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Groundwater quality and origin within Dibdibba aquifer near Jabel Sanam area southern of Basrah Governorate, Iraq

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Abstract - The study aims at assessing the groundwater quality and identify of its origin within Dibdibba aquifer (Jabel Snam area) south of Basrah. Twenty well has been selected from the studied area were subjected to comprehensive physical and chemical analysis involving major cations (Ca^{2+}, Mg^{2+}, Na^{+} and K^{+}), anions (HCO_3^-, Cl^- and SO_4^{2-}) and trace elements (Zn, Cd, Ni and Pb) besides general parameters (pH, EC, TDS and total hardness). The spatial distribution of parameters were drawin using geostotistic interpolation technique namely ordinag Kriging in Arc GIS 10.2.2. Based on the results the groundwater quality was classified to chloride group-sodium family-type (Na^{+} >Ca^{2+} >Mg^{2+}). On the other hand, the groundwater origin investigate by Sullin diagram which showed old meteoric origin for all studied wells.

Keywords: Dibdibba, groundwater, aquifer, meteoric, Jabel Sanam.

Introduction

Groundwater is an important resource in many areas of the world for drinking, irrigation, industrial and other usages. In recent years, concerns have been grown about the decrease in discharge and water quality degradation of the Tigris and Euphrates Rivers, thus increasing the need for detailed studies on groundwaterand quality. Then best mangement for the important water source in Iraq, because there are several formations which are bearing groundwater such as Dibdibba aquifer. Recently, many water purification stations (RO) had been constructed using the groundwater from the wells in the area to product drinking water. Dibdibba aquifer is considered as one of the main shallow aquifer in central and southern Iraq, because of the high horizontal extension of its outcrops, as well as the present of clastic sediments make the runoff percolation to the aquifer easly (Al-Kubaisi, 1996).

The study area is considered as a part of Dibdibba aquifer, Southern Desert of Iraq. The upper part of Dibdibba formation (Pliocene-Upper Miocene), in which the most productive units are sands and gravels, is the main aquifer in Safwan-Zubair area. It is Characterized by unconfined to semi-confined conditions. The average of its saturated thickness is nearly (14 m) (Haddad and Hawa, 1979; Al-Jawad *etal*., 1989; Al-Kubasi, 1996).

Many studies have been made on the study area and its surroundings. These studies included the southern region as a whole and particularly the area in Zubair-Safwan. These included hydrological and hydrogeological, study of hydrogeochemical assessment of groundwater system of the region (Al-Kubaisi, 1996: Al-Suhail, 1999: Al-Mansoury, 2000), as well as studies on contamination of groundwater with saltwater (Al-Musawi, 2009) and the study of water balance in the region of Safwan by (Haddad, 1977). Most of these studies dealt with the region as a whole, where results showed that there was significant variation in groundwater levels and quality of the sites of selected areas, as well as neighboring wells, therefore the present study aims to examine the quality of groundwater for the area between Jabal Sanam, and Safwancity, one of the most important areas which fall within the zone of Dibdibba formation.

Materials and Methods

Groundwater 40 samples were collected from 20 water wells in the south west Basrah province near Jabal Sanam. Locations of these wells were showed in Figure (1). The groundwater samples were collected in clean polyethylene bottles during 2013 by sampling routines set for water quality studies (Hem, 1991). Major ions (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, HCO_3^{-}, Cl^{-} and SO_4^{2-}) were analyzed according to standard methods as described in APHA (1992).

