638	0,89474	0,24828	3,05879	0,96124	0,8766	0,97391	0	2,81075	1
		epm%	30,7113	31,9205	29,2514	8,11681		25,2178	22,9973	25,5502	0		26,234628
6	392	ppm	22	10	51	1,1		87	73	18	0		4
		epm	0,17778	0,08197	0,10303	0,3143	0,39421	0,14262	0,06854	0,16216	0	0,37332	20
		epm%	45,0979	20,7931	26,1363	7,97267		0,70005	0,33644	0,79595	0		98,167557
7	1240	ppm	53	28	149	0,7		189	223	69	0		1,1
		epm	0,28495	0,22581	0,29216	0,1944	0,82236	0,0484	0,21298	0,61607	0	1,03389	5,5
		epm%	34,6501	27,4585	35,5269	2,36449		4,59517	3,21048	9,28673	0		82,907615
8	1282	ppm	115	79	158	0,7		309	456	80	0		8,5
		epm	3,59375	7,9	3,09804	11,8182	26,40899	3,55172	6,24658	4,44444	0	14,24274	2,125
		epm%	13,6075	29,9129	11,7306	44,7489		21,6995	38,1639	27,1537	0		12,982852
9	6551	ppm	561	264	950	20,1		1168	2149	729	0		3,5
		epm	10,5849	9,42857	6,37584	28,7143	55,1035	6,17989	9,22318	10,5652	0	25,96827	3,18182
		epm%	19,2091	17,1106	11,5706	52,1096		21,2002	21,6402	36,2442	0		10,915289
10	4052	ppm	404	250	810	120		1050	2102	366	0		0,1
		epm	3,51304	3,16456	5,12658	9,23077	21,03495	3,39806	4,60965	4,575	0	12,58271	0,01176
		epm%	16,701	150443	24,3717	43,882		26,9806	36,6006	363255	0		0,0934117
11	3615	ppm	360	230	740	115		994	1920	242	0		0,1
		epm	0,64171	0,87121	0,77895	5,72139	8,01316	0,85103	0,89344	0,33196	0	2,07642	0,02857
		epm%	8,00811	10,8721	9,72073	71,399		40,4289	42,4437	15,7702	0		1,357313
12	4242	ppm	430	260	840	130		1065	2236	370	0		0,1
		epm	1,06436	1,04	1,03704	1,08323	4,22453	1,014229	1,06375	1,01093	0	3,08897	1
		epm%	25,1935	24,617	24,5468	25,6427		24,8054	26,0151	24,7234	0		24,456076

٢ -٢ Accuracy of the results :

Calculating the error that occurs in the measurement method, and it is expressed as a ratio between the measured value of the element by the method to the actual value originally present" (1975, APHA). The validity of the results represents the amount of dependence on the use of the results of hydro chemical analyzes for interpretations related to the hydro chemical properties, and it is calculated in several ways, including: The balance of positive and negative ions (1989 Hem), which depends on the sum of the concentrations of positive ions, which is co-operated by a group of concentrations of negative ions. How close it is to the real value is expressed by the relative difference, which is The difference in the total over the total percentage.

$$R.D = \Sigma\, Cation - \Sigma\, Anion \,/\, \Sigma\, Cation \;X100\%$$

Then the accuracy of the results %A is extracted as follows:

$$A\% = 100 - R.D$$

Table 2-2 shows the relative difference and the accuracy of the results for the analyzes.

Well NO.	R.D	A%	Result
W1	7	93%	questionable
W2	2	98%	High precision
W3	9	91%	questionable
W4	11	89%	questionable
W5	8	92%	questionable
W6	5	95%	High precision
W7	3	97%	High precision
W8	18	82%	inaccurate
W9	47	53%	inaccurate
W10	40	60%	inaccurate
W11	74	26%	inaccurate
W12	27	73%	inaccurate

where

Relative Difference=R.D

Accuracy=A

$\sum$ Cation = concentration of positive ions in units (epm)

$\sum$ Anion = concentration of negative ions in units (epm)

(epm) = the equivalent weight in milligrams per million of the concentration of the element in the solution.

The value of the relative difference less than 5% means that the validity is high, and in the event that the relative difference is more than 5% and less than 10%, the results have possibilities that may be important, and in this case the results are used for interpretation with caution, but if the differences are more than 10 % cannot be relied upon in the hydro chemical interpretations (1989, Hem), and based on the equation, the relative differences of the analyzes of the water models for the study area were calculated and according to the attached table (2-12), which shows that most of the relative differences are less than (5%), which confirms The validity is high and therefore reliable in the hydro chemical explanations .

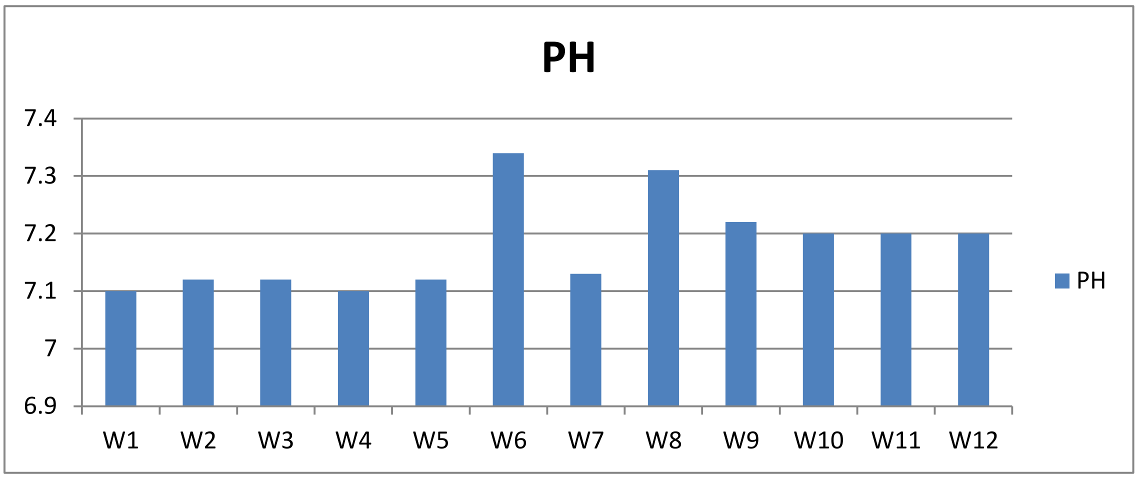
2 - 3 Physical Analysis :

2-3-1 Hydrogen function (PH) :

The hydrogen function is defined as the negative logarithm of hydrogen ion activity, a measure of acidity and basicity under normal conditions of pressure and temperature. It is also the dominant factor in most reactions of gas-water-rock systems such as hydration, polymerization, adsorption, complex formation, and oxidation-reduction reactions (Langmuir, 1997).

(Al-Bidari and Al-Bassam, 1997) mentioned that the factors that affect the value of the hydrogen function in water are: temperature, the presence of bicarbonate, calcium, and the presence of aquatic plants, as the process of photosynthesis reduces the amount of CO2 and then increases the hydrogen function.

The average was (7.18) ,The highest value of the hydrogen function in the study samples was (7.34) in the sample (Albu Youssef) The lowest value was in the sample (Al-Shekej, Ain Laila) (7.1) , which is within the natural rates in water (8.5-6.5) according to the parameters (WHO, 2006).



A graph showing the pH values of the samples in the study area.

2-3-2 Electrical Conductivity (E.C) :

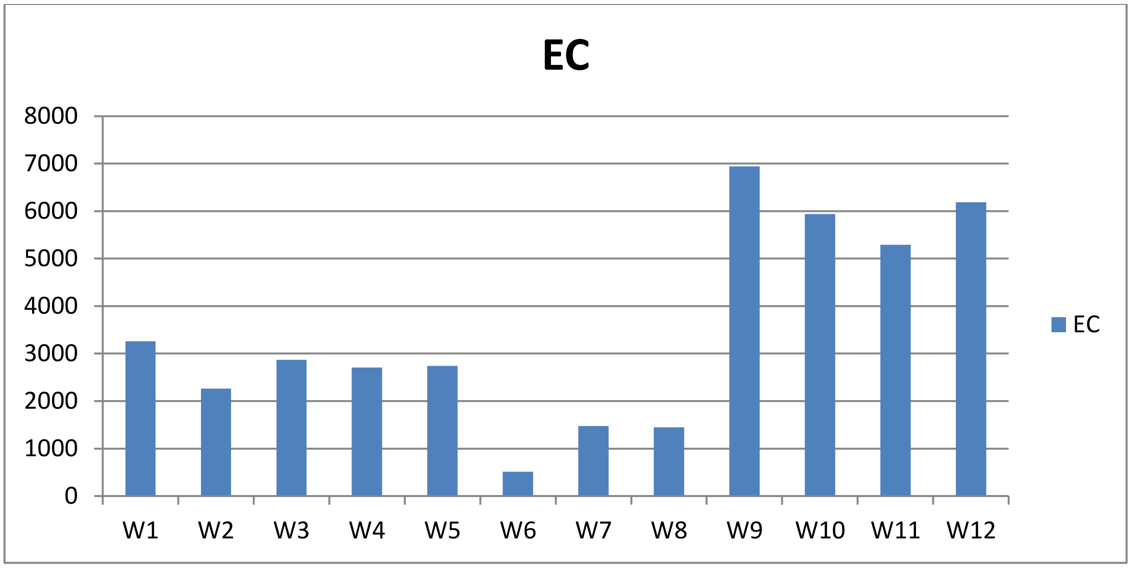
is defined as the ability (1 cm) of water to conduct electricity at a temperature (25 degrees), that is, it represents the inverse measure of the specific resistance that is exchanged by a column of water with a length of (cm) and cross-sectional area (cm 2). The conductivity of saline solutions is usually measured (mhose/cm)(milmhose / cm) (1988, Tood) and under the International Nomenclature System (SI) consider the unit in the name (Siemens) and its parts (Microsimens µs) the same with the difference in the name of the unit (micromhose) (Hem 1989) .