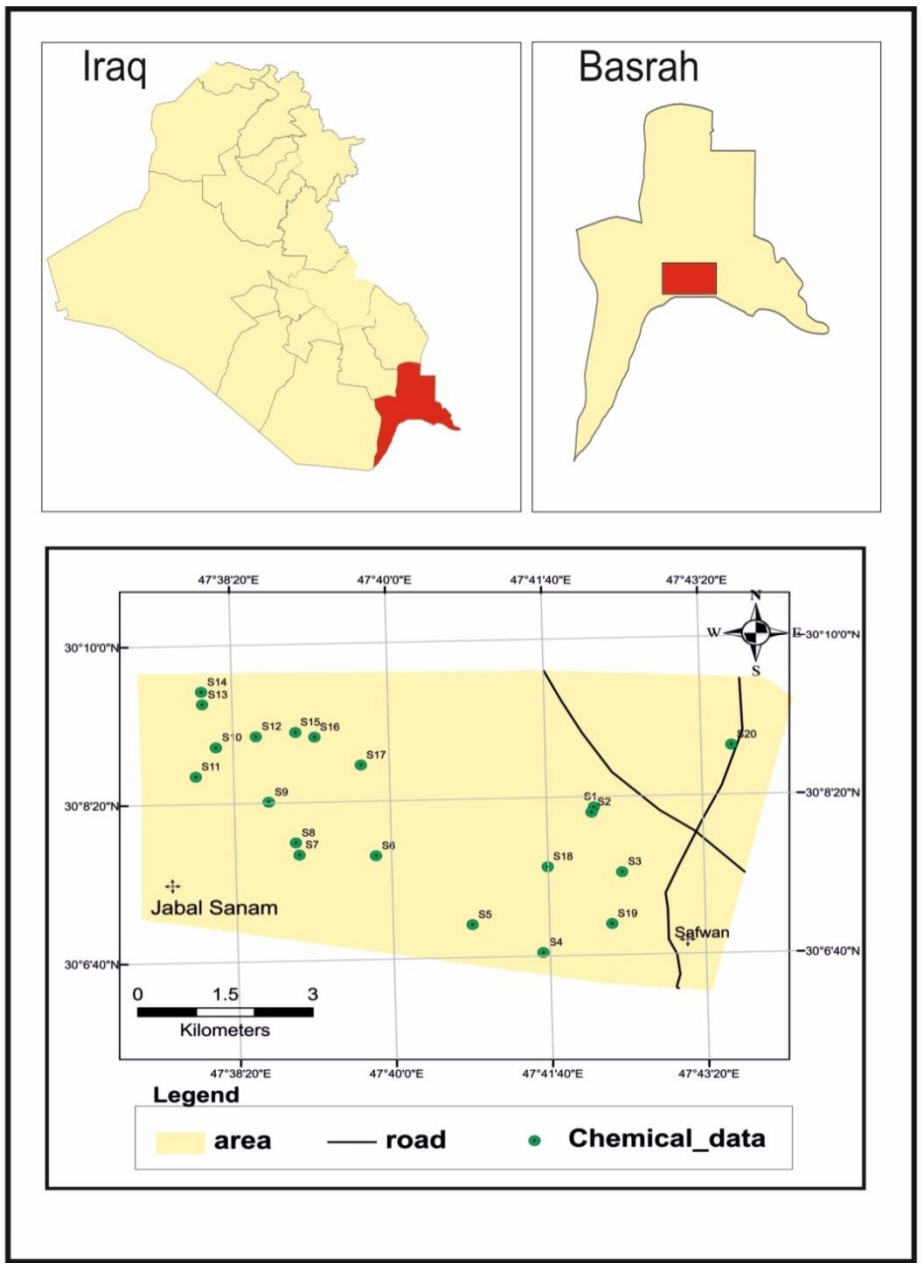

Figure 1. Location map of study area.

After collection Samples for laboratory trace element analysis for each sample ware immediately acidified to pH<2 with ultrapure nitric acid. Analysis of Pb, Zn, Ni and Cd in water samples were performed by APHA (1992), using atomic absorption model Sens AA spectrometer.

pH and electric conductivity (EC) were measured by using the WTW portable electronic instruments model 3210 SET 2 and 3110 SET 1, respectively.

Results and Discussion

Electrical Conductivity (EC):

Result show that electric conductivity of groundwater were ranged from 7.37 to 14.36 $ds.cm^{-1}$ with an average of 11.31 ds/cm (Fig. 2). The conductivity is low in the western of Jabal senam zone (about 7.37 $ds.cm^{-1}$) due torecharge from the ALbatin alluvial fan (Hadad, 1977), where the salinity decreases. The conductivity is high in the eastern zones of study area (about 14.36 $ds.cm^{-1}$) which due to water-rock interactions in the studied aquifer (Al-Suhail and Al-Mansory, 2003).

Hydrogen Ion Activity (pH):

Generally the groundwater of the study area is slightly alkaline (Fig. 3). The pH values range from 6.9 in well 5 in the south to 7.8 in well 1 in the north of the study area with an average of 7.41. The variations of pH values aremostly due to the chemical composition of the aquifer rocks (Sharaky *et al.*, 2007).

Major Ions:

Sodium (Na^+):

The concentration of Na^+ ion ranges from 924 in well 9 in the west to 2638 mg/l in will 18 in the east with anaverage of 1680.85 mg/l (Fig. 4). Sodium concentration is directly related to salinity content and EC of the groundwater in the Al-Dibdibba aquifer, so the high value due to the same reason has been explained in EC part and halite rocks which have high availability in studied area (Al-Mansory, 2000)

Potassium (K^+):

The potassium content in the groundwater of the Jabal senam area same as sodium distribution but its low in most of the wells, where it ranges from 9 to 59 mg/l with an average of 24.5 mg/l (Fig. 5). The low concentration of potassium in the study areamybe due to the type of aquifer matrix, where potassium salts in most rocks are not easily dissolved in the groundwater (Stumm and Morgan, 1996).

Calcium (Ca^{2+}):

The concentrations of calcium ion ranges between 371mg/l in well 7 to 541 mg/l in well 14 with an average of 474.4 mg/l (Fig. 6). Theincreasing of calcium concentration is due to the type of water-caring strata, which have calcite, dolomite, gypsumand anhydrite minerals, which responsible of enriching the groundwater with calcium ions in this aquifer (Al-Mansory, 2000).

Magnesium (Mg^{2+}):

The magnesium concentrations change from 72 in well 9 to the west of 462 mg/l in will 18 in the eastern Jabal senam area with an average of 210 mg/l. The minimum values were found close to Jabal Senam (Fig. 7) which due to the recharge from the ALbatin alluvial fan (Haddad, 1977), while the maximum value due to Dolomite rocks in Dibdiba aquifer that indicate local sources of Magnesium.

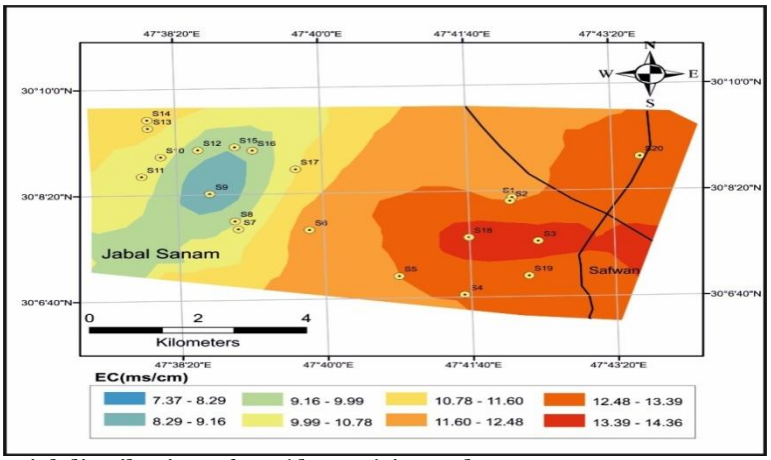

Figure 2. Spatial distribution of EC (ds.cm^{-1}) in study area.