The value of the electrical conductivity depends on the temperature, the type of ions and their concentration in the solution (Walton 1970), where it was found that an increase in water temperature by one degree Celsius causes a (2%) increase in electrical conductivity, because heat increases the speed of ionization of salts in water. Through the relationship between electrical conductivity and the concentration and type of solid ions, the extent of mineralization or salinity of water can be known through the electrical conductivity values (1997, Detay) and according to Table below .

Table showing the relationship between electrical conductivity (EC)and mineralization (١٩٩٧, Detay) .

EC (µs/cm)	Mineralization
< 100	Very weakly mineralized water (granite terrains)
100 – 200	Weakly mineralized water
200 – 400	Slightly mineralized water (limestone terrains)
400 – 600	Moderately mineralized water
600 – 1000	Highly mineralized water
> 1000	Excessively mineralized water

Where the conductivity rate in the study samples was (3469.333 µs/m), and the highest value of conductivity was in the sample (Khashm Zarzour) (6940 µs/m), while the lowest value of the conductivity was (510 µs/m) in the sample (Albu Yousef). This means that the water is very saline (Excessively mineralized water) This is due to the interaction of groundwater.



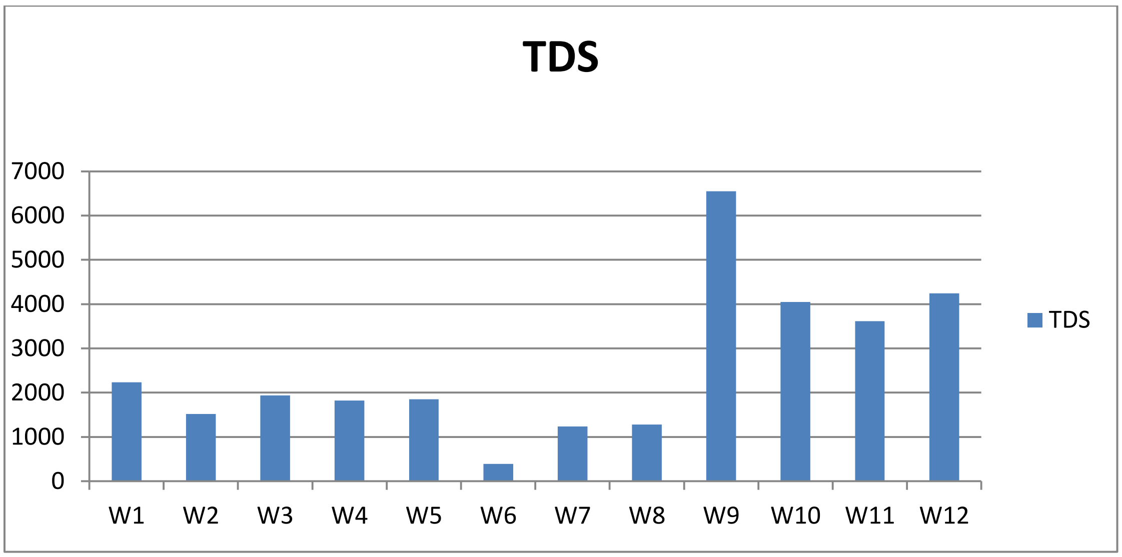
A graph showing the EC values of the samples in the study area.

2 – 4 Chemical Analyses :

2-4-1Total Dissolve Solid (TDS) :

It includes solids dissolved in water, whether they are ionized or not, and does not include suspended substances and dissolved gases (1966, Davis and Dewiest). (TDS) consists mainly of ions and cations, and the concentrations of dissolved ions within natural waters depend on the type of rocks and soils that are in contact with them and on the time taken for the contact process (1970, Hem). As for salinity, it depends on the percentage of sodium and chloride present in the solutions, in addition to What dissolves from the mineral gypsum that comes in contact with this water (Al-Baidari and Al-Bassam, 1997).

The results of the chemical analyzes showed that the percentage of dissolved solids was (30,677 mg/l), which means that the water in the study area is mostly (brackish and slightly brackish water) according to the table above This is because the well is located in an area where there are many drains, from which the water of the well is fed . except for the water in the study area, well No. 7 (Albu Yousef) It contains a type of (fresh water) (392 mg/l).



A graph showing the TDS values of the samples in the study area.

Table showing the classification of the area's water according to the amount of dissolved salts (ppm) .

Water class	Altoiviski , 1962	Todd , 1980
Fresh water	0 – 1000	10 – 1000
Slightly – brackish water	1000 – 3000	-
Brackish water	3000 – 10000	1000 – 10000
Salty water	10000 – 100000	10000 – 100000
Brine water	> 100000	> 100000

2 – 5 Major Elements :

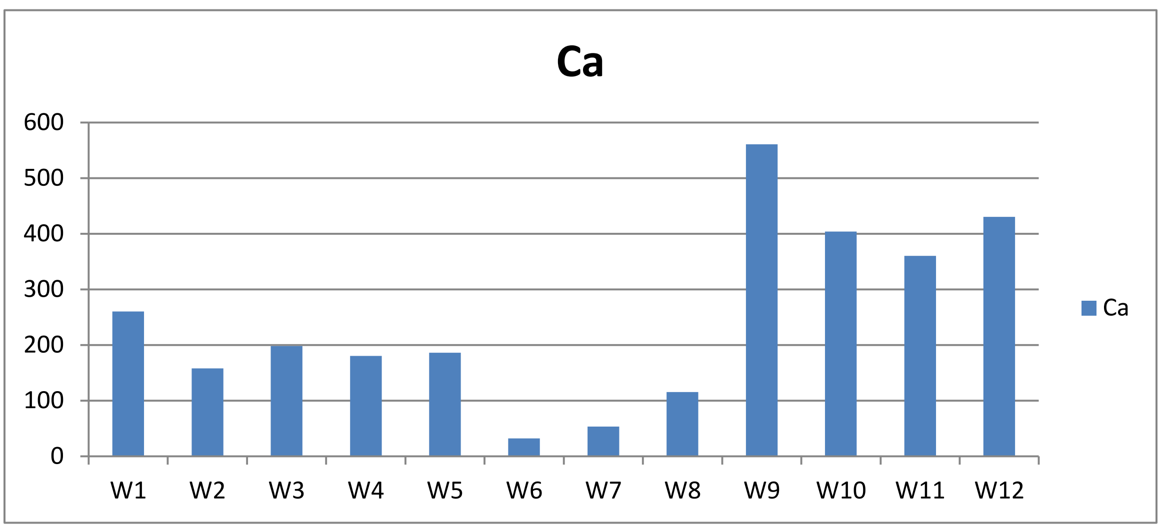
2-5-1 Cations :

1- Calcium Ion Ca^{+2} :

Calcium is one of the most common alkaline earth metallic elements. It is an essential element for plants and animals. The calcium ion comes from chemical weathering of rocks and minerals containing the calcium ion represented in igneous rock minerals such as: amphibole, feldspar, and pyroxene. Sedimentary rock minerals such as: calcite, dolomite, aragonite, and fluorite (Hem, 1989). Calcium concentration in river water reaches (15) ppm, and human activities also contribute to the release of calcium ion and its increase (Langmuir, 1997).

The calcium ion rate was (244.75mg/l) where the values ranged from (32 to 561 mg/l) .

The increase in the values of ($Ca^{٢+}$) was consistent with the increase in the value of ($SO^{-}_{٤}$), meaning that both ions resulted from the dissolution of secondary gypsum present in the soil (sediment).



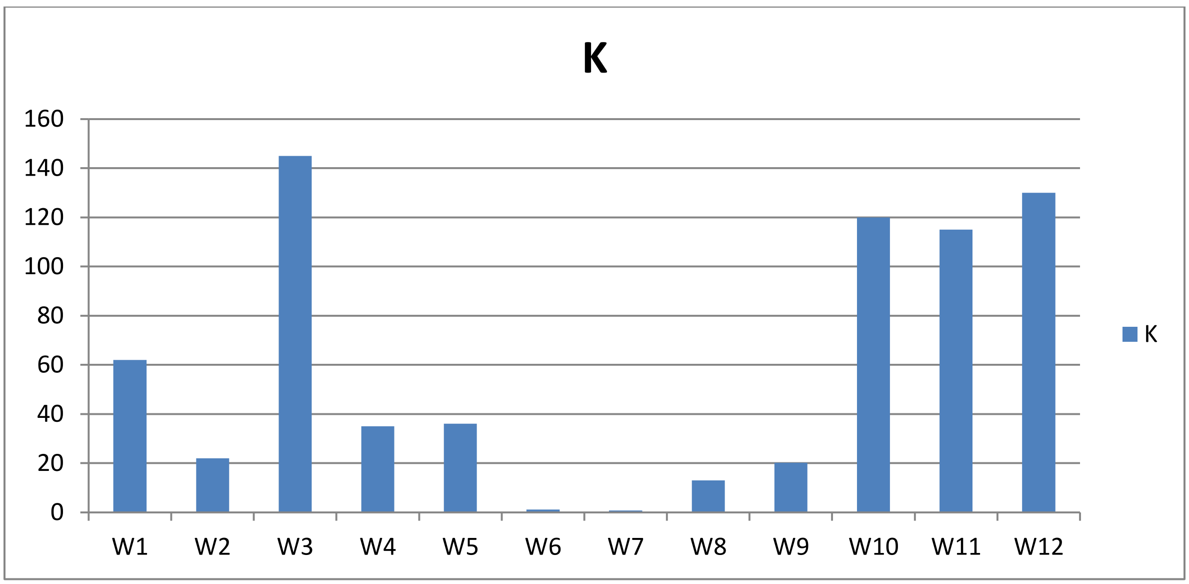
A graph showing the Ca values of the samples in the study area.

2- potassium ions K^{+1} :

Potassium is a less abundant metal than sodium, and its source is chemical weathering of potassium-containing minerals such as feldspar minerals (microclines and orthoclase), and in evaporate rocks such as sulfites, and it is found in lower proportions than sodium (Hem, 1989).

The ratios ranged between 0.7 - 145, where the rate was 663.9 mg / l .

The high percentage of potassium is attributed to the fact that the area is agricultural and the effect of agricultural operations and the addition of fertilizers, in addition to the lack of drainage for water drainage in the area of the well.



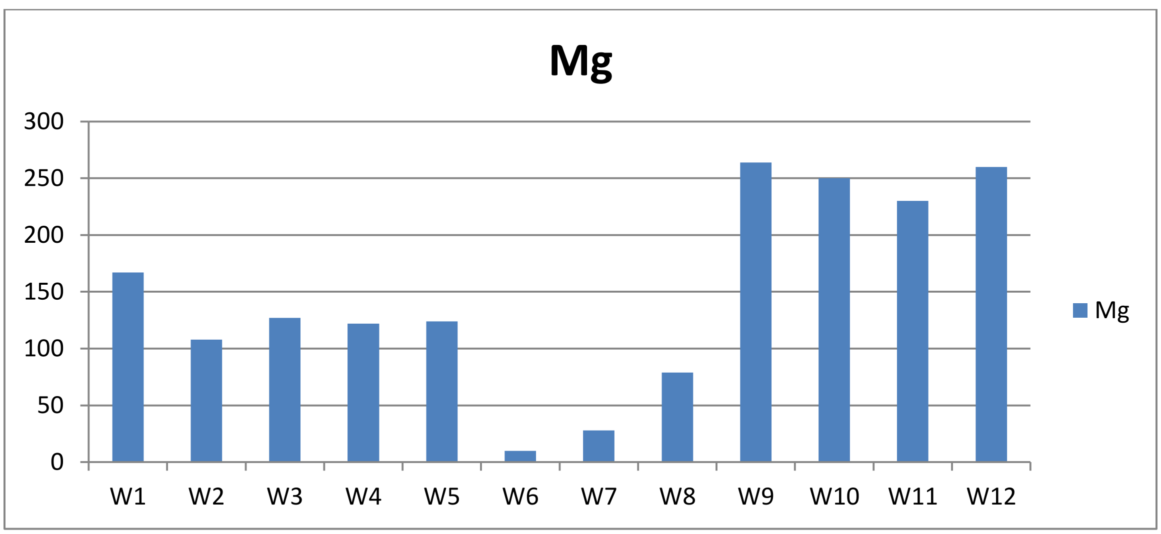
A graph showing the K values of the samples in the study area.

3- Magnesium Ion $Mg^{٢+}$:

Magnesium is an alkaline earth metal that has one oxidation state in water (Hem, 1989), ($Mg^{٢+}$). Magnesium is found in the mineral dolomite, which is the second most important carbonate mineral after calcite.

It is also found in ferromagnetic igneous rocks and in the minerals pyroxene, amphibole and olivine. Clay minerals are another source of magnesium ion in water (Collins, 1975).

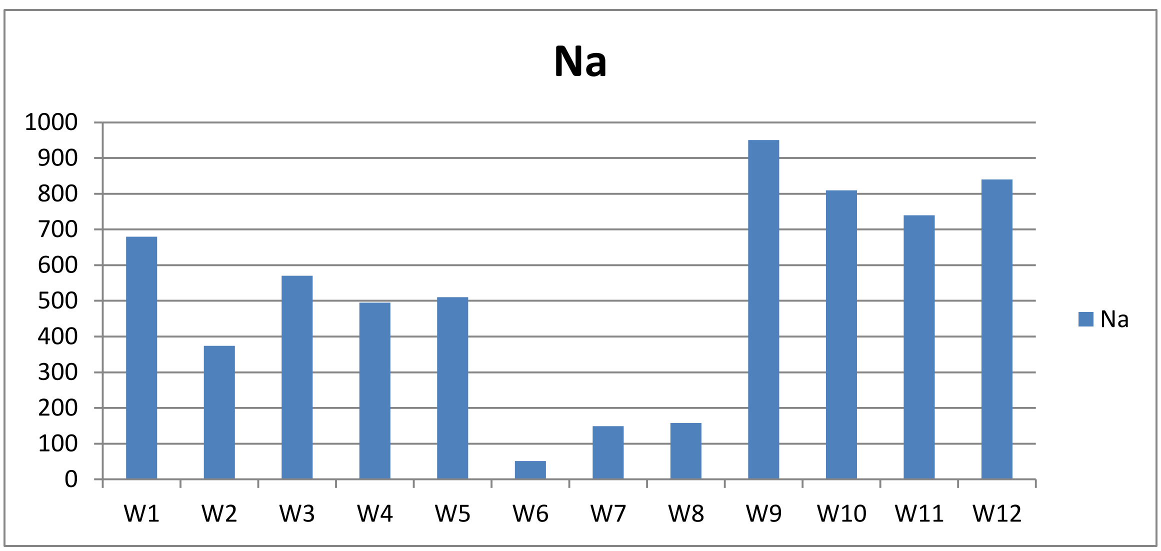
Magnesium chloride and sulfate are among the most soluble magnesium compounds, and despite the high solubility of magnesium, its presence remains in lower concentrations than calcium in natural waters. The concentration of magnesium is five times that of calcium (Davis and Deviest, 1966). The chemical results showed that the values of magnesium ions ranged between (10-260 mg/L) with an average of (1769 mg/L) . The high values of $Mg^{٢+}$ concentrations in the area are probably due to the presence of carbon dioxide (CO) in the study area, which dissolves magnesium from the silica and carbonic minerals (1975.Collins), in addition to the common clay minerals (montmorillonite) present in the area containing high concentrations. of magnesium. The amount of magnesium in evaporation rocks depends on the salinity of the water. and depth for the sedimentation basin, and the relationship between magnesium and salinity is a direct relationship, that is, an increase in salinity increases the concentration of magnesium in sedimentary minerals (1971, Braitsch).



A graph showing the Mg values of the samples in the study area.

4 - Sodium Na^{+1} :

is the most common of the group of alkali metals, including lithium, potassium, manganese, rubidium and cesium) its presence in igneous rocks is more than potassium, but in sediments the presence of sodium is less common but sodium which forms evaporates and sodium present as a solution in the oceans constitute A significant portion of the total presence of sodium (Hem , 1989). Sodium can also be adsorbed on the outer surfaces of minerals, especially minerals that have a high ion exchange capacity, such as clay minerals, which separate the adsorption of sodium when they are cemented (compacted), on the contrary when the clay particles are dispersed in water, where calcium absorption is preferred (hanshow 1964 at Hem1989). Represents the concentration of sodium in natural water over a wide range ranging from less than (1 mg/l) to rainwater and some stream water in the heavy rain area, which reaches a limit of (100,000 mg/l) in salt water salts associated with evaporation deposits in closed basins. (Hem , 1989). Chemical analyzes showed that the value of sodium ranges between (51-950 mg/L) , at a rate of (6,327 mg/L) . The presence of high concentrations of sodium is attributed to the cause of the melting of halite salts (NaCl), Because of the soil washing processes that occur when rain falls.