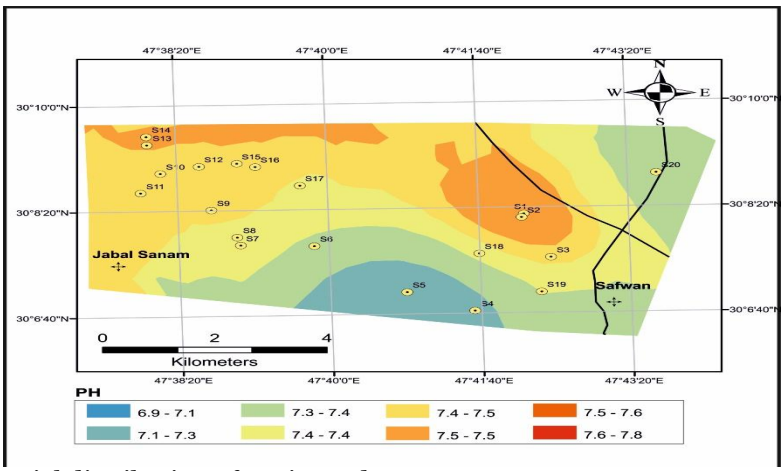

Figure 3. Spatial distribution of pH in study area.

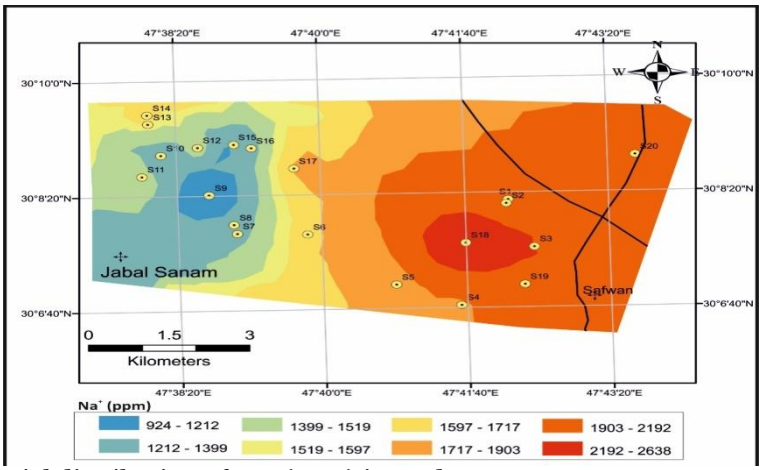

Figure 4. Spatial distribution of Na^+ (ppm) in study area.

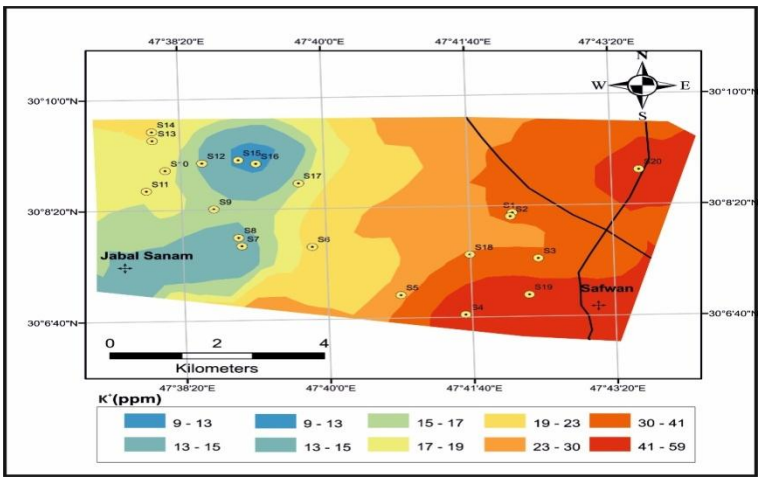

Figure. 5. Spatial distribution of K^+ (ppm) in study area.

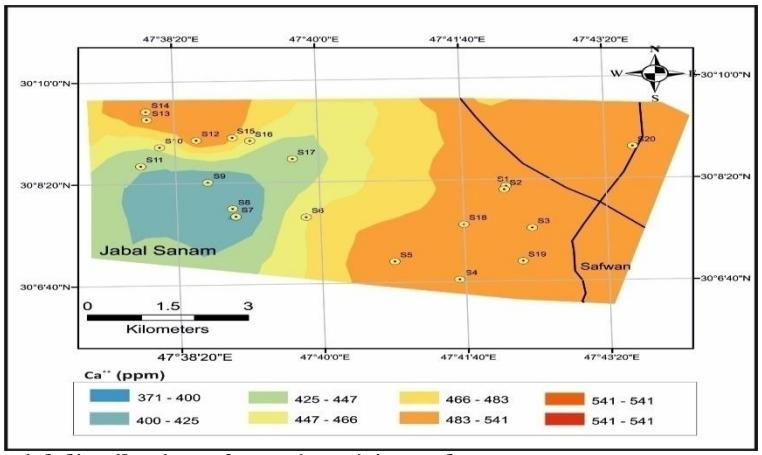

Figure 6. Spatial distribution of Ca^{2+} (ppm) in study area.