A graph showing the Na values of the samples in the study area.

2-5-2 Cations :

1- Ionic Carbonate (CO_3^{-2}) and Bicarbonate (HCO_3^{-1}) :

The carbonate ion (CO_3) and bicarbonate (HCO_3) is a source of alkalinity, which is also called (carbonate alkalinity), which is the ability of water to react with [H^+] ions. Carbonates and bicarbonates are among the most important components that affect pH values, as the process of depletion of [HCO_3] to [CO_3] in solutions is high when it is pH> 8.2, but when it is pH< 8.2, carbonates are added to it to become hydrogen ions. Bicarbonate dissolved as in the equation .

$$H^{+}+CO3^{-2}{=}\rightarrow HCO_3^{-}$$

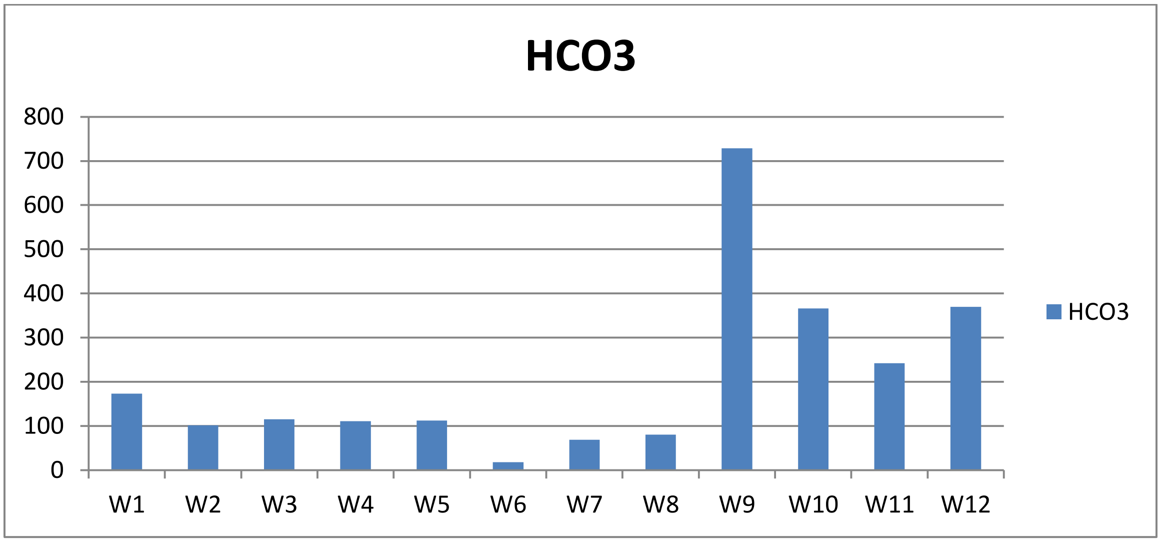
Thus, the proportion of ($HCO_{٣}/CO_{٣}$) increases to more than (1/100) in addition to the fact that carbon dioxide dissolves in water in the form of bicarbonate, and therefore it is considered the main source of alkalinity in water (Colline, 1975, White 1964) .

The chemical results showed that the bicarbonate ion concentration ($HCO_{٣}$) ranged between (69-729mg/L) at a rate of (197.916mg/L) for the wells of the study area. From studying the results , we can conclude the following :

The high value of bicarbonate for some wells can be attributed to the effect of ($CO_{٢}$) resulting primarily from the fact that the surface soil contains plants, and from the occurrence of the respiration process or the decayation process, the decomposition of plants after their death, the(CO_2) gas is released and takes its way into the moist soil To groundwater and when it participates in the weathering process, where when one molecule of ($CO_{٢}$) interacts with carbonate minerals (Solid Co_3), two molecules of HCO3 are produced, and when it interacts with non-carbonate minerals, one molecule of (HCO_3) is produced for each molecule of (CO_2) involved in the reaction (1989, Hem) .

The process of reducing sulfate to part of the bicarbonate also contributes to some wells :

$2CH_2O + SO_4 = H_2S + 2HCO_3$



A graph showing the HCO_3 values of the samples in the study area.

2_Sulfate So_4 :

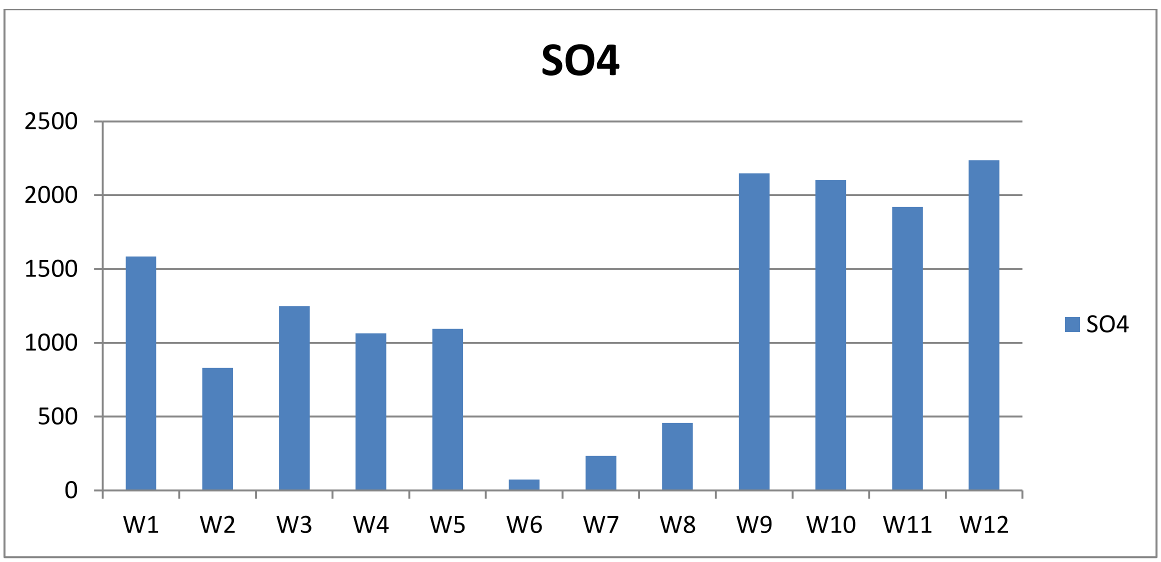
The main source of sulfate in water in general is from rain and snow, whose concentration ranges between (1-3) mg / liter, which depends locally on the percentage of air pollution, where the concentration can increase About this limit (1971, Parson and Fisher) in Hem (1989).

In addition to the solutions of sulfate minerals present in sedimentary rocks such as gypsum and anhydrite (1966 Davis and Dewiest) as well as from the oxidation of pyrite minerals, most of the sulfate compounds are soluble in water and have a high solubility.

In the area with little rain, where salts are produced in the soil, the irrigation water and the increase of that water works to wash the soil and increase the solutes in the soil water or the water that is pumped back, which increases the dissolved substances and over time the effect of the process increases and affects the groundwater and the dissolved substances increase in it and Including sulfates, and even if the soil is poor in chloride and sulfates, the water recovered from irrigation contains these substances in a higher percentage than their concentration in the original water that was used for irrigation (Hem 1989).

The chemical results showed that the sulfate ion concentrations ranged between (73-2236 mg/L) at a rate (1249.166mg/L) for the wells of the study area.

There are some factors that lead to the removal of sulfates from water, as sulfates are exposed to reducing sulfur bacteria to sulfides .



A graph showing the SO4 values of the samples in the study area.

3- Chloride Cl^- :

The geochemical behavior of chlorine, three-quarters of what is present on the earth's crust in the atmosphere and water, is in the form of chloride ion. The source of the chloride ion from groundwater comes from:

1- Chloride that comes from ancient groundwater found in sediments and at great depths.

2- Solutions of halite salts and minerals that belong to the sediments of the navigators.

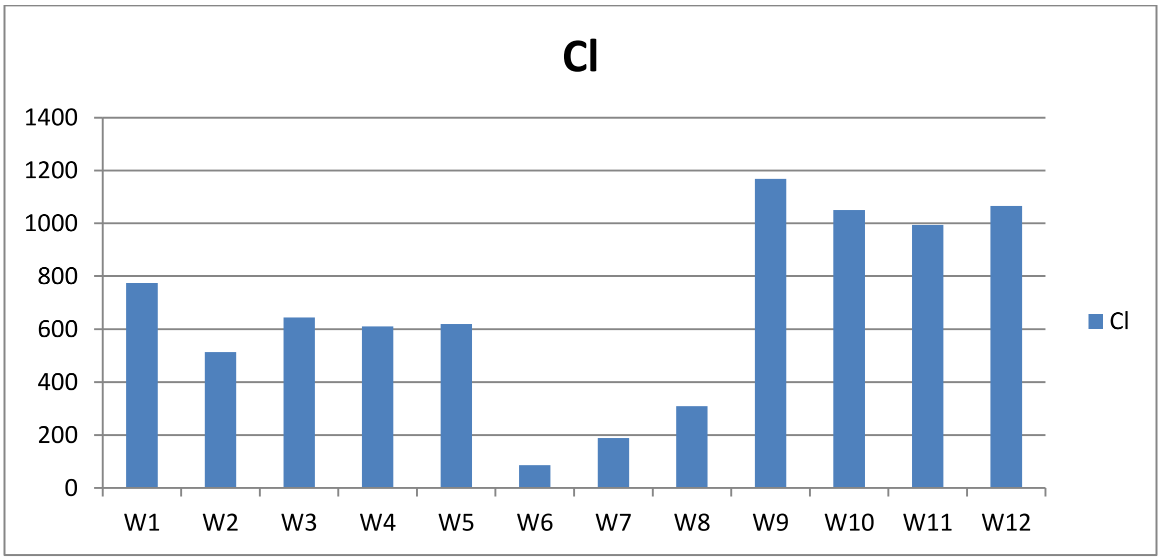
3- Increasing the chloride content due to exposure of the solutions to the evaporation processes.

The solutions resulting from rainfall, especially in dry areas, that contain an increase in uric minerals, especially chloride salts (1966, Davisond Dewist, 1966). There are other sources of chloride are organic waste and potassium fertilizer (Potassium Fertilizer (Al Manma, 2002).

The last three factors are important because the chloride content increases in the water due to the evaporation process, and the salts formed by chloride have a high solubility, such as the chloride salts of sodium, potassium, magnesium and calcium (Al-Ani, 1986). Although chloride-containing minerals are found in igneous rocks in the form of (Feldspathoiad sodalite) and in the form of phosphate mineral apatite, but it can be said that these rocks do not have a great influence on the concentration of chloride in natural waters, as in sedimentary rocks, especially marine (1989 Hem) and because of the large chloride ion compared to the main ions and because of the different permeability of the clay and shale layers, and thus constitute an important factor in the formation of saline groundwater accompanying the fine sediments, where the water molecule passes while these sediments do not allow the passage of the chloride ion as well as the chloride ion + calcium and this mechanism is the origin of (calcium chloride) in saline water

(Valsova 1965 at hem 1989) and in most waters when the chloride concentration is predominant, the sodium concentration will also be in it.

The chemical results showed that the chloride ion concentrations ranged between (87-1168 mg/L) with an average of (668,833Mg/l) The presence of these high concentrations of chloride is attributed to rain water and irrigation operations.



A graph showing the Cl values of the samples in the study area.

1- Nitrate ion $NO3^-$:

After the nitrate ion is one of the forms of the nitrogen cycle, as nitrogen is an important element in the biogeochemical cycle, the groundwater is polluted with nitrogen. Storage of industrial raw materials, agriculture, fertilizer storage, chemicals, soil, and extensive pollution may be due to burning (fossilized) fuel, air pollution by fertilizer factories, where nitrogen compounds pollute the air, as well as agriculture, where the use of organic and mineral fertilizers is one of the main minerals for polluting With nitrogen (Klimas, A. and Paukvstys B.1993) Nitrogen contains many oxidation states in groundwater. It is found in the form of dissolved gases (N_2O_3, NO_2, NO, NH_3, N_2, N_2O) or ions derived from them (NO_2, NO_3 and ammonia NH_3). These gases react quickly with water:

$$2NO+O_2 \rightarrow 2NO_2$$

$$2NO_2+H_2O \rightarrow 2H+(aq)+NO_3^-+NO_2^-$$

$$NH_3+H_2O \rightarrow NH_4^++OH^-$$

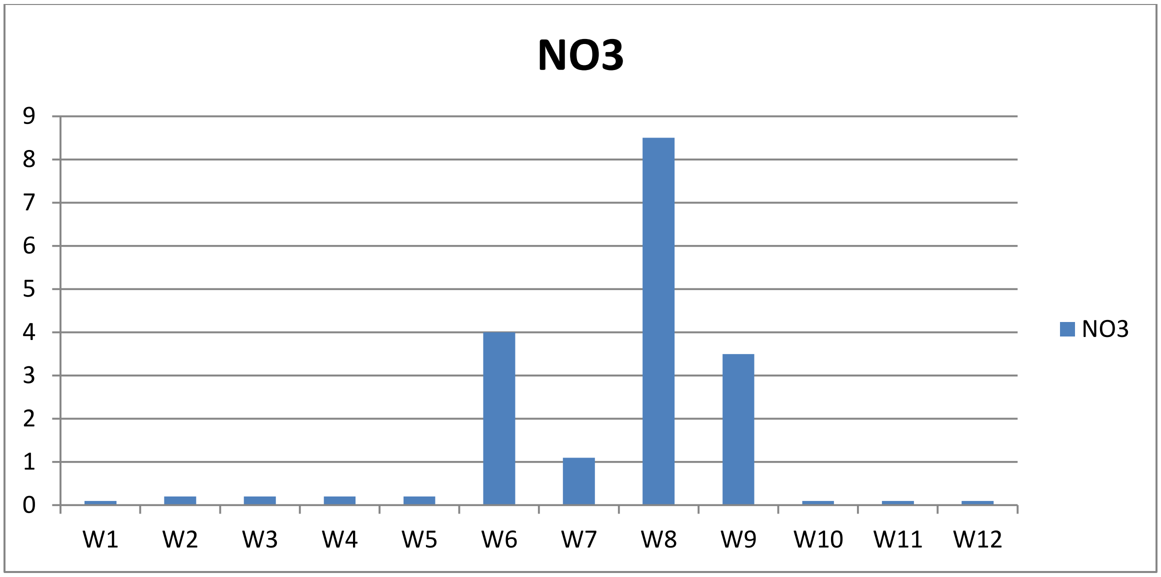
Ammonia reacts with water to form a basic solution, and the bulk remains in the solution in the form of dissolved ammonia (Karinov etal 1989), and the two dominant determinants of nitrogen presence remain (oxygen and organic matter) . In groundwater, the most stable form of nitrogen compounds is nitrate. In a closed system, organic materials are oxidized by dissolved oxygen after depleting oxygen. Other dissolved forms (SO_4^{-2}, NO_3^-) then reduce nitrite and nitrate to ammonium after (Eh) reaches the lowest stage Where iron and manganese oxides are reduced, and before (Eh) is the highest value when sulfate is reduced to sulfide (Karinov etal 1989).

The activity of bacteria includes all stages of nitrogen reactions and its transformation into different forms:

$NO3^{-} \Leftrightarrow NO2 \Leftrightarrow NH4^{+}$

The contamination of groundwater with nitrogen compounds, whether local on a large scale, follows a horizontal or vertical geochemical zonation. The best example of vertical zonation is the presence of nitrates in shallow aquifers and the increase of aluminum in deep aquifers (Zabulis 1988, Krainvo etal1989). High levels of nitrates in shallow groundwater near animal husbandry areas and in large numbers. The process of washing manure nitrogen completely in some areas is slow so that the movement of the solutions through the unsaturated zone between the surface of the earth to the level of the groundwater. It was found that nitrates travel a distance Vertical up to (30) meters during the unsaturated zone with a period ranging (1-49) years. During this period, some nitrates are lost by the process of re-nitrification (Hem 1989) (dentirification). The chemical results showed that nitrate ion concentrations ranged between (٠.1-8.5 mg/L)) at a rate of (1.525 mg/L) .

An increase in nitrates in drinking water causes methemoglobinemia in young children when the nitrogen concentration exceeds (10) mg / liter, as the nitrate in the body turns into nitrite that reacts With hemoglobin, blood gives compounds that are less efficient in transporting oxygen and thus affects the respiration of the organism, according to (1989 NAS-NAE 1972 P73 at hem) .



A graph showing the NO3 values of the samples in the study area.

2-6 Hydrochemical formula and water quality:

This formula is based on the presence of the main positive and negative ions expressed in the relative milligram equivalent (%epm) and their values are arranged in descending order for all the ions having a presence greater than (15 %). Negative ions are placed in the numerator of the equation, while positive ions are placed in the denominator, in addition to placing the value of the dissolved salts TDS in units (g/L) and the pH value, as in the formula now (Kurolov, 1967) shown in the table below:

Table show the Hydrochemical formulae and Water Type .