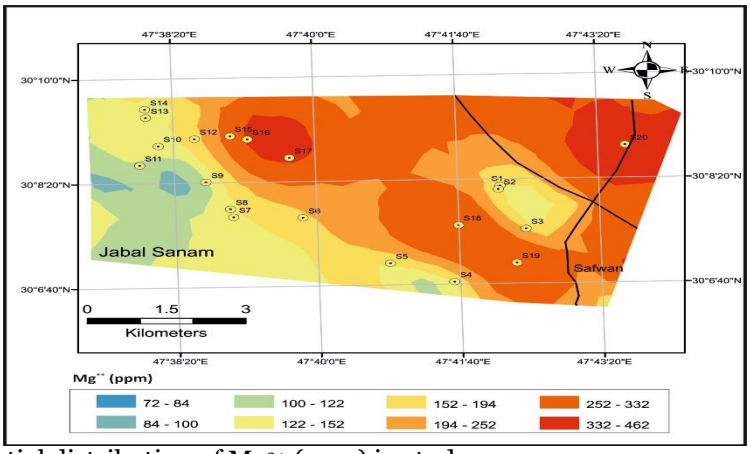

Figure 7. Spatial distribution of Mg^{2+} (ppm) in study area.

Major Anions:

Chloride (Cl^-):

Chloride concentration changes from 1479 in well 16 western to 2726 mg/l in well 18 eastof Jabal Sanam area withan average of 2070.6 mg/l (Fig. 8). Chloride ion is the common major anion in Dibdiba aquifer groundwater.Chloride and sodium content increase rapidly with the increase of TDS (Fig. 9) (Sharaky *et al.*, 2007).

Sulfate (SO_4^{2-}):

The sulfate concentration changes from 1884 in well 12 north west to 2731 mg/l in well 3 eastern with an average of 2276 mg/l (Fig. 10). The high sulfate content in the study area due to the extending of Miocene sediments containing gypsum and limestone which mean that there is a local sources of sulfates (Qusay and Al-Mansory, 2003).

Bicarbonate (HCO_3^-):

The bicarbonate concentration changes from 86 in well 7 close to Jabal senam to 161 mg/l in well 11 western with an average of 128 mg/l (Fig. 11). The maximum value due to dissolution of carbonate rocks (Hem, 1991).

Water Type:

Sulin's graph (Sulin, 1948) for genetic classification has been used to indicate the groundwater genesis using the chemical composition.

According to Sulin's classification, all the 20 wells samples are located in the lower quadrant of Sulin's diagramand characterized by sodium-sulfate (Fig. 12) indicating old meteoricwater in origin.

Also the groundwater origin could be detect using the NC value as fallowing equation (Ivanov *et .al.*, 1968).

$$NC = [r\ epm\ Na^+ + r\ epm\ K^+] / r\ epm\ Cl^-$$

If the calculated NC value is higher than 1.0 it indicates that meteoric water origin while NC value less than 1.0 indicates the marine water origin.(Ivanov *et al.*, 1968). Calculated NC values in Table (1) show that all 20 wells in studded area have meteoric ground water origin.