Well no.	Hydrochemical formulae	Water Type
معادلة kurolov	**HCO_{3}^{-}**(epm%) **Cl^{-}**(epm%) **SO_{4}^{-}**(epm%) **TDS mg/l** **PH** **Na^{+}**(epm%) **Ca^{+2}**(epm%) **Mg^{+2}**(epm%) **K^{+}**(epm%)	
1	**Cl^{-}** (52.996) **SO_{4}^{-}**(40.013) **HCO_{3}^{-}**(6.9878) **No_{3}^{-}**(0.003915) **TDS g/l 2.236** **PH7.1** **Na^{+}**(66.428) **Mg^{+2}**(15.441) **Ca^{+2}**(14.568) **K^{+}**(3.5628)	Mg Na So_4 _ Chloride
2	**Cl^{-}** (50.379) **SO_{4}^{-}**(30.052) **HCO_{3}^{-}**(5.8474) **No_{3}^{-}**(0.011224) **TDS g/l 1.516** **PH 7.12** **Na^{+}**(78.314) **Mg^{+2}**(21.405) **Ca^{+2}**(18.976) **K^{+}**(2.7098)	Ca Mg Na So_4 _Chloride
3	**No_{3}^{-}** (46.67579) **Cl^{-}** (19.423) **SO_{4}^{-}**(18.387) **HCO_{3}^{-}**(15.514) **TDS g/l 1.94** **PH 7.12** **K^{+}**(49.771) **Na^{+}**(17.839) **Ca^{+2}**(16.207) **Mg^{+2}**(16.184)	Mg Ca Na K Hco3 So_4 Cl _ Nitrate
4	**SO_{4}^{-}**(28.084) **Cl^{-}** (25.975) **HCO_{3}^{-}**(24.054) **No_{3}^{-}**(21.88704) **TDS g/l 1.824** **PH 7.1** **K^{+}**(30.693) **Na^{+}**(25.534) **Ca^{+2}**(21.979) **Mg^{+2}**(21.794)	Mg Ca Na K No_3 Hco_3 Cl _ Sulfate
5	**No_{3}^{-}** (26.23463) **Cl^{-}** (25.218) **HCO_{3}^{-}**(25.55) **SO_{4}^{-}**(22.997) **TDS g/l 1.85** **PH 7.12** **Mg^{+2}**(31.92) **Ca^{+2}**(30.711) **Na^{+}**(29.251) **K^{+}**(8.1168)	Na Ca Mg So_4 HCO_3 Cl _ Nitrate
6	**No_{3}^{-}** (98.1675) **HCO_{3}^{-}**(0.796) **SO_{4}^{-}**(0.3364) **Cl^{-}** (0.7) **TDS g/l 0.392** **PH 7.34** **Ca^{+2}**(45.098) **Na^{+}**(26.136) **Mg^{+2}**(20.793) **K^{+}**(7.9727)	Mg Na Ca _ Nitrate
7	**No_{3}^{-}** (82.90761) **HCO_{3}^{-}**(9.2867) **Cl^{-}** (4.5952) **SO_{4}^{-}**(3.2105) **TDS g/l 1.24** **PH 7.13** **Na^{+}**(35.527) **Ca^{+2}**(34.65) **Mg^{+2}**(27.459) **K^{+}**(2.3645)	Mg Ca Na _ Nitrate
8	**SO_{4}^{-}**(38.164) **HCO_{3}^{-}**(27.154) **Cl^{-}** (27.7) **No_{3}^{-}**(12.98285) **TDS g/l 1.282** **PH7.31** **K^{+}**(44.749) **Mg^{+2}**(29.913) **Ca^{+2}**(13.608) **Na^{+}**(11.731)	Mg K Cl Hco_3 _ Sulfate
9	**HCO_{3}^{-}**(36.244) **SO_{4}^{-}**(31.64) **Cl^{-}** (21.2) **No_{3}^{-}**(10.91529) **TDS g/l 6.531** **PH 7.22** **K^{+}**(52.11) **Ca^{+2}**(19.209) **Mg^{+2}**(17.111) **Na^{+}**(11.571)	Mg Ca K Cl So_4 _ Bicarbonate

10	SO_4^{-}(36.606) HCO_3^{-}(63.325) Cl^{-} (26.981) No_3^{-}(0.093412) **TDS g/l 4.052** **PH 7.2** K^{+}(43.883) Na^{+}(24.372) Ca^{+2}(16.701) Mg^{+2}(15.044)	Mg Ca Na K Cl Hco_3 _ Sulfate
11	SO_4^{-}(42.444) Cl^{-} (40.429) HCO_3^{-}(15.77) No_3^{-}(1.357313) **TDS g/l 3.615** **PH 7.2** K^{+}(71.399) Mg^{+2}(10.872) Na^{+}(9.7207) Ca^{+2}(8.0081)	K Hco_3 Cl _ Sulfate
12	SO_4^{-}(26.015) Cl^{-} (24.805) HCO_3^{-}(24.723) No_3^{-}(24.45608) **TDS g/l 4.242** **PH 7.2** K^{+}(25.643) Ca^{+2}(25.193) Mg^{+2}(24.617) Na^{+}(24.547)	Na Mg Ca K No_3 Hco_3 Cl _ Sulfate

Most of the water was (mg-sulfate) .

CHAPTER THREE

3-1 Ground Water Use :

Determining the use of groundwater for various purposes depends on the salinity of the water and the amount of concentrations of positive and negative ions in addition to the concentrations of inorganic pollutants such as: nitrates, boron, phosphates, and rare toxic elements. An assay between the concentrations present in groundwater with the existing upper and lower limits of the same elements in the global and local classifications is determined in the light of which the appropriate powers for the uses of groundwater include the following:

3-1-1 The suitability of groundwater for human drinking :

The standards specifications of the World Health Organization (WHO, 2006), Iraqi standards (IQs-1996) and American standards (USE, 2009), which depend on the concentration of the main group of ions (positive and negative) as well as the values of TDS, TH and PH, were adopted. The specifications indicate that there are limits to the concentration of each ion, and that exceeding the standard limit means that the water is contaminated with this ion. Table (1-3) includes the comparison between the values of the rates of Hydrochemical variables for the water of the study area and the corresponding standard values in the Iraqi standards (IQS-2011) and international standards (WHO-2006) with drinking water for humans.

We note that the water of most of the wells in the study area is not suitable for human drinking .

Table of rates of Hydrochemical variables for the water of the study area with the corresponding standard specifications .

Elements	study area average	WHO,2006 global standards	IQZ,2011 Iraqi standards	USE,2009 American standards
PH	7.18	8.5-6.5	8.5-6.5	8.5-6.5
TDS (mg/l)	2561.6	Less than 1000	Less than 1000	Less than 1000
EC (µS/cm)	3490.3	Less than 2000	Less than 1600	Less than 1600
Na^+ (mg/l)	6327	200	200	200
Ca^{+2}(mg/l)	2937	150	200	200
K^+ (mg/l)	699.1	12	12	20
Mg^+(mg/l)	1769	100	50	125
Cl^- (mg/l)	8026	250	250	250
So_4^{-2} (mg/l)	13896	400	250	250
$HCO3^{-3}$(mg/l)	2486	250	250	.....
$NO3^{-3}$(mg/l)	18.3	50	50	10

3-1-2 The suitability of groundwater for drinking animals :

Most animals can drink poor quality water that humans cannot drink. The classification of (Crist and Lowery, 1972) for drinking animals used Table (2-3), as well as the classification of (Ayres and Westcot, 1989) Table (3-3), which refers to the symptoms associated with diseases as well as determines the extent of contamination with trace elements, if any.

A table (2-3) showing the suitability of water for drinking animals:

<table>
<tr><th colspan="3">Crist and Lowery, 1972</th></tr>
<tr><th>Type of animals</th><th>Quality</th><th>TDS mg/L</th></tr>
<tr><td rowspan="2">٢٨٦٠ to / Poultry</td><td>Good</td><td>1000 ></td></tr>
<tr><td>Acceptable</td><td>1000−3000</td></tr>
<tr><td rowspan="2">٦٤٣٥ to / Horses</td><td>Weak</td><td>3000−5000</td></tr>
<tr><td>Very weak</td><td>5000−7000</td></tr>
<tr><td>٧١٥٠ to / milk cows
١٠٠٠٠ to / Meat cows
١٢٩٠٠ to / Sheep</td><td>Unacceptable</td><td>7000></td></tr>
</table>

(3-3) Specifications of drinking water for animals and poultry according to classification (Ayres and Westcot, 1989) .