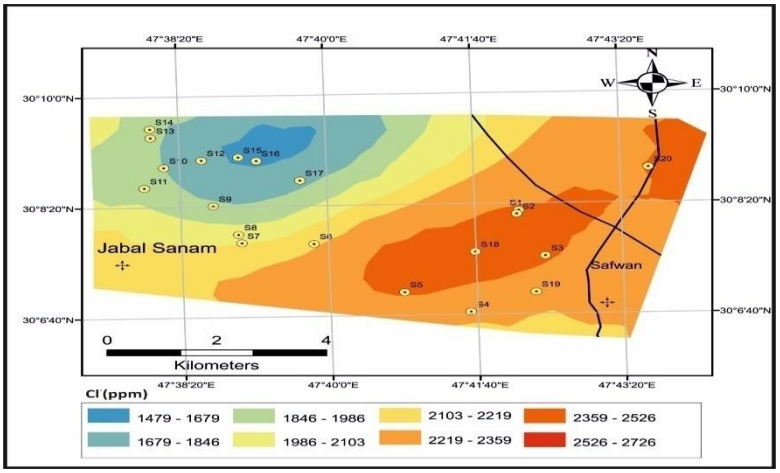

Figure 8. Spatial distribution of Cl^- (ppm) in study area.

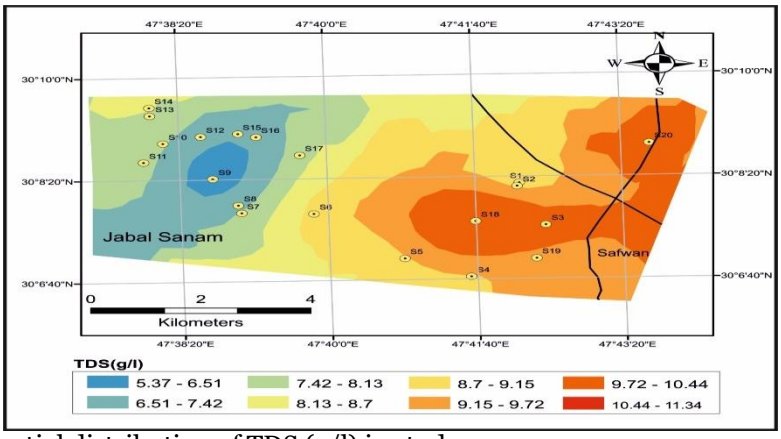

Figure 9. Spatial distribution of TDS (g/l) in study area.

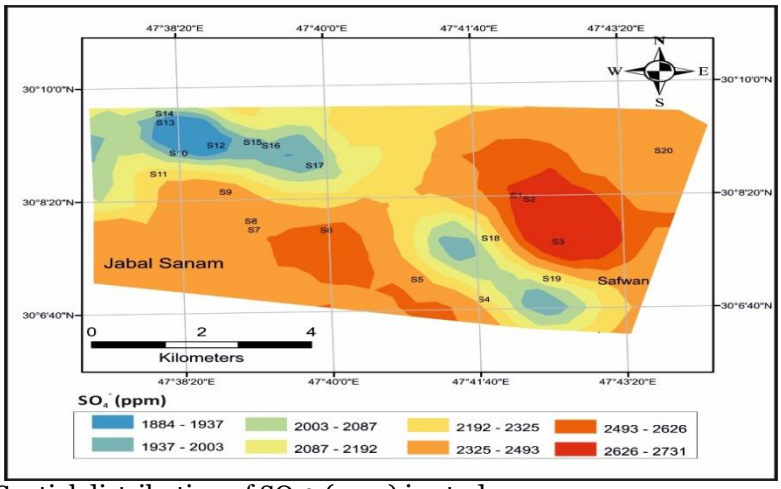

Figure 10. Spatial distribution of SO_4^{2-} (ppm) in study area.

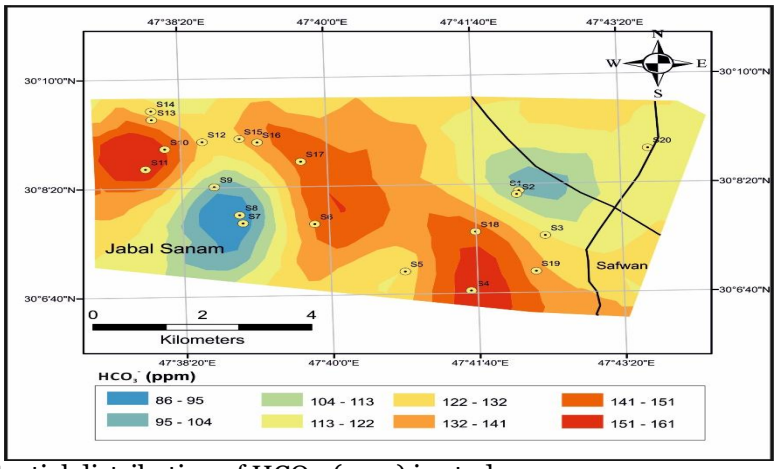

Figure 11. Spatial distribution of HCO_3^- (ppm) in study area.