The electrical conductivity of used water and its damages			permissible limit Presence of rare elements	
Ec(µs/cm)	Degree	Notes	ions	Mg/L
<1500	excellent	It is used for all types of livestock and poultry	Cd	0.05
-5000 1500	very acceptable	It is used for all types of livestock and may cause temporary diarrhea in poultry	Cr	1
-8000 5000	Acceptable for animals and not acceptable for poultry	It causes temporary diarrhea in livestock and causes death to poultry and reduced growth	Co	1
			Cu	0.5
-11000 8000	Limited to animal use and not acceptable to poultry	Not to be given to pregnant and nursing animals and is not acceptable for poultry	pb	0.1
			Zn	24
-16000 11000	Very limited use	Not acceptable for animals	NO3	100
>16000	It is not recommende d to use	The risks are very high and its use is not recommended	NO2	10

According to the results of chemical analyzes and when comparing them with the specifications of tables (2-3) and (3-3), it becomes clear: -

1- In terms of the percentage of dissolved solids (TDS) and according to (Crist and Lowery, 1972) Table (2-3), the well water in the study area is suitable for drinking for all animals except for wells (W9, W10, W11, W12). TDS is abnormal and does not meet the allowable limit for poultry.

2- In terms of electrical conductivity (EC) and trace elements, according to the classification of (Ayres and Westcot, 1989) Table (3-3), the well water in the study area is suitable for drinking for all animals.

It causes temporary diarrhea in poultry, except for wells W9, W10, W11, W12, which are not suitable for drinking poultry, as they cause death to poultry and reduce the growth and cause temporary diarrhea for livestock.

3-1-3- Validity of groundwater for agricultural purposes :

The tolerance of plants to salinity in irrigation water varies, as a classification was adopted (Todd, 1980) on the tolerance of agricultural crops to concentrations of dissolved salts. Winter crops such as wheat, barley, jet, legumes and green onions are spread throughout the region.

Table (4-3) classification (Todd, 1980) of the tolerance of agricultural crops to salinity of irrigation water.

Crops that are resistant to high concentrations of salinity (EC μs/cm)	Crops that are resistant to medium concentrations of salinity (EC μs/cm)	Crops that are resistant to low salinity concentrations (EC μs/cm)	crop varieties
4000−10000 Palm	3000−4000 olives, figs, pomegranate	0−3000 Lemon, peach, apricot, orange, apple	Fruits
10000−12000 spinach, beet	4000−10000 Cucumber, onion, carrot, potato, lettuce, tomato	3000−4000 green beans	Vegetables
10000−100000 Cotton, beet, diabetes, barley	6000−10000 Sunflower, flax, corn, rice, wheat	4000−6000 agricultural pulses	Agricultural crops

By comparing the quality of the groundwater of the study area with the table above, we note that the water from the wells of the study area is suitable for all types of agricultural crops.

3-1-4- The validity of groundwater for irrigation purposes:

There are many classifications for determining the suitability of water for irrigation, including the classification (Ritchard, 1954), which adopted the relationship between sodium adsorption ratio (SAR) and electrical conductivity (EC).

And the classification of the Food and Agriculture Organization (FAO, 1997), which depends on the (EC) and (TDS) for water only. In the current study, a classification was adopted (Ayres and Westcot, 1989) to determine the validity of the area's water for irrigation uses; This is due to its dependence on many variables. There are five groups that represent the heterogeneity of the Hydrochemical data, including:

Salinity and concentrations of the main positive and negative ions.

And nutrients (Nutrients) and other influences (Miscellaneous), and for this it was adopted as shown in Table (5-3).

Table (5-3) Standard specifications for irrigation water according to (Ayres and Westcot, 1989) .

Groups	Index	Unit	Usual Rang
Salinity	EC TDS	µs/cm ppm	0-3000 0-2000
Cations	Ca Mg Na	ppm ppm ppm	0-400 0-60 0-920
Anions	Co3 HCO3 Cl So4	ppm ppm ppm ppm	0-3 0-610 0-1063 0-960

Nutrients	No_3-N NH_4-N Po_4-p K	ppm ppm ppm ppm	0-10 0-5 0-2 0-2
Miscellaneous	B PH SAR	Ppm 1-14 epm	0-2 6.0-8.5 0-15

By comparing the quality of the groundwater of the study area with the above table, we note that the water of the wells of the study area, we conclude the following : -

- The water of the wells of the study area is completely suitable for irrigation in terms of its salinity, which is of low values, except for the wells (W1, W9, W10, W11, W12).

- Positive ions: the water from the wells of the study area falls within the permissible limits, except for the well W9 for (Ca^{+2}), as for the ion of (Mg^{+2}), there are three wells that fall within the limits which are (W6, W7, W8). ,) As for the rest of the wells, they do not fall within the limits, and for the (Na^{+1}) ion, all the waters of the wells of the study area fall within the permissible limits.

- Negative ions: the water of the study area falls within the permissible limits for the ion (SO_4^{-2}) in the wells (W8, W7, W6), while the rest of the wells do not match the value of (SO_4^{-2}); While all of them are within the permissible limits for the ions (HCO_3^{-1}), (Co^{-2}) and (Ca^{+2}) except for well W9.

- Nutrients :- For No_3 , the water of wells and springs in the area has concentrations that are within the permissible limits, while for ion (K^{+1}), all of them contain a concentration much greater than the permissible limits, except for the sixth and seventh well which are within the permissible limits .

- Other influences: Regarding the pH in the water of the study area, it is within the permissible limits. As for the sodium adsorption rate (SAR), which expresses the concentration of sodium in the water. When the concentration of sodium increases over calcium concentrations by (1-3), the value of (SAR) will be high, and this will lead to the fragmentation of the soil and reduce its porosity, and then the filtration of irrigation water will decrease during it. (SAR) was calculated from the following equation (Todd, 1980)

$$SAR = \frac{Na}{\sqrt{(Ca + Mg)/2}}$$

where ASR is the adsorption rate of sodium

Na , Ca $^{٢+}$, Mg $^{٢+}$ Ion concentrations in epm

(ASR) was calculated for the water wells of the study area

All (ASR) values of the wells water in the study area were recorded in Table (6-3).

Table (6-3) of the (ASR) values for the water wells of the study area.

Well No.	SAR
W1	11.4
W2	6.4
W3	0.7
W4	0.8
W5	0.6
W6	0.2
W7	0.4
W8	0.6
W9	0.7
W10	1.4
W11	0.6
W12	0.6

We note that the area's waters with SAR values are within the permissible limits.

3- 1-5 water suitability for industrial purposes :

The specifications of water used for industrial purposes vary according to the type and nature of the industry, and in general, salinity and hardness are important for this purpose. When comparing the results of chemical analyzes with the limits proposed by (Salvato, 1982) Table (7-3), we find that wells W6, W7) are valid for food industries And the paper industry. As for the rest of the wells, they are not suitable for the food and paper industries because of their high hardness. As for the chemical industries and refineries, all wells are suitable for industry except for wells W1, W2, W9, W10, W11, W12)), which are not suitable for chemical industries and refineries because of their high hardness.

Table (7-3) Suggested limits for water used in industries (Salvato,1982) .

ion concentrations ppm					total hardship ppm	basal	PH	Possible industries
Fe+	Mg+	Ca+	SO_4−	Cl^-				
0.40		5.98	5.2	8.46	316	300	6.5	Food Industry
5.0		9.98	17.96	14.10	1000	500	6.9	chemical industries
25.0		−	5.20	7.05	−	4000	6.5−8.5	Cement
15.0	6.99	10.97	11.86	45.13	900	−	6−9	Refineries
2.6	0.99	0.99	−	5.6	475	−	6−9	Paper

3-1-6 Water suitability for building and construction purposes :

From assaying the results of chemical analyzes of water wells and when comparing them with the limits proposed by (Altoiviski) Table (3-8) for construction purposes, the following becomes clear:

Table (8-3) Suggested limits for water validity for construction purposes (Altoiviski , 1962) .

Concentrations ppm	negative ions	Concentrations ppm	positive ions
2187	Cl^{-}	1160	Na^{+}
1460	$SO_4{}^{-2}$	437	Ca^{+2}
150	$HCO_3{}^{-}$	271	Mg^{+2}

As for the sodium and chlorine ions, the water from the wells and springs of the study area are all within the permissible limits. As for the magnesium ion, the water in the area is within the permissible limits.

As for the positive ions, all the wells fall within the permissible limits. As for the negative ions, the chlorine ion falls within the permissible limits and the So4 ion falls within the permissible limits, except for the wells (W1, W9, W10, W11, W12), which are within the permissible limits with it.

The Hco3 ion falls within the permissible limits, except for the wells (W9, W10, W11, W12), which do not fall within the permissible limits.

$$TDS_{(g/L)} = \frac{Anion\ epm\ \%\ indecreasing\ order}{Cation\ epm\ \%\ \ ndecreasing\ order}\ pH$$

CHAPTER FOUR

4-1 conclusions :

1- Groundwater in the study area is neutral water tending to alkaline, saline, hard, and its quality varies according to its geographical locations and its rocky reservoirs and its depths.

2 - It was found that the chemical type of water was mostly of the type of sodium chloride (Mg-sulfate) , According to the Kurolov equation .

3 - Most of the water was basic according to the classification of (who, 2006), and the highest pH was in the well NO . 6 in the Al-Buyousef area, this increase is due to the high concentration of CO_2 gas.

4 - Electrical conductivity EC , based on (Detay , 1997) , the water was of the type Excessively mineralized water, and the highest percentage was in well NO .9 in Khashm Zarzour. This increase is due to the interaction of groundwater with the existing rock formations.

5 - The TDS , based on (Todd, 1980), (Altoiviski, 1962) the water was brackish and slightly brackish and well number 6 was fresh water due to the presence of many drains that feed the area .

6- The highest value of calcium ion was in well No. 9. The reason for this increase is due to the dissolution of secondary gypsum present in the soil, which is the same reason for the increase of so_4. and human activities also contribute to the release of calcium ion and its increase (Langmuir, 1997).

7 - The high percentage of potassium is attributed to the fact that the area is agricultural and the effect of agricultural operations and the addition of fertilizers, in addition to the lack of drainage for water drainage in the area of the well.

8 - The high values of $Mg^{٢+}$ concentrations in the area are probably due to the presence of carbon dioxide (CO) in the study area, which dissolves magnesium from the silica and carbonic minerals (1975.Collins), in addition to the common clay minerals (montmorillonite) present in the area containing high concentrations. of magnesium.

9 - The presence of high concentrations of sodium is attributed to the cause of the melting of halite salts (NaCl), Because of the soil washing processes that occur when rain falls.

10 - The high value of bicarbonate for some wells can be attributed to the effect of ($CO_٢$) resulting primarily from the fact that the surface soil contains plants, and from the occurrence of the respiration process or the decayation process, the decomposition of plants after their death, the(CO_2) gas is released and takes its way into the moist soil To groundwater and when it participates in the weathering process, where when one molecule of ($CO_٢$) interacts with carbonate minerals (Solid Co_3), two molecules of HCO3 are produced, and when it interacts with non-carbonate minerals, one molecule of (HCO_3) is produced for each molecule of (CO_2) involved in the reaction (1989, Hem) .

11 - The concentration of SO4 In Well NO. 6 is low due to some factors that lead to the removal of sulfates from water, as sulfates are exposed to reducing sulfur bacteria to sulfides .

12 - Increasing the chloride content due to exposure of the solutions to the evaporation processes.

13 - High levels of nitrates in shallow groundwater near animal husbandry areas and in large numbers.

14 – ground water uses :

First: - According to the standard specifications of the World Health Organization (WHO, 2006), Iraqi specifications (IQs-1996) and American specifications (USE, 2009), which depend on the concentration of the main group of ions (positive and negative), as well as the values of TDS, TH and PH. We note that The water of all wells in the study area is unfit for human drinking

Second: - According to the classification of (Crist and Lowery, 1972) related to drinking animals, as well as the classification of (Ayres and Westcot, 1989), we note that in terms of the percentage of dissolved solids (TDS) and according to (Crist and Lowery, 1972) the table, the well water in the study area Drinkable for all animals except for wells (W9, W10, W11, W12), the percentage of total dissolved solids (TDS) in it is abnormal and does not match the permissible limit for poultry. As for electrical conductivity (EC) and trace elements, according to the classification of (Ayres and Westcot, 1989) We note that the water from the wells in the study area is suitable for drinking for all animals and may cause temporary diarrhea in poultry except for wells (W9, W10, W11, W12) , which are not suitable for drinking poultry as they cause death to poultry and reduce growth and cause temporary diarrhea for livestock

Third:- A classification was adopted (Todd, 1980) on the tolerance of agricultural crops to concentrations of dissolved salts, and by comparing the quality of the groundwater of the study area with the classification of (Todd, 1980), we note that most of the water from the wells of the study area is valid for all types of agricultural crops.

Fourth: A classification (Ayres and Westcot, 1989) was adopted to determine the validity of the area's water for irrigation uses. This is due to its dependence on many variables. There are five groups representing the variation of the Hydrochemical data, including:

Salinity and concentrations of the main positive and negative ions. Nutrients and other miscellaneous influences. We note that:

1- The water of the wells of the study area is completely suitable for irrigation in terms of its salinity, which is of low values, except for the wells (W1, W9, W10, W11, W12).

2- Positive ions: the water of the wells of the study area falls within the permissible limits, except for the well W9) for (Ca^{+}), as for the ion of (Mg^{+2}), there are three wells that fall within the limits which are (W6, W7, W8). ,) As for the rest of the wells, they do not fall within the limits, and for the (Na^{+}) ion, all the waters of the wells of the study area fall within the permissible limits.

3- Negative ions: the water of the study area falls within the permissible limits for the ion (SO_4^{-2}) in the wells (W8, W7, W6), while the rest of the wells do not match the value of (SO_4^{-2}); While all of them are within the permissible limits for the ions (HCO_3^{-1}), (Cl^{-1}) and (Ca^{+2}) except for well (W9).

4- Nutrients :- For NO_3, the water of wells and springs in the area has concentrations that fall within the permissible limits, while for ion (K^{+}), all of them contain a concentration much greater than the permissible limits, except for the sixth and seventh well which are within the permissible limits

5- Other influences: Regarding the pH and the sodium adsorption rate (SAR) in the water of the study area, it is within the permissible limits.

Fifth:- A classification was adopted (Salvato, 1982) to determine the suitability of groundwater for industrial purposes. We find that the wells (W6, W7) are suitable for the food and paper industries, while the rest of the wells are not suitable for the food and paper industries because of their high hardness.

As for the chemical industries and refineries, all wells are suitable for industry except for wells(W1, W2, W9, W10, W11, W12), which are not suitable for chemical industries and refineries because of their high hardness.

Sixth: - Altoiviski classification was adopted to determine the validity of groundwater for building and construction purposes. We note that for the sodium and chlorine ions, the waters of the wells and springs of the study area are all within the permissible limits. For the magnesium ion, the waters of the area are within the permissible limits.

As for the positive ions, all the wells fall within the permissible limits. As for the negative ions, the chlorine ion falls within the permissible limits. As for the So4 ion, it falls within the permissible limits, except for the wells (W1, W9, W10, W11, W12), which are not Within the permissible limits

As for the Hco3 ion, it falls within the permissible limits, except for the wells (W9, W10, W11, W12), which do not fall within the permissible limits.

2-4 Recommendations:

1- The area needs to calculate the water balance in it in order to complete the study of the Hydrochemical quality of the groundwater.

2- The area needs a geophysical study to determine the amount of extensions of water reservoirs.

3- Because of the low concentrations of total salts of the water samples in the study area, it is possible to find geographical locations for wells with good water to ensure a good quality of groundwater suitable for civil uses and thus avoid polluted wells.

4- Since the area is agricultural, it is better to rehabilitate irrigation projects in it due to the abundance of its groundwater.

5- Warn the people of the area not to drink from well water because it does not conform to international standards.

6- It was recommended to conduct chemical analyzes of heavy elements for the wells of the study area.

4-3 Reference :

١ : Sissakian, V.K. and Fouad, S.F.2012. Geologic Map Of Iraq, Scale 1:1000000, 4th edit. GEOSURV, Baghdad, Iraq.

٢ : Jassim, S.Z. and Goff, J C. 2006. Geology of Iraq, Czech Republic, ISBN 80- 7028-287-8.

٣: Yousif, L. D. 2017. Active tectonic assessment of Mandili watershed using GIS technique. Iraqi Bulletin of Geology and Mining. 13(1): 43-62.

٤: Al - Kadhimi, J. A. M., Sissakian, V. K., Fattahm A., S. and Deikran, D. B. 1996. Tectonic map of Iraq 1:1,000,000 scale series, Publication of GEOSURV, Baghdad, sheet No. 2.

٥: Fouad S. F. 2012.Western Zagros Fold-Thrust Belt, Part I: The Low Folded Zone. Iraqi Bull. Geol. Min., Special Issue(5): 39–62.

٦: Ajirlu M.S., Moazzen M. and Hajialioghli, R. 2016. Tectonic evolution of Zagros Orogeny in the realm between of the Neotethys between the central Iran and Arabian Plates: An Ophiolite perspective. Central European Geology, 59: 1 – 4, 1 – 7.

7: İlde endemik hastalıklarıncoğrafi dağılımı gösterdiği artan nüfus yoğunluğu ve nüfus yoğunlaşması , hem de nüfusilin (Bakuba harcama) ve yüzdesi (62.51 %) merkezinde tifo vakalarınınyüksek sayısıdır.

8: https://www.iasj.net/iasj/download/ccfcbe01bea69930 .