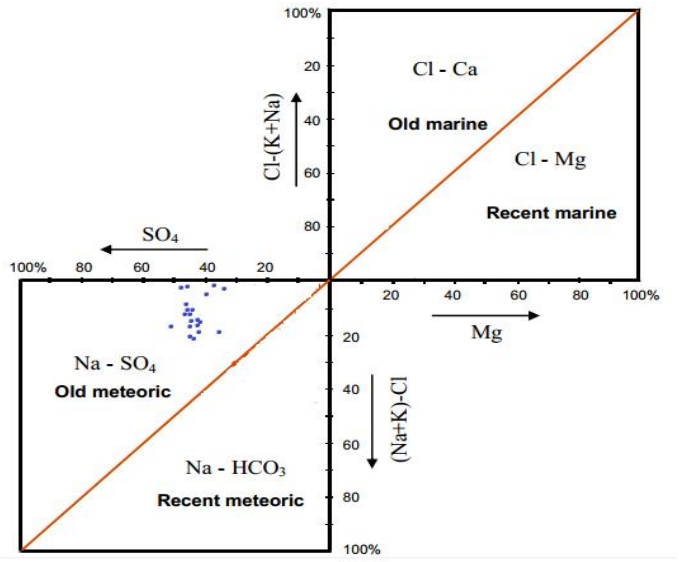

Figure 12. Sullin diagramfor genetic classification of the groundwater.

Table 1. NC values of the study area.

Well no.	NC	Well no	NC	Well no	NC	Well no	NC
1	1.03	6	1.28	11	1.24	16	1.28
2	1.15	7	1.16	12	1.27	17	1.38
3	1.02	8	1.24	13	1.16	18	1.37
4	1.01	9	1.12	14	1.37	19	1.32
5	1.07	10	1.02	15	1.17	20	1.23

The chloride group is dominant in the studied wells. In spite of the concentrations of sulfates which are relatively high, however it is still less than concentrations of chlorides. The previous studies of water type are referred to the chloride group that contains two families (sodium and calcium). However, all the studied groundwater wells are chloride group-sodium family-type ($Na^{+}>Ca^{2+}>Mg^{2+}$) only.

Trace Elements:

Figure (13 and 14) showed that the Zn and Pb concentrations in the groundwater of the studded area changes from 0.1 and 0.02 in wells (9 and 16) to 2.2 and 0.18 mg/l in wills (20 and 10) with an average of (0.98 and 0.07) mg/l, respectively. The minimum values was found north of Jabal Senam. Concentrations of Zn and Pb may be belong to natural causes such as contact between the groundwater and the parent rocks in sandstone Dibdibba formation that contain (Zn and Pb) medium (39 and 7), respectively (Al-Bassam and Yousif, 2014).

The high values of Pb and Zn may attribute to the anthropogenic activities such as using the hydrocarbon fueland soil fertilizer which contained Pb and Zn as a result of the agriculture activities in the studied area.

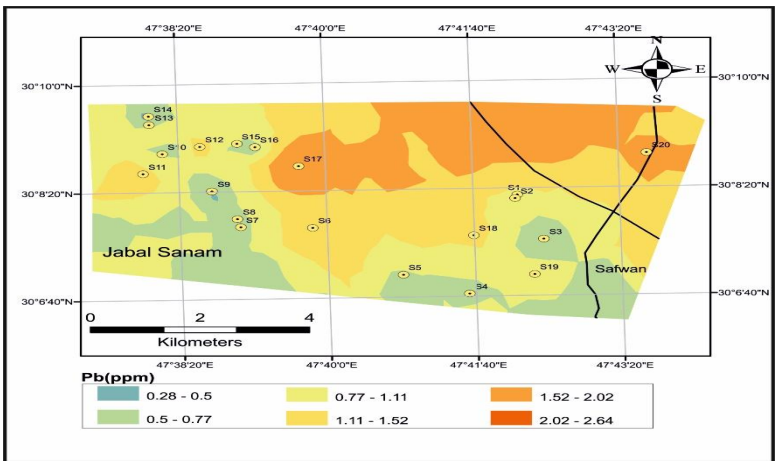

Figure 13. Spatial distribution of Pb (ppm) in study area.

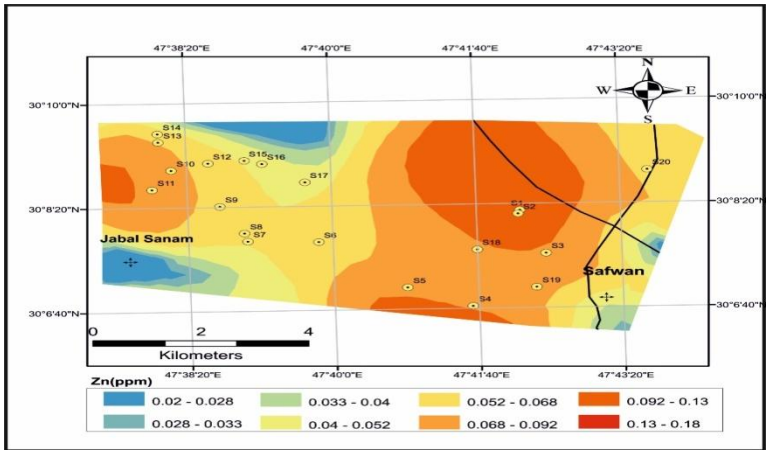

Figure 14. Spatial distribution of Zn (ppm) in study area.

Conclusion

Generally the concentrations of salts and major ions in groundwater of study area are high. The maximum values are recorded eastern part of the study area, whereas the minimum values were occored in the northwestern Jabel Sanam. All the studied wells contain chloride group sodium family type. The groundwater of the studied area is old meteoric origin according to Sulin's classification. The concentrations of trace elements in the groundwater are very low, with the exception of lead and Zinc. That may be attributed to the natural and anthropogenic factors.

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أصل ونوعية المياه الجوفية ضمن خزان الدبدبة في منطقة جبل سنام جنوب البصرة، العراق

مهند كاظم التميمي

مركز علوم البحار، جامعة البصرة، البصرة، العراق

المستخلص - تهدف هذه الدراسة إلى تقييم نوعية المياه الجوفية وتحديد اصل تكوينها في خزان الدبدبة (منطقة جبل سنام) جنوب البصرة. اختير عشرين بئرا في منطقة الدراسة لجمع عينات المياه واجريت عليها التحليل الفيزيائية والكيميائية والتي شملت الايونات الموجبة الرئيسية (الصوديوم، البوتاسيوم، الكالسيوم، المغنيسيوم)، والأيونات السالبة الرئيسية (الكلور، الكبريات، والبيكربونات) والعناصر النزرة (الزنك، الكادميوم، النيكل ،الرصاص) إلى جانب القياسات العامة (درجة الحموضة، التوصيلية، الاملاح الذائبة الكلية، العسرة الكلية). رسمت خرائط للنتائج باستخدام نظم المعلومات الجغرافية (GIS 10.2.2-based a Co-kriging) لتحديد نوعية المياه الجوفية في المنطقة وصلاحيتها للري. أظهرت النتائج ان النوع السائد للمياه الجوفية في منطقة الدراسة هو (صوديوم > كالسيوم > مغنيسيوم) من عائلة الصوديوم ضمن مجموعة الكلوريد. كذلك جرى التحري عن اصل المياه الجوفية وباستخدام مخطط سولن والرسم البياني وجد ان مياه الآبار المدروسة ذات أصل قاري قديم